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THERMODYNAMIC CHARACTERIZATION OF MULTICOMPONENT MIXTURES OF ESTERS AND ALCOHOLS AT ATMOSPHERIC AND ELEVATED TEMPERATURES AND PRESSURES

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TERMODINAMIČKA KARAKTERIZACIJA VIŠEKOMPONENTNIH SMEŠA ESTARA I ALKOHOLA NA ATMOSFERSKIM I USLOVIMA POVIŠENIH TEMPERATURA I PRITISAKA

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Thermodynamic characterization of multicomponent mixtures of esters and alcohols at atmospheric and elevated temperatures and pressures

ABSTRACT

Biofuels have attracted considerable attention for current and future utilization because of their benefits as promising alternative, ecological and economical viable fuels, with particular reference to biodiesel and alcohols. In order to use biodiesel in diesel engines, the volumetric and transport properties of the fuel (i.e. density and viscosity) must be improved since they affect spray properties, atomization and combustion processes of a fuel. In addition, the derived thermodynamic magnitudes, such as isothermal coefficient and isobaric thermal expansion coefficient, greatly influence the atomization process and, consequently, the fuel consumption of diesel engines. Therefore, knowledge of these properties at different pressures and temperatures is important in order to predict and improve the performance of diesel engines. Densities, viscosities, sound velocities and refractive indices of pure components: 1-butanol, 1-propanol, ethyl laurate, ethyl linoleate, ethyl myristate, ethyl oleate, methyl laurate and *n*-hexadecane were measured at temperatures T= (293.15 to 343.15) K and atmospheric pressure. The measured values were compared to several available literature data, and good agreement was noticed: an overall absolute average percentage deviation (*AAD*) of 0.04%, 0.07%, 3 % and 0.1% for density, speed of sound, viscosity and refractive index data, respectively.

Besides that, densities, viscosities, speeds of sound and refractive indices of ternary mixture ethyl oleate + *n*-hexadecane + 1-butanol (3), and for the corresponding binary mixtures: ethyl laurate + 1-propanol, ethyl oleate + 1-butanol, ethyl oleate + 1-propanol, ethyl oleate + *n*-hexadecane, *n*-hexadecane + 1-butanol and *n*-hexadecane + 1-propanol were measured in the temperature range T= (293.15 to 343.15) K at atmospheric pressure. The measurements were performed on an Anton Paar DSA 5000 M density and sound velocity meter, Anton Paar SVM 3000 digital viscometer, and Anton Paar RXA 156 refractometer. From the experimental data, a number of thermodynamic parameters were also calculated, namely, excess molar volumes (V^E), viscosity deviation functions ($\Delta\eta$), deviations in refractive index (Δn_D), excess molar Gibbs energy of activation of viscous flow (ΔG^{*E}) and deviation in isentropic compressibility ($\Delta\kappa_s$). The binary and ternary properties are then correlated as a function of the mole fraction by using the Redlich–Kister and Nagata and Tamura equations, respectively, and then used to analyze molecular interactions present in the mixtures.

The densities of all studied components, except *n*-hexadecane, were measured in the temperature range T= (293.15 to 413.15) K (along 15 isotherms) and at pressures up to 60 MPa by means of Anton Paar DMA HP densimeter. Deviation of the experimental data from literature data selected for comparison, in the studied ranges of temperature and pressure was around 0.05 % for studied components. The obtained densities were correlated using the modified Tammann-Tait equation with an *AADs* between measured and calculated values lower than 0.05% for all studied esters. Further, that enabled calculation of the derived thermodynamic properties, such as the isothermal compressibility, the isobaric thermal expansivity, the internal pressure and the difference between the specific heat capacity at constant pressure and at constant volume.

Viscosity modeling for pure components was carried out by means of the Vogel-Fulcher-Tammann (VFT) equation. Viscosities of four binary systems were modeled applying two approaches: group contribution models UNIFAC-VISCO and ASOG-VISCO, and correlative one to three-parameter models (Teja-Rice, McAllister-3 and McAllister-4).

Keywords: experimental measurements, viscosity, density, refractive index, ester, alcohol, excess thermodynamic properties, molecular interactions, viscosity modeling.

Termodinamička karakterizacija višekomponentnih smeša estara i alkohola na atmosferskim i uslovima povišenih temperatura i pritisaka

IZVOD

Biogoriva su privukla značajnu pažnju, kako za trenutnu, tako i za buduću upotrebu zahvaljujući svojim prednostima kao obećavajućim alternativnim, ekološkim i ekonomičnim gorivima, a posebno se ističu biodizel i bioalkoholi. Da bi se biodizel koristio u dizel motorima moraju mu se poboljšati volumetrijska i transportna svojstva (tj. gustina i viskoznost), jer utiču na raspršivanje, atomizaciju i sagorevanje goriva. Pored toga, izvedene termodinamičke veličine, kao što su izotermska stišljivost i izobarni koeficijent termičkog širenja, značajno utiču na proces atomizacije, a samim tim i na potrošnju goriva u dizel motorima. Stoga je poznavanje ovih svojstava pod različitim pritiscima i temperaturama važno kako bi se predvideo i poboljšao rad dizel motora. Gustine, viskoznosti, brzine zvuka i indeksi refrakcije čistih komponenti: 1-butanola, 1-propanola, *n*-heksadekana, etil oleaat, etil linoleata, etil laurata, etil miristata i metil laurata su mereni na temperaturama T = (293,15 do 343,15) K pri atmosferskom pritisku. Izmerena vrednosti su poređene sa nekoliko dostupnih literaturnih podataka, I primećeno je dobro slaganje, ukupno prosečno pocentualno odstupanje (AAD) je bilo oko 0,04%, 0,07%, 3% i 0,1%, redom za gustine, brzine zvuka, viskoznosti i indekse refrakcije.

Pored toga, merene su i gustine, viskoznosti, brzine zvuka i indeksi refrakcije ternerne smeše etil oleat + *n*-heksadekan + 1-butanol , i odgovarajućih binarnih smeša etil oleat + 1-butanol, etil oleat + 1-propanol, etil oleat + *n*-heksadekan, etil laure + 1-propanol, *n*-heksadekan + 1-butanol i *n*-heksadekan + 1-propanol u temperaturnom opsegu T = (293,15 do 343,15) K sna atmosferskom pritisku. Merenja su izvršena na Anton Paar DSA 5000 M uređaju za merenje gustine i brzine zvuka, Anton Paar SVM 3000 digitalnom viskozimetru i Anton Paar RKSA 156 refraktometru. Iz eksperimentalnih podataka su, takođe, izračunai I brojni termodinamički paramtetri, kao na pr. Dopunska molarna zapremina (V^E), odstupanje viskoznosti ($\Delta\eta$), odstupanje indeksa refrakcije (Δn_D), dopunska molarna Gibsova energija aktivacije viskoznog toka (ΔG^{*E}) i višak izentropske kompresibilnosti ($\Delta\kappa_s$). Binarna i ternarna svojstva su nakon toga korelisana u zavisnosti od molekulskih sastava primenom Redlih-Kister i Nagata i Tamura jednačina, redom, a potom su korištena za analizu molekulskih interakcija unutar smeša.

Gustine ispitivanih komponenti, osim *n*-heksadekana, merene su u temperaturnom opsegu T = (293,15 do 413,15) K (duž 15 izotermi) i pri pritiscima do 60 MPa korišćenjem densimetra Anton

Paar DMA HP. Odstupanje izmerenih vrednosti od literaturnih podataka izabranih za poređenje, u rasponu proučavanih temperatura i pritiska, je bilo oko 0,05% za proučavane komponenti. Izmerene gustine su korelirane primenom modifikovane Taman-Tejtove jednačine sa AAD nižim od 0,05% za sve proučavane komponenti. To je, dalje, omogućilo računanje termodinamičkih svojstva, kao što su izotermska stišljivost, koeficijent izobarskog oplotog širenja, unutrašnji pritisak i razlika između specifičnog toplotnog kapaciteta pri konstantnom pritisku i konstantnoj zapremini.

Modelovanje viskoziteta čistih komponenti vršeno je pomoću jednačine Vogel -Fulcher-Tammann (VFT). Viskoznosti četiri binarna sistema su modelovane primenom dva pristupa, modela doprinosa grupa UNIFAC-VISCO i ASOG-VISCO, i korelativnim modelima sa od jednog do tri parametra (Teja -Rice, McAllister-3 i McAllister-4).

Ključne reči: eksperimentalna merenja, viskoznost, gustina, indeks refrakcije, estar, alkohol, dopunske termodinamičke veličine, molekulske interakcije, modelovanje viskoznosti.

Nomenclatures

ν	specific volume ($m^3 \cdot kg$)
m	mass (kg)
V	volume (m^3)
m_{tot}	total mass of an ideal solution (kg)
V_{tot}	total volume of an ideal solution (m^3)
m_i	mass of the component i (kg)
V_i	the molar volume of the components ($m^3 \cdot mol^{-1}$)
k	number of components in the solution
γ	specific weight (dimensionless)
ρ_{ref}	refrence density ($kg \cdot m^{-3}$)
k_T	coefficient of isothermal compressibility (GPa^{-1})
α_p	isobaric thermal expansivity (K^{-1})
β	isentropic bulk modulus (MPa)
ρ	density ($kg \cdot m^{-3}$)
u	speed of sound ($m \cdot s^{-1}$)
L_f	the intermolecular free length (m)
K_j	temperature dependent Jacobson's constant
T	absolute temperature (K)
F	Force (N)
A	Area (m^2)
τ_{yx}	shear stress (Pa)
$d\omega_x/dy$	gradient velocity (s^{-1})
η	dynamic viscosity(mPa·s)
n_D	refractive index(dimensionless)
ε_r	relative (dielectric) permittivity of the medium
μ_r	relative (magnetic) permeability of the medium
V^E	excess molar volume ($m^3 \cdot mol^{-1}$)
M	molar mass ($kg \cdot mol^{-1}$)
x	corresponding mole fraction
$\Delta\eta$	viscosity deviation (mPa·s)
η_i	viscosity of pure component *i* (mPa·s)
Δn_D	refractive index deviation (dimensionless)
n_D	refractive index of mixture
$n_{D,i}$	refractive index of pure component *i*
ΔG^{*E}	excess free energies of activation of viscous flow ($J \cdot mol^{-1}$)
R	gas constant (8.314 $J \cdot K^{-1} \cdot mol^{-1}$)
κ_S	isentropic compressibility of mixture (Pa^{-1})
$\Delta\kappa_S$	deviation in isentropic compressibility (Pa^{-1})
$\Delta\kappa_{S,i}$	isentropic compressibility of pure component *i* (Pa^{-1})
ϕ_i	volume fraction of *i*-th component
ρ^{ref}	denotes density of the sample at reference pressure (0.1MPa)
γ	thermal pressure coefficient (dimensionless)
p_{int}	internal pressure (MPa)
U	internal energy (J)
c_p	specific heat capacity at constant pressure ($J \cdot Mole^{-1} \cdot K^{-1}$)
c_v	specific heat capacity at constant volume ($J \cdot Mole^{-1} \cdot K^{-1}$)

ΔY_{123}	excess property of ternary mixture i.e. V^E, $\Delta\eta$, Δn_D and $\Delta\kappa_s$
Y_{12}, Y_{23}, and Y_{13}	contribution of binary mixtures *ij* to the ternary system
Δ_{123}	ternary contribution
$B_0, B_1, \ldots, B_8$	adjustable parameters of the ternary contribution
A_p	fitting parameters
k	number of parameters
m	number of experimental data points
$(\Delta^* G^{EC}/RT)$	combinatorial part of excess Gibbs free energy
$(\Delta^* G^{ER}/RT)$	residual part of excess Gibbs free energy
$V^E_{0.5}$	excess molar volume at equimolar composition
η_m	viscosity of mixture
PD_{max}	maximum percentage deviations
α_{nm}	interactions of the functional groups within the mixture in the UNIFAC-VISCO model
(m_{kl} and n_{kl})	interactions of the functional groups within the mixture in the ASOG-VISCO model
$R1$ and $R2$	reference fluid
ω	acentric factor
ε_m	mixture parameter in the Teja-Rice model
ψ_{ij}	interaction parameter in the Teja-Rice model
v_{12} and v_{22}	binary interaction parameters in the McAllister-3 model
v_{1112}, v_{1122} and v_{2221}	binary interaction parameters in the McAllister-4 model

Subscripts/ Superscripts

1, 2, and 3	components of binary and ternary mixture
i	*i* th component of the mixture
E	excess
s	isentropic
cal	calculated value
exp	experimental value
i, j	component *i*, *j*
max	maximum value
m	mixture

Acronyms

AAD	absolute average deviation
rmsd	root mean square deviation
OF	objective function

Table of Contents

1 Introduction

Over the past decades, a lot of effort has been devoted to reduce the dependence on petroleum-based fuels for power generation and transportation throughout the world. The main reasons for this are the increase in prices of petroleum fuels, stringent emission norms and rapidly dwindling worldwide petroleum reserves[1-6]. The major consumers of energy are the industrial and the transport sectors, with assumed common share of about 70% in the total growth of worldwide consumption of petroleum and related liquid fuels in the period 2010 to 2040[7]. The energy consumption of the transport sector increased year by year from 1986 to 2017, an average consumption of diesel fuel had increased by 2.46 times from 1.5 million barrels per day in 1986 to more than 51 million barrels per day in 2017. In 2017, almost 14 million barrels of petroleum fuels as a whole were consumed[8]. Globally, an average consumption of energy in the transport sector rises by 1.1% per year as a response to the development of motor industry. It is very important to mention that transportation is one of the major contributors of greenhouse gases emissions which have a great effect on the oxidation−reduction capacity of the atmosphere, such as carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides (NOx), and volatile organic compounds (VOCs), as well as aerosols and increase of particulate matter (PM) concentration[9]. The International Energy Agency(IEA) expects not only that greenhouse gas emissions from transport sector will be increased by 92% between 1990 and 2020 but also that 8.6 billion metric tons carbon dioxide will be released to the air from 2020 to 2035[10]. These predictions have challenged researchers to study the performance of diesel engine aiming to meet the future rigorous emission standards. Therefore, the research projects have generally been focused on some of promising engine technologies, e.g. advanced fuel injection system, combustion process and a new exhaust gas treatment system[11, 12]. Despite high level of achievements, further reduction of engine emissions and fuel consumption are the most significant demands imposed on engines and these requirements have been increasingly stringent every year[5, 11]. Due to these growing concerns, many researchers have focused on exploring different sources of renewable energy for partial or total replacement of fossil fuels for automobiles[11]. Consequently, the production and use of biofuels have drawn a considerable attention, especially the biodiesel and bioalcohols, in order to reduce the global exhaust emissions without significant modifications in diesel engines design[13]. They have gained a great deal of attention in recent years not only because they are produced in an ecologically sustainable way, but also because they are highly oxygenated fuels, and, therefore, a strong contenders for reductions in environmental pollution[11, 14].

Biodiesel consists of long-chain alkyl (methyl or ethyl) esters produced by transesterification of vegetable oils or other feedstocks, largely composed of triacylglycerols, with short-chain alcohol, such as methanol or ethanol, in the presence of a catalyst[11, 15, 16].Unlike diesel fuel, biodiesel consists of a limited number of components which enables the study of the properties of each individual component and the prediction of the thermophysical properties of biodiesels as a function of their fatty acid profile[11, 17]. Fuel injection and combustion take place at moderate temperatures and high pressures and are strongly influenced by the volumetric and transport properties of the fuel, especially density and viscosity. In order to use biodiesel in diesel engines, these properties must be improved since they affect spray properties, atomization and combustion processes of a fuel[14, 18-20]. In addition, the derived thermodynamic magnitudes, such as isothermal coefficient and isobaric thermal expansion coefficient, greatly influence the atomization process and, consequently, the fuel consumption of diesel engines[21-23]. Therefore, knowledge of these properties at different pressures and temperatures is important in order to predict and improve the performance of diesel engines.

Density data of pure biodiesel have been mostly measured at atmospheric pressure[24, 25], and only in the last decade data on densities of pure biodiesel at high pressures have been published[21, 22, 26-30]. The impact of various substitutes for fossil diesel fuels, especially biodiesel and alcohols, on the operation and design of diesel engines, has been studied[31-35]. Blending biodiesel with alcohols of lower viscosity is one of the methods which on one side increase the biofuels content in mixture, and on the other side maintaining the properties within prescribed limits for the commercial diesel [13, 19, 36, 37]. This allows the diesel engine to use biodiesel without any further modification. Such investigations about addition of certain alcohols into biodiesel-diesel blends can be found in the literature [38, 39].

Recent researches have shown that the alcohols with a high-carbon structure like *n*-propanol (three carbons) and *n*-butanol (four carbons) are appropriate fuel additives to improve the biodiesel properties due to several advantages like higher cetane number, lower heat of vaporization, higher heating value and better miscibility with biodiesel-diesel blends[40-43]. However, the properties of the blends are directly influenced by the operating conditions as well as by the composition of biofuels. Therefore, the knowledge of the fundamental thermodynamic properties of biodiesel blends and their dependence on temperature and pressure is of the greatest importance[13].

Density measurements of 1-butanol at pressures up to 140 MPa along isotherms ranging from (263.15-468.15) K were previously conducted[44]. Alaoui et al. [45] determined density of 1-butanol at pressure up 140 MPa at the temperature range (293.15-403.15) K. Davila and co-authors [46] reported densities of 1-butanol and 1-propanol at pressure up to 60 MPa within temperature range (278.15-358.15) K. Also, Abdulagatov et al.[47] examined density of 1-propanol at pressure up to 40 MPa within temperature range (298.15-423.15) K. Ndiaye et al. [27, 28]examined the acoustic and thermodynamic properties of methyl myristate, ethyl myristate, and methyl palmitate at temperatures (293.15-403.15) K and pressures up to 100 MPa, of methyl oleate and methyl linoleate in the temperature range (283.15-393.15) K and pressures up to 200 MPa, and the mentined properties of methyl caprate and ethyl caprate at temperatures (283.15-403.15) K and pressures up to 210 MPa. Tat and Van Gerpen [48] studied speeds of sound and densities of methyl laurate at pressures up to 34.5 MPa along isotherm ranging from (293.15-373.15) K. Moreover, Pratas et al [26] reported measurements for methyl laurate, methyl myristate and methyl oleate at pressures up to 45 MPa. Schedemann [29] reported densities of methyl linoleate at temperatures between (278-367) K and pressures between (0.4-130) MPa, while Dzida et al.[30, 49] determined densities of ethyl caprylate, ethyl caprate, ethyl myristate, as well as ethyl laurate from speed of sound measurements at pressures up to 100 MPa within the temperature limits (293.15-318.15) K. Recently, Zarska et al.[50] reported densities of methyl caprylate, methyl caprate, and methyl myristate and methyl laurate from speed of sound measurements at a narrower temperature range (293.15-318.15) K and at pressures up to 100 MPa. In the case of binary systems, volumetric and ultrasonic behaviors of binary liquid mixtures of 1-butanol with n-hexadecane have been examined by a few authors[51-53]. Molecular interactions for the ethyl oleate + 1-butanol has been spectroscopicly investigated[54], as well as the thermo-physical properties of similar binary systems, such as, *n*-hexadecane + 1-octanol[55] and *n*-hexadecane + 2-propanol[56].

Due to the apparent lack of data on the thermodynamic and transport properties of pure components of biodiesel, as well as their mixtures with diesel fuel and alcohols, attention was paid to these components within this doctoral dissertation. The aim of this thesis is to report experimental data on densities, speeds of sound viscosities and refractive indices of 1-butanol, 1-propanol, ethyl laurate, ethyl linoleate, ethyl myristate, ethyl oleate, methyl laurate and *n*-hexadecane at temperatures from (293.15-343.15) K and atmospheric pressure. Besides pure components, the above-mentioned properties for the corresponding binary mixtures: ethyl laurate + 1-propanol, ethyl oleate + 1-butanol, ethyl oleate + 1-propanol, ethyl oleate + *n*-hexadecane, *n*-hexadecane + 1-butanol, *n*-hexadecane + 1-propanol and for ternary mixture ethyl oleate + *n*-hexadecane + 1-butanol are measured in the temperature range 293.15 to 343.15) K and at atmospheric pressure. From the experimental data , a number of thermodynamic parameters is also calculated, namely, excess molar volumes (V^E), viscosity deviation functions ($\Delta\eta$), deviations in refractive index (Δn_D), excess molar Gibbs energy of activation of viscous flow (ΔG^{*E}) and deviation in isentropic compressibility ($\Delta\kappa_s$). The properties of binary and ternary mixtures are then correlated as a function of the mole fraction by using the Redlich–Kister [57] and Nagata [58] and Tamura equations, respectively, and used afterwards to get better insight into molecular interactions existing in the mixtures.

Also, for the pure components, except *n*-hexadecane, densities are reported in the temperature range (293.15-413.15) K and at pressures up to 60 MPa. After that, the measured data are correlated by the modified Tammann-Tait equation, an empirical model that is commonly used in correlating densities at high pressures[59-62]. Based on the obtained parameters, the values of derived thermodynamic properties, such as isothermal compressibility (κ_T), isobaric thermal expansivity (α_p) and the internal pressure (p_{int}) over wide ranges of pressure and temperature, were calculated. From the aforementioned data, it is also possible to determine the difference between the isobaric and isochoric specific heat capacity, $c_p - c_v$, which enables the calculation of the specific heat capacity at a constant volume, c_v, if the one at constant pressure, c_p, is measured or derived from the speed of sound values.

Viscosity modeling for pure components was carried out by means of the Vogel-Fulcher-Tammann (VFT) equation. Viscosities of for binary mixtures were modeled applying two approaches: group contribution models UNIFAC-VISCO [62, 63] and ASOG-VISCO [63], and correlative one to three-parameter models (Teja-Rice [64, 65], McAllister-3 [66] and McAllister-4 [66]).

1.1 Dissertation Structure

The theoretical part of the doctoral dissertation will introduce some basic definitions and relationships in thermodynamics. It also provides a summary of the fundamental concepts that are needed to understand the thermodynamic and excess thermodynamic properties, correlation of high pressure densities and excess properties correlations.

At experimental part, there will be given an overview of the choice of systems used in the analysis, the description of the apparatus at which the experimental measurements were made, as well as the description of the treatment of the experimental materials for pure compounds and their binary and ternary mixtures. The features of apparatuses were examined as means of obtaining reliable experimental data, which have been shown to be valid.

Inside results of experimental chapter, complete results will be provided with the examination of the temperature, pressure and structure of the selected esters or alcohols on the behavior of multicomponent systems. Subsequently, a comparison of the properties of the examined mixtures of fossil fuels will be made in order to evaluate the possibility of their use as an alternative fuel.

In the modeling chapter, the obtained results will comprise the calculation and analysis of other volumetric properties of the selected mixtures. Experimentally determined viscosities were correlated using Vogel-Fulcher-Tammann (VFT) equation, and the densities and viscosities of the mentioned binary mixtures, measured at atmospheric pressure, were used to evaluate the performance of two predictive and three correlative models. Experimental high pressure densities were correlated using the modified Tait-Tammann equation and the derived thermodynamic properties such as isothermal compressibilities and isobaric expansion coefficients were calculated and evaluated, on the studied temperature and pressure ranges.

Based on the performed analysis, the conclusion chapter will summarize all the obtained results of the performed research. The quoted statements, as well as the works that were made during the research and work on this doctoral dissertation, will be found in the reference section

2 Theoretical Part

The purpose of the present chapter is to introduce some basic definitions and relationships in thermodynamics**.** Moreover, it also provides a summary of the fundamental concepts that are needed to understand the thermodynamic and excess thermodynamic properties, density at high pressures correlation and excess properties correlations

2.1 Thermodynamic Properties

Knowledge and understanding of relevant thermophysical properties of a system are required for a suitable design of the corresponding process or operation unit. The influence of temperature on these properties responds to different patterns, and must be taken into account in process design. If working with mixtures, a further influence to be analyzed is that of composition. In both cases, the development of simple correlations for the continuous description of discrete experimental values with small number of adjustable parameters is of high interest. In addition, a deeper insight on the interactions occurring in the system at a molecular level can be obtained. Ideally, an expression for prediction (with sufficient accuracy) of the properties of a mixture from properties of its pure components would be preferred, but this is only possible in a limited number of occasions.

2.1.1 Density

Density is one of the major physical properties and provides valuable and practical information on the behavior of pure liquids or mixtures for the understanding of the molecular interactions. Moreover, precise values of density, as a function of temperature, T, and pressure, p are not only necessary for many industrial applications, such as the design of several industrial processes including storage, transport and separation and mixing processes or optimization of operating conditions, but also to determine other physical properties such as solubility and viscosity. Density values are fundamental data for developing and testing models based on the experimental PVT data. Several important properties can be determined from density data. One of them is the isothermal compressibility κ_T, (inverse of the bulk modulus) and another is isobaric expansion, α_p, both functions of temperature, pressure and molecular structure. Knowledge of these properties is an essential for internal combustion engines which directly affects the engine performance characteristics. Density is also associated with the properties like cetane index and heating value. The performance of fuel atomization and combustion characteristics are influenced by its density. The fuel density variance will influence the output power of the engine because of altered mass of the injected fuel. Broadly speaking, a higher density of fuel leads to inferior spray and atomization [67].

The density (ρ) can be expressed as the ratio of mass and volume [68]:

$$\rho = \frac{m}{V} \tag{2.1}$$

Specific volume (ν)is the reciprocal value of the density [68]:

$$\nu = \frac{1}{\rho} = \frac{V}{m} \tag{2.2}$$

Generally, the density is usually based on pressure, temperature and characteristics of the substance. However, for substances in solid and liquid phase, the density does not change significantly over a wide temperature and pressure ranges. Also, the density usually decreases as the temperature rises, but, in some cases, it could increases with increasing of temperature.

Thus, for example, the density of water increases with increasing the temperature from 0 to 3.98 °C, and then began to decrease with further increase of temperature up to the boiling point. Densities of many pure substances can be found in the standard reference data banks [69]. For the ideal gas and liquid solution with the similar components, almost the same attractive or repulsive forces are present. In that case the density of the solution could be calculated as [68]:

$$\rho_r = \frac{m_{tot}}{V_{tot}} = \frac{\sum_{i=1}^{k} m_i}{\sum_{i=1}^{k} V_i} \tag{2.3}$$

where:

m_{tot} - total mass of an ideal solution.

V_{tot} - total volume of an ideal solution.

m_i - mass of the component *i*.

V_i - the molar volume of the components.

k- number of components in the solution.

However, in many cases, the conditions for an ideal solution cannot be applied and then the volume of solution must be measured or predicted using empirical models [68].

Specific weight (γ) of a substance represents the ratio of the density of that substance (ρ) and the density of the reference substances in certain circumstances:

$$\gamma = \frac{\rho}{\rho_{ref}} \tag{2.4}$$

For solids and liquids the reference substance is usually water at 4 ° C $\rho_{ref} = 1000$ kg/m^3 [68].

In the case of ideal solution it could be assumed that the constituents are molecules with the same size and the same attractive or repulsive interactions.

2.1.2 Speed of sound

The speed of sound is also an essential property in chemistry and physics that is commonly employed in the development of an equation of state which describes the liquid. Furuther, it can be employed to obtain several thermophysical properties, such as the reduced isobaric thermal expansion coefficient, isentropic and isothermal compressibility, bulk modulus, thermal pressure coefficient, isobaric and isochoric heat capacities [70]. Speed of sound is related to diesel engine start-up. A higher speed of sound and isentropic bulk modulus of biodisel results in a quicker fuel pressure rise from the fuel pump towards the injectors which leads to earlier injection timing and, consequently, to a higher NO_x emission[11, 48, 71, 72].

The isentropic bulk modulus (β), can be obtained at each temperature level using the following equation:

$$\beta = \rho u^2 \tag{2.5}$$

where u is speed of sound and ρ refers to the density of a sample.

The knowledge of the isentropic bulk modulus enables calculation of the intermolecular free length:

$$L_f = K_j \cdot \sqrt{\kappa_S} = \frac{K_j}{\sqrt{\beta_S}} \tag{2.6}$$

where K_j denotes temperature dependent Jacobson's constant[72-74].

Jacobson [73] gave values of the constant at a few temperatures in the range 273.15-323.15 K that were correlated and its dependence on temperature is presented as [75]:

$$K_j = (93.875 + 0.375 \cdot T) \cdot 10^{-8} \tag{2.7}$$

2.1.3 Viscosity

Viscosity, also a vital fuel property, describes the resistance of a fluid to shear stress, which is directly related to the operation of fuel injection system.

$$\tau = \frac{F}{A} \tag{2.8}$$

Experiments have shown that speed of the fluid layer in direct contact with the boundary is identical to the speed of this boundary. Between particles or layers that move at different speeds, internal friction forces resist the movement of fluid. This tangential force of friction relative to the surface area, in accordance with Newton's viscosity law, is proportional to the gradient of velocity in the direction of motion, where the proportionality coefficient, which depends on the nature of the fluid and its temperature, is called dynamic viscosity η (Pa·s) [76]. Dynamic viscosity is represented by equation 2.12:

$$\tau_{yx} = \eta\left(\frac{\partial \omega_x}{\partial y}\right) \quad (2.9)$$

where: τ_{yx} - shear stress, $(d\omega_x/dy)$ - gradient velocity, η - dynamic viscosity.

Viscosity is a thermodynamic variable that varies as a function of pressure and temperature. Generally speaking the viscosity of a liquid increases weakly with pressure [77]. Temperature can greatly effect on the value of fluid’s viscosity where the viscosity declines with the increase in temperature, because of the increased spacing between molecules. In gasses, viscosity raises with temperature, owing to the increased interaction between gas molecules.

Dynamic viscosity is numerically equal to the force of friction (shear stress) per unit area of the two layers of fluid in the touch moving over one another, under the conditions that the unit of length relative to the shear of the shear rate changes for the unit. All real fluids are characterized by viscosity. In general, η is not a constant and fluids are classified as Newtonian and non-Newtonian depending on whether it is observed as a constant or not. The viscosity of the liquid with raising temperature declines and does not depend on the pressure. It increases with raising pressure and temperature in the case of gases. Viscosity of ideal gas does not depend on the pressure.

According to the European Pharmacopoeia [78], viscosities can be represented in two different forms: dynamic viscosity or kinematic viscosity. Dynamic viscosity is the tangential force per unit area involved to move one horizontal plane with respect to the other at unit velocity when maintained a unit distance apart by the fluid. Kinematic viscosity is the ratio between the dynamic viscosity and the density. The unit of dynamic viscosity (which is described in this thesis) is the millipascal·second (mPa·s) while the kinematic viscosity unit is $m^2 \cdot s^{-1}$. The kinematic viscosity is often used in hydrodynamic and heat transfer equations. The kinematic viscosity of the liquid decreases with rising temperature as the dynamic viscosity does, since the density does not change notably with the temperature. In gases, the density with increasing temperature decreases noticeably, and with rising temperature, kinematic viscosity increases quickly [76].

2.1.4 Refractive Index

The refractive index is a fundamental physical quantity for materials that describes how fast light propagates through the material. So it can be defined as the ratio of the speed of a wave either light or sound in vacuum to the phase speed in the medium. The refractive index depends on the wavelength of light, which is experimentally expressed as a spectrum. Since the speed of light (electromagnetic waves) is related to the electrical and magnetic properties of the medium, the refractive index can be expressed by the following relation:

$$n_D = \sqrt{\varepsilon_r \mu_r} \tag{2.10}$$

Where n_D is the refractive index, ε_r is the relative (dielectric) permittivity of the medium and μ_r is the relative (magnetic) permeability of the medium. For non-magnetic materials μ_r is very close to the unity so the refractive index n_D is approximately equal to $\sqrt{\varepsilon_r}$.

2.2 Excess Thermodynamic Properties

2.2.1 Excess molar volume

Excess molar volumes (V^E) were calculated from the experiemental density values as follows:

$$V^E = \sum_{i=1}^{N} \frac{x_i M_i}{\rho} - \sum_{i=1}^{n} \frac{x_i M_i}{\rho_i} \tag{2.11}$$

In which ρ is the density of mixture, x_i *and* M_i represent the mole fraction of one compound in a mixture and its molar mass, respectively, and ρ_i is the density of pure component *i*.

2.2.2 Viscosity deviations

The deviations in the viscosity, $\Delta\eta$, were determined from the viscosity of the pure component *i* (η_i) and the mixture (η), using Eq.2.12:

$$\Delta\eta = \eta - \sum_{i=1}^{N} x_i \eta_i \tag{2.12}$$

2.2.3 Refractive index deviations

The refractive index deviations were determined based on the experimental refractive index data of the mixture and its pure components.

$$\Delta n_D = n_D - \sum_{i=1}^{N} x_i n_{D,i} \tag{2.13}$$

In which n_D and $n_{D,i}$ refer to the refractive index of the mixture and the pure component *i*, respectively.

2.2.4 Excess molar Gibbs energy of activation of viscous flow

Another excess property used in the analysis of the molecular interactions present in the mixtures is the molar Gibbs activation energy of the viscous flow ΔG^{*E} [79]. Since both density (molar volume) and the viscosity are calculated in the calculation of this excess property, it is considered more convenient for interpreting the interactions of the change in the viscosity of the mixing. The excess molar Gibbs energy of the viscous flow ΔG^{*E} for binary mixtures is obtained using the following equation:

$$\Delta G^{*E} = RT[(\ln \eta V / \eta_2 V_2) - x_1 \ln(\eta_1 V_1 / \eta_2 V_2)] \tag{2.14}$$

2.2.5 The deviation in isentropic compressibility

Another thermodynamic property which is influenced by the interactions between the molecules in the liquid mixture is called the isentropic compressibility (κ_s). It can be computed directly from the measured values of density and speed of sound as follows:

$$\kappa_s = \frac{1}{\rho u^2} \tag{2.15}$$

The deviation in isentropic compressibility, $\Delta\kappa_s$, is obtained from the following equation:

$$\Delta\kappa_s = \kappa_s - \sum_{i=1}^{N} \kappa_{s,i}\phi_i \tag{2.16}$$

In the above given equation, ϕ is the volume fraction of *i*-th component:

$$\phi_i = \frac{x_i V_i}{\sum_{i=1}^{N} x_i V_i} \tag{2.17}$$

In which N is the number of components in a mixture, and V_i represents the molar volume of pure component *i*.

2.3 Correlations of excess properties

The influence of the composition on the physical properties is typically studied by the analysis of their excess and deviation properties rather than directly on the physical properties. If the excess and deviation properties can be adequately correlated by any mathematical equation, the physical properties will be automatically correlated by means of the defining equations of excess and deviation properties. One of the most commonly used equations for correlation of excess and deviation properties is the polynomial expansion proposed by Redlich and Kister [57]. This is an empirical algebraic expansion, fairly straightforward because it consists of polynomial terms of the molar fractions. For a binary system, the Redlich-Kister polynomial adopts the following form:

$$Y^E(\text{or}\,\Delta Y) = x_i x_j \sum_{p=0}^{k} A_p (x_i - x_j)^p \tag{2.18}$$

where $Y^E(\text{or}\,\Delta Y)$ represents V_{ij}^E , $\Delta\eta_{ij}$, Δn_{Dij} , ΔG^{*E}_{ij} or $\Delta\kappa_{s,ij}$;A_p are fitting parameters of the related property and (k + 1) is the number of parameters determined using the F-test, and mole fractions of the i and j components are taken based on the composition of the ternary system.

The experimental values of excess molar volumes (V^E_{123}), viscosity deviations ($\Delta\eta_{123}$), and refractive index deviations (Δn_{D123}) of the ternary system were correlated with the Nagata−Tamura (NT) equations [58]:

$$\begin{aligned} Y_{123}^E &= Y_{12}^E + Y_{13}^E + Y_{23}^E + \\ &+ x_1 x_2 x_3 RT(B_0 - B_1 x_1 - B_2 x_2 - B_3 x_1^2 - B_4 x_2^2 - B_5 x_1 x_2 - B_6 x_1^3 - B_7 x_2^3 - B_8 x_1^2 x_2) \end{aligned} \tag{2.19}$$

where Y_{123}^E represents the excess molar volumes (V^E_{123}), viscosity deviations ($\Delta\eta_{123}$), and refractive index deviations (Δn_{D123})of the ternary system, Y_{12}^E , Y_{13}^E , Y_{23}^E are known as binary contributions, calculated for corresponding binary mixtures using eq. 2.18 and A_p binary fitting parameters, but where mole fractions of i and j components are taken based on the composition of the ternary system; and B0, B1,..., B8 are adjustable parameters. The final part of eqs. (2.19) is the ternary contribution to the total value of the related property.

2.4 High Pressure Density Correlation

To make the present results immediately usable for engineering and design purposes[11], the modified Tammann-Tait [80] equation was applied to correlate the experimental high pressure density data and also to enable calculation of various derived properties. It is one of the simplest empirical equations widely used [26, 81-83] as a method to correlate liquid density data over a broad pressure and temperature ranges:

$$\rho(T,p) = \frac{\rho^{ref}(T,p)}{1 - C\cdot\ln\left(\dfrac{B(\mathrm{T}) + p}{B(\mathrm{T}) + p^{ref}}\right)} \tag{2.20}$$

where ρ^{ref} denotes density of the sample at reference pressure, p^{ref}, and it depends on temperature, as well as $B(T)$, while C is temperature independent parameter. ρ^{ref} and $B(T)$ could be expressed as a function of temperature by considering a second-order polynomial form[11]:

$$\rho^{ref}(T,p)=\sum_{i=0}^{2}a_iT^i \qquad (2.21)$$

$$B(T)=\sum_{i=0}^{2}b_iT^i \qquad (2.22)$$

The adjustable parameters a_i of the Eq. (2.21), as well as the parameters b_i and C of eqs. (2.20) and (2.22) need to be optimized.

2.4.1 Derived Thermodynamic Properties

Very important properties can be derived from measured densities since most of thermophysical properties are linked together by thermodynamic relations[11]. These properties are partial derivatives of the density as a function of pressure or temperature. The physical properties that can be determined from density are, for example, coefficients of isothermal compressibility κ_T and isobaric expansion α_p.

Coefficient of isothermal compressibility κ_T, expresses the influence of pressure on the density at constant temperature [84]:

$$\kappa_T=\frac{1}{\rho}\cdot\left(\frac{\partial\rho}{\partial p}\right)_T \qquad (2.23)$$

For the liquids, coefficient of isothermal compaction has lower value, for example, for the water $\kappa_T = 5\cdot10^{-10}$ Pa^{-1}. For the systems where the gas ratio is much higher, compressibility is also higher, for example, for air at the normal conditions $\kappa_T = 10^{-5}$ Pa^{-1} [84].

For an ideal gas, this coefficient can be expressed as:

$$\kappa_T=\frac{1}{p} \qquad (2.24)$$

Pressure effect on density can be described by the isothermal compressibility, κ_T, which can be expressed from the following equation [11, 85, 86]:

$$\kappa_T=-\frac{1}{V_m}\left(\frac{\partial V_m}{\partial P}\right)_T=\frac{1}{\rho}\left(\frac{\partial\rho}{\partial P}\right)_T=\left(\frac{\partial\ln\rho}{\partial P}\right)_T \qquad (2.25)$$

Isothermal compressibility can be obtained by incorporating equation(2.20) into(2.25) as follows [85]:

$$\kappa_T = \left(\frac{C}{B(T)+p}\right)\left(\frac{\rho(T,p)}{\rho^{ref}(T,p)}\right) \tag{2.26}$$

Isobaric thermal expansivity α_p, expresses the influence of temperature on the density at constant pressure[84].

$$\alpha_p = -\frac{1}{\rho}\cdot\left(\frac{\partial\rho}{\partial T}\right)_p \tag{2.27}$$

When the gases could be considered as an ideal, this coefficient can be expressed as [84]:

$$\alpha_p = \frac{1}{T} \tag{2.28}$$

The effect of temperature on density can be expressed by the isobaric thermal expansivity, α_p, which can be defined as [48, 49]:

$$\alpha_p = -\frac{1}{V_m}\left(\frac{\partial V_m}{\partial T}\right)_P = -\frac{1}{\rho}\left(\frac{\partial\rho}{\partial T}\right)_P = -\left(\frac{\partial \ln\rho}{\partial T}\right)_P \tag{2.29}$$

The following expression is derived from the modified Tait-Tammann Eq. (2.20) and Eq. (2.29)[48]:

$$\alpha_P = -\left[\frac{\rho^{ref\,'}(T,p)}{\rho^{ref}(T,p)}\right] - \frac{C\cdot\dfrac{B'(T)(p^{ref}-p)}{(B(T)+p)(B(\mathrm{T})+p^{ref})}}{\left(1-C\cdot\ln\dfrac{B(T)+p}{B(T)+p^{ref}}\right)} \tag{2.30}$$

where $\rho^{ref\,'}(T, p)$ and $B'(T)$ are derivatives with respect to T of the parameters $\rho^{ref}(T, p)$ and $B(T)$ of Eq. (2.20), respectively:

$$\rho^{ref\,'}(T,p) = \sum_{i=0}^{2} i b_i T^{i-1} \tag{2.31}$$

$$B'(T) = \sum_{i=0}^{2} i b_i T^{i-1} \tag{2.32}$$

The thermal pressure coefficient [83], γ, and the internal pressure, p_{int}, provide a great deal of information about the nature of the liquid state and they can be calculated by the following thermodynamic relationships [11, 86]:

$$\gamma = \frac{\alpha_p}{\kappa_T} \tag{2.33}$$

$$p_{\mathrm{int}} = \left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_\rho - p = T\gamma - p = \frac{T\alpha_P}{\kappa_T} - p \tag{2.34}$$

where *U* refers to an internal energy and *V* is volume of the sample.

Another important parameter for the investigation of the thermodynamic properties of methyl and ethyl esters is the difference between the specific heat capacity at constant pressure, c_p, and the specific heat capacity at constant volume, c_v, and it can be obtained from the following equation [11, 86]:

$$c_p = c_v + T\,\frac{\left(\partial p/\partial T\right)_\rho^2}{\rho^2(\partial p/\partial T)_T} \tag{2.35}$$

Coupling Eqs. (2.25) and (2.29) with Eq. (2.35) leads to the following expression of mentioned property:

$$c_p - c_v = \frac{\alpha_p^2 T}{\rho\kappa_T} \tag{2.36}$$

The knowledge of the isothermal and isentropic compressibility, as well as the isobaric thermal expansivity, allows determination of the specific heat capacity at constant pressure[11]:

$$c_p = \frac{\alpha_p^2 T}{\rho(\kappa_T - \kappa_S)} \tag{2.37}$$

which further leads to calculation of the isochoric heat by combining equations (2.36) and (2.37):

$$c_V = \frac{\alpha_p^2 T\kappa_S}{\rho\kappa_T(\kappa_T - \kappa_S)} \tag{2.38}$$

2.5 Evaluation Methods

For the purpose of verifying the quality of density data modeling and the correlation for the binary and ternary data V^E, $\Delta\eta$, Δn_D, ΔG^{*E} and $\Delta\kappa_s$, the absolute average percentage deviation, the percentage maximum deviation, the average percentage deviation and the standard deviation were calculated by using the following equations:

$$AAD = \frac{100}{N}\sum_{i=1}^{N}\left|\frac{Y^{\exp} - Y^{\mathrm{cal}}}{Y^{\exp}}\right| \tag{2.39}$$

$$MD = \max\left(100\left|\frac{Y^{\exp} - Y^{\mathrm{cal}}}{Y^{\exp}}\right|\right),\ i=1,N \tag{2.40}$$

$$Bias = \frac{100}{N}\sum_{i=1}^{N}\frac{Y^{\exp} - Y^{\mathrm{cal}}}{Y^{\exp}} \tag{2.41}$$

$$\sigma = \left(\sum_{i=1}^{m}(Y^{\exp} - Y^{cal})^2\big/(n-m)\right)^{1/2} \tag{2.42}$$

3 Experimental Equipment and Procedures

The purpose of the present chapter is to illustrate the apparatus used to measure the densities, viscosities, speed of sounds and refractive indices of all pure components as well as the corresponding mixtures involved in the present research. Furthermore, the chapter deals with detailed explanation of the procedure and the steps involved in carrying out the experiments.

3.1 Chemicals

The pure components used in composing the systems involved in the present work were purchased from Sigma-Aldrich. These components are: ethyl oleate, ethyl laurate, ethyl myristate, ethyl linoleate, methyl laurate, *n*-hexadecane, 1-propanol and 1-butanol. Chemicals were kept in dark bottles in an inert atmosphere, degassed just before a sample preparation and used without further purification.

Two sets of components were used in the apparatus calibration. The first set was used in the DMA HP densimeter calibration. These were: *n*-decane which were supplied by Merck Chemical Company, and double deionized Millipore water, provided by Veolia IonPRO-LX MkII system. The second set used to perform calibration checks on viscometer and densimeter; these were double deionized Millipore water and ambient air. All chemicals are used as it is without further purification. **Table** 3.1 reports all the pure components along with their supplier and their stated. The purities of the chemicals were tested by comparing the experimental density, speed of sound and refractive index values of the pure chemicals at different temperatures with those published in the open literature.

Table 3.1 Chemicals used in this work.

Components name	CAS	Supplier	Purity mass fraction[a]
1-Butanol	71-36-3	Merck	≥ 0.995
1-Propanol	71-23-8	Merck	≥ 0.995
Ethyl laurate	106-33-2	Sigma–Aldrich	≤ 0.98
Ethyl linoleate	544-35-4	Sigma–Aldrich	≥65%
Ethyl myristate	124-06-1	Sigma–Aldrich	≤ 0.99
Ethyl oleate	111-62-6	Sigma–Aldrich	Ph. EUR
Methyl laurate	11-82-0	Sigma–Aldrich	≤ 0.995
n- Hexadecane	544-76-3	Sigma–Aldrich	≥ 0.99

[a]As stated by supplier

1-Butanol

It is a primary alcohol with a 4-carbon structure and the chemical formula C_4H_9OH. It is one of the groups of fusel alcohols, which have more than two carbon atoms and 1-butanolhave significant solubility in water (**Figure** 3.1).

Figure 3.1 the structure of 1-butanol

1-Propanol

1-Propanol is a primary alcohol with the formula $CH_3CH_2CH_2OH$. It is colorless liquid which also known as propan-1-ol, 1-propyl alcohol, n-propyl alcohol, and n-propanol (**Figure** 3.2).

Figure 3.2 the structure of 1-propanol

Ethyl laurate

Ethyl laurate is a fatty acid ethyl ester of lauric acid. It has a role as a metabolite (**Figure** 3.3).

Figure 3.3 the structure of ethyl laurate

Ethyl linoleate

Ethyl linoleate is a long-chain fatty acid formed by the formal condensation of the carboxyl group of linoleic acid with the hydroxy group of ethanol. It has a role as an anti-inflammatory agent and a plant metabolite. It is product of a linoleic acid (**Figure** 3.4).

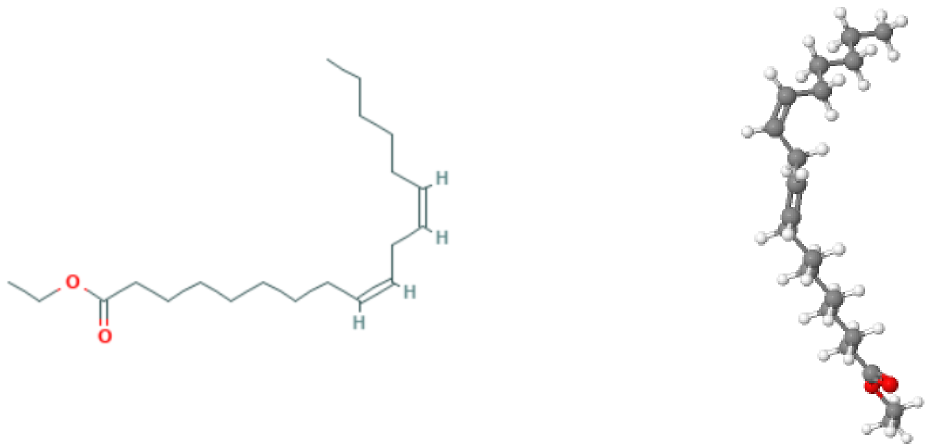


Figure 3.4 the structure of ethyl linoleate

Ethyl myristate

Ethyl myristate is a long-chain fatty acid formed by the formal condensation of the carboxy group of myristic acid with the hydroxy group of ethanol (**Figure** 3.5).

Figure 3.5 the structure of ethyl myristate

Ethyl oleate

Ethyl oleate is a fatty acid ester resulting from the formal condensation of oleic acid and ethanol. It is a colorless to light yellow liquid (**Figure** 3.6)

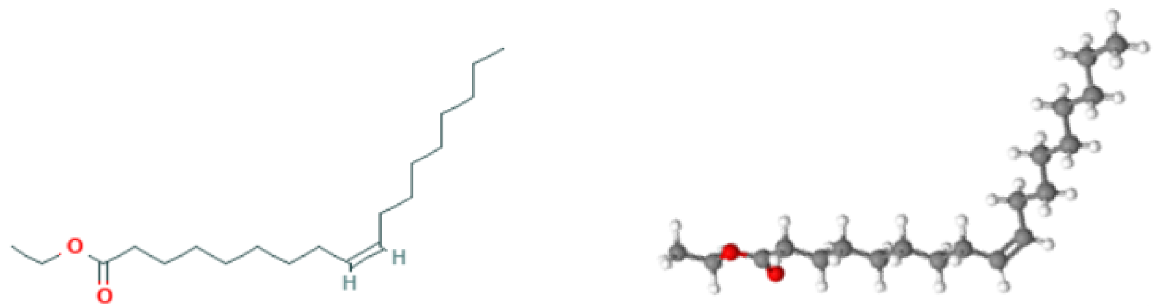


Figure 3.6 the structure of ethyl oleate

Methyl laurate

Methyl laurate is a fatty acid methyl ester of lauric acid. It has a role as a metabolite. It is a fatty acid methyl ester and a dodecanoate ester (**Figure** 3.7).

Figure 3.7 the structure of methyl laurate

***n*-Hexadecane**

Hexadecane is a straight-chain alkane with 16 carbon atoms. It is a component of essential oil isolated from long pepper. It has a role as a plant metabolite, a volatile oil component and a non-polar solvent (**Figure** 3.8).

Figure 3.8 the structure of n-hexadecane

The pure components investigated in this study are:

- **1-Butanol**
- **1-Propanol**
- **Ethyl laurate**
- **Ethyl linoleate**
- **Ethyl myristate**
- **Ethyl oleate**
- **Methyl laurate**
- ***n*-Hexadecane**

The selected binary liquid mixtures for analysis are:

- **Ethyl laurate + 1-Propanol**
- **Ethyl oleate + 1-Butanol**
- **Ethyl oleate + 1-Propanol**
- **Ethyl oleate + *n*-Hexadecane**
- ***n*-Hexadecane + 1-Butanol**
- ***n*-Hexadecane + 1-Propanol**

as well as one ternary system:

- **Ethyl oleate + *n*-Hexadecane + 1-Butanol**

3.2 Preparation of Mixtures

All substances are stored in dark bottles in a dry place and dissected in an ultrasonic bath (**Figure** 3.9) before use. All the vessels used for the measurement are washed with water after washing with ethanol and acetone before disposing into the dryer (**Figure** 3.9). Before starting to measure the thermophysical characteristics of the binary / ternary mixture, it is first necessary to make a mixture of a particular composition. The relative content of the component in the mixture is expressed through a molar fraction. An automatic scale Mettler Toledo AG 204 (**Figure** 3.9) was used to prepare the mixture, with a precision of 1×10^{-7} kg and the standard uncertainty in mole fraction in this work was less than $\pm1\times10^{-4}$ [13]. The mixtures were made in glass containers with a minimum volume of 10 cm^3. An empty and clean vessel is placed on the analytical scale of the analytical scales and performs the tare. In an empty normal vessel, a certain mass of the first pure component is injected by means of a syringe. Note the number of the component number one and reset the tare again. The same procedure is repeated for the second component (in the case of binary systems) or the third component (in the case of ternary systems), taking into account that the sum of the molar shares of all the components is equal to the unit. For the binary system, nine mixtures were made so that the molar shares of the first, or other components, cover the whole concentration range from 0 to 1 with step 0.1.

Figure 3.9 An automatic scale Mettler Toledo AG 204, Branson 3210 ultrasonic bath and dryer.

Ternary mixture was made with constant ratio of molar fraction of the first and third components x_1 / x_3, for the following relationship values: 0.11, 0.25, 0.67, 1.5, 4.0 and 9.0. Therefore, six lines with a constant ratio of the molar fraction of the first and third components were selected, while the molar fraction of the second component was chosen so that the experimental points cover the whole concentration field of 0-1 to 0 molar increments with step 0.1. Thus, in the experimental measurement of the ternary system, nine points were measured for each line, which totals 54 points. Before each series of measurements, each sample was degassed in Branson 3210 ultrasonic bath (for 15 minutes) at room temperature (**Figure** 3.9) and withdrawn from the glass vials using 0.005 L hypodermic syringe and afterwards it was injected carefully into the inlet of the measuring tube.

3.3 Density Measurement at atmospheric pressure

During work on this doctoral thesis, atmospheric pressure densities were measured on a DMA 5000 density gauge manufactured by Anton Paar (**Figure** 3.10). This gauge provides the ability to measure densities with very high precision at different temperatures in the range (273.15-363.15) K and at pressures of (0-10) bar. What is important to mention is the wide range of densities that can be measured from 0-3 g · cm-3 with a precision of $1 \cdot 10^{-6}$ g · cm^{-3}, as well as a very short time for determining individual densities of 40 s. The temperature is adjusted automatically by setting the desired temperature or range at which measurements are taken via the device screen, and the Peltier element with two integrated Pt 100 thermometers maintains the temperature with a precision of 0.001 K. The DMA 5000 is a density gauge with oscillating U tube, made in this case made of borosilicate glass and allowing the sample to be observed during measurement. The unit automatically converts the measured oscillation periods in the sample filled tubes into the sample densities and displays the results on its screen.

Figure 3.10 DMA 5000 Density Measurement Device.

The results are also stored in the device memory, which greatly facilitates the density measurement process. The device also automatically corrects the measured densities due to the influence of the viscosity of the tested samples. A detailed operating principle, device calibration procedure, and the procedure itself for measuring atmospheric pressure densities have been given in the literature[87-91]. The basic properties of the device are given in **Table** A 1.

3.4 Viscosity Measurement

A digital Stabinger viscometer (model SVM 3000/G2) was employed to determine the density and the dynamic and kinematic viscosity in the temperature range from (288.15 - 373.15) K and in the viscosity range of 0.2 mPa·s to 20 Pa·s at atmospheric pressure. A scheme of the measurement cell can be found in **Figure** 3.11. It contains two measuring cells; one of which is used for determining the density of the sample, while the other one measures the dynamic viscosity. The kinematic viscosity of the liquid sample is derived from the relationship between the measured density and dynamic viscosity. Before running each experiment, all samples were degassed by using a Branson 3210 ultrasound bath and then were injected into U-shaped tube that was excited to produce mechanical resonant vibrations. The density measurement is based on the relation between the oscillation period and sample density. The cell used for dynamic viscosity measurements contains a straight tube filled with sample in which a light weight magnetic rotor floats freely. A rotating magnet generates an eddy current field in the surrounding copper casing with a speed-dependent brake torque. Shortly after the start of the measurement, the rotor reaches a stable speed determined by the equilibrium between the brake torque caused by eddy currents and the shear forces at work in the sample. The temperature in the cell was regulated to ±0.01 K with a built in solid-state thermostat. The stated reproducibility of the dynamic viscosity and density measurements is 0.35% and 0.5 kg $\cdot m^{-3}$ in the temperature interval (293.15 to 373.15) K.

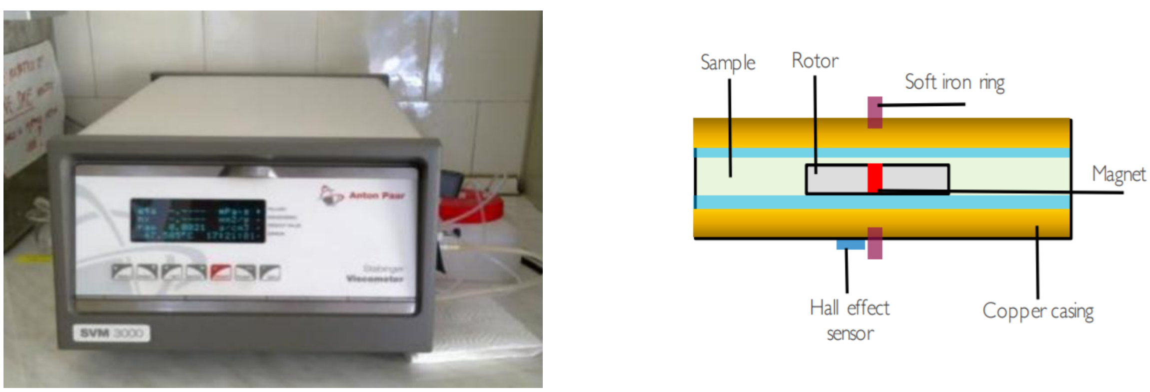


Figure 3.11 Viscosimeter Anton Paar SVM 3000 and Schematic Displacement of Viscosimeter Cell Meters.

The temperature in the cell was regulated to 0.01 K with a built in solid-state thermostat. Over the temperature range studied, the relative expanded uncertainty in the dynamic viscosity measurements (*k*= 2, 95% confidence level) was estimated to be within 0.70 %. A detailed description of the device operation and measurement procedure is given in the literature [89, 91], and the specification data in **Table** A 2 in the Appendix.

3.5 Density and Speed of Sound Measurements

Anton Paar DSA 5000 M was used to simultaneously measure two physically independent properties within one sample (**Figure** 3.12). The density and speed of sound measuring ranges are from (0 to 3000) kg·m^{-3} and from (1000 to 2000) m·s^{-1}, respectively. The density is determined by measuring the oscillation frequency of a sample-filled U-shaped tube while the speed of sound is measured using an ultrasonic transmitter and receiver located on one side of the U-tube. Before each series of measurements, each sample was withdrawn from the glass vials using 0.005 L a plastic-tipped hypodermic syringe and afterwards it was injected carefully into a U-shaped borosilicate glass tube. The tube is electro-magnetically excited to vibrate at its characteristic frequency, at a given temperature, and automatically converted to liquid density through accurate determination of the characteristic frequency and a mathematical conversion. The speed of sound measuring cell is bordered by an ultrasonic transmitter and receiver that are placed opposite to each other on either side of the sample. The transmitter emits sound waves of a known frequency through the sample. The speed of sound can be determined by using the period of received sound waves and the distance between the transmitter and receiver Eq. 3.1.

Figure 3.12 DSA 5000 M Density and Sound Speed Measurement Device

An apparatus is able to detect small bubbles of gas present in the whole measuring cell by an advanced analysis of its oscillations pattern and generates a warning message. The filling process of the sample can also be checked visually using a real-time camera display with zoom function. After each measurement, the measuring cell has to be washed first with Millipore quality water many times and rinsed and cleaned with up to two rinsing liquids (ethanol and acetone) and subsequently dried by a filtered flow of air from a built-in pump. Calibration of the apparatus was carried out daily at the corresponding temperature using air and Millipore quality water in accordance with the technical recommendations for the instrument. The measuring results of density and speed of sound are shown together on the LED display, saved and can be exported or printed. In the apparatus was used the option “temperature scan” in which it can automatically change the temperature in chosen steps. During this procedure, the temperature is kept constant with a built-in solid-state thermostat that can control temperature in the cell within ± 0.01 K. The measurement uncertainty (combined expanded uncertainty at the 95% confidence level with a coverage factor of k = 2) of the density and speed of sound are 0.01 % and 0.10 %, with repeatabilities of 0.001 $kg\cdot m^{-3}$ and 0.1 $m\cdot s^{-1}$ respectively. The measured densities and speed of sounds were used to determine volumetric and acoustical properties of mixtures.**Table** A 3 with specifications on DSA 5000 M device is given in the Appendix.

$$W = \frac{L\left(1+1.6\times10^{-5}\,\Delta T\right)}{\frac{P}{512}-\tau f_3} \tag{3.1}$$

where *L* is the original path length of the sound waves; △*T* is the temperature deviation to 293 K; P is the oscillation period of the received sound waves; τ is the apparatus constant for sound velocity; f_3 is the correction term for temperature.

When a sample is inserted into a measuring cell and a measurement is initiated, it is electronically excited to oscillate at a characteristic frequency that varies with temperature. Precise determination of this frequency and further calibration calculations give the density of the injected sample. Densities are determined by measuring the oscillation frequency of a sample-filled U-shaped tube and the reference oscillator:

$$\rho = K_A.Q^2.f_1 - K_B.f_2 \tag{3.2}$$

where K_A and K_B are the constants of the apparatus, Q is the oscillation period in the tube divided by the oscillation period of the reference oscillator, and f_1 and f_2 are the correction factors for temperature, viscosity and nonlinearity.

3.6 Refractive Index Measurement

An automatic Anton Paar refractive index analyzer RXA-156 was employed to determine the refractive index pure components and their mixtures (**Figure** 3.13). It works with a synthetically sapphire prism at the wavelength of 589.3 nm and the temperature of the sample is kept constant with a built-in thermostat within an uncertainty of 0.03 K. The refractive index data have an uncertainty of 2×10^{-5}. The RXA 156 measuring module is operated in combination with DSA 5000 M in order to save time by simultaneously determining the density, speed of sound, and refractive index. A photograph of the DSA 5000 M and the RXA 156 is given in Figure 3.16. The measuring results of the RXA 156 are transmitted to the DSA 5000 and shown together with density and speed of sounds on the LED screen display. The calibration was performed with pure liquids with known refractive indices. Over the temperature range studied, the estimated experimental uncertainties in the refractive index measurements (k = 2, 95% confidence level) were about $\pm 1 \times 10^{-4}$. The procedure for measuring and operating the refractometer is explained in more details in the literature[89-91], and more precise device data are presented in **Table** A 4 in the Appendix.

Figure 3.13 RXA 156 Refractometer connected to DSA 5000 M Density and Sound Speed Measurement Device.

3.7 Density Measurement at high pressure

The compressed liquid density measurements at various temperatures and pressures were carried out using an Anton Paar DMA HP vibrating tube densimeter[91]. A brief description of the experimental setup and procedures is given here. The experimental system comprises of DMA HP vibrating-tube densimeter, DMA 5000 densimeter, pressure transducer, a rupture-disc, fill and drain valves, syringe and vacuum pumps as schematically shown in **Figure** 3.14. The core component is an Anton Paar DMA HP vibrating-tube densimeter which consists of the measuring cell for high pressures and temperatures. It is connected with DMA 5000 densimeter as a reading device, which evaluates the oscillation period of the measuring cell filled with a sample. AP SoftPrint software program (a Microsoft Excel Add-In) was employed to read out and transfer the measured values from DMA 5000 to a PC[11].

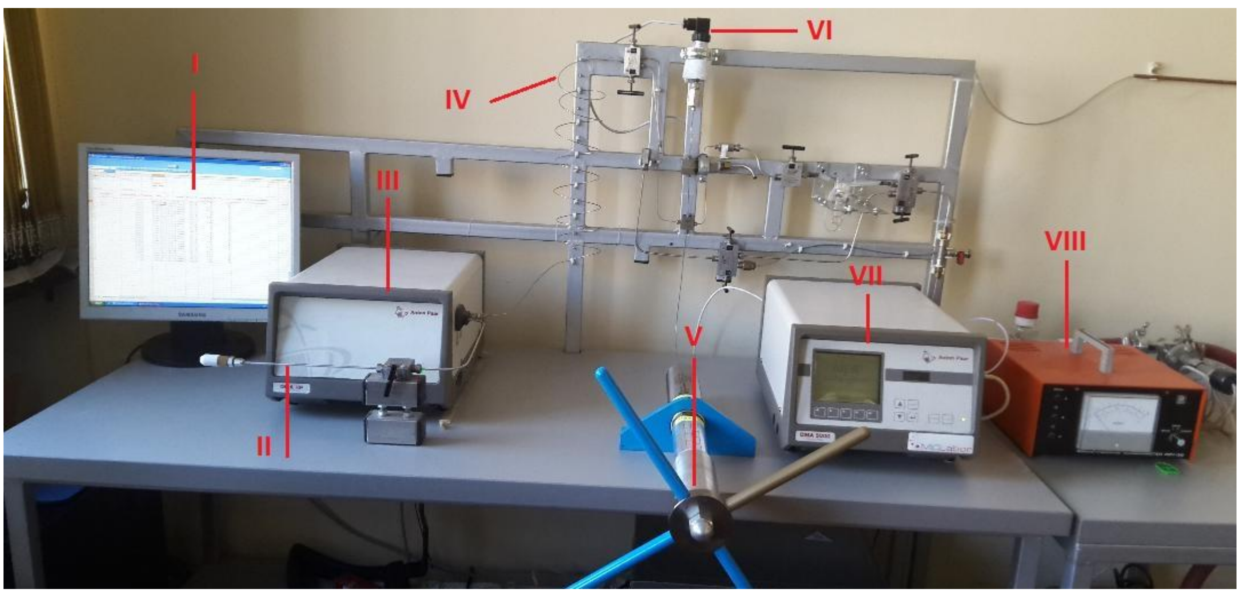


Figure 3.14 The apparatus for density measurements at high pressures

Parts of apparatus are as marked in **Figure** 3.14:

I Computer for the monitoring of the measurements - which records (every 15s) data of the measured values of pressure, temperature and period of tube vibration (placed inside the densimeter),

II Tube in which the sample is injected,

III DMA HP - apparatus for the density measurements at high pressures and temperatures,

V Buffer tube,

IV High pressure generator (HiP, model No. 50-6-15),

VI The pressure sensor that sends an analog signal to DMA 5000 (type: Wika S-10)

VII DMA 5000 densimeter as a reading device, which evaluates the oscillation period of the measuring cell filled with a sample[11].

VIII Vacuum meter (Pirani - penning vacuum meter PPV - 30).

The apparatus enables density measurements at temperatures up to 473.15 K and at pressures ranged from 0.1 to 60 MPa. The process conditions, pressure and temperature, are set using the DMA 5000 densimeter. An integrated Peltier thermostat with the stability of ±0.05K was used to monitor each selected temperature. The required pressure was generated and controlled with a Pressure Generator model 50-6-15,High Pressure Equipment Co. (HiP), using acetone as the hydraulic fluid, and was measured with a pressure transducer WIKA, S-10, Alexander Wiegand GmbH & Co[11]. The transducer was calibrated up to 60 MPa and the expanded uncertainty for the pressure was 0.05 MPa with a level of confidence of 95% (coverage factor, k = 2).

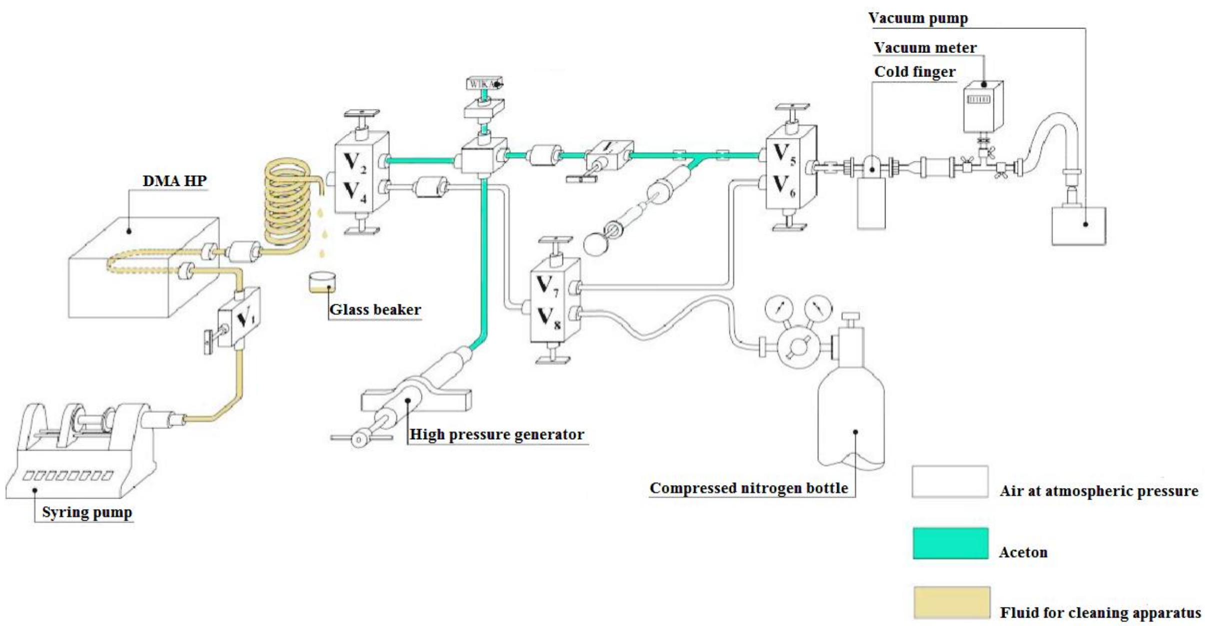


Figure 3.15 Scheme of cleaning procedure

Prior to loading the apparatus with the sample, the measuring cell and its connections are rinsed with successive use of ethanol and acetone to ensure the removal of any residues from previous sample; then it was dried using nitrogen injection for appropriate period of time (**Figure** 3.15). After degasification in Branson 3210 ultrasonic bath (for 15 minutes) at room temperature, the pure sample is pumped through a stainless steel tube into the apparatus using a syringe pump (**Figure** 3.16).

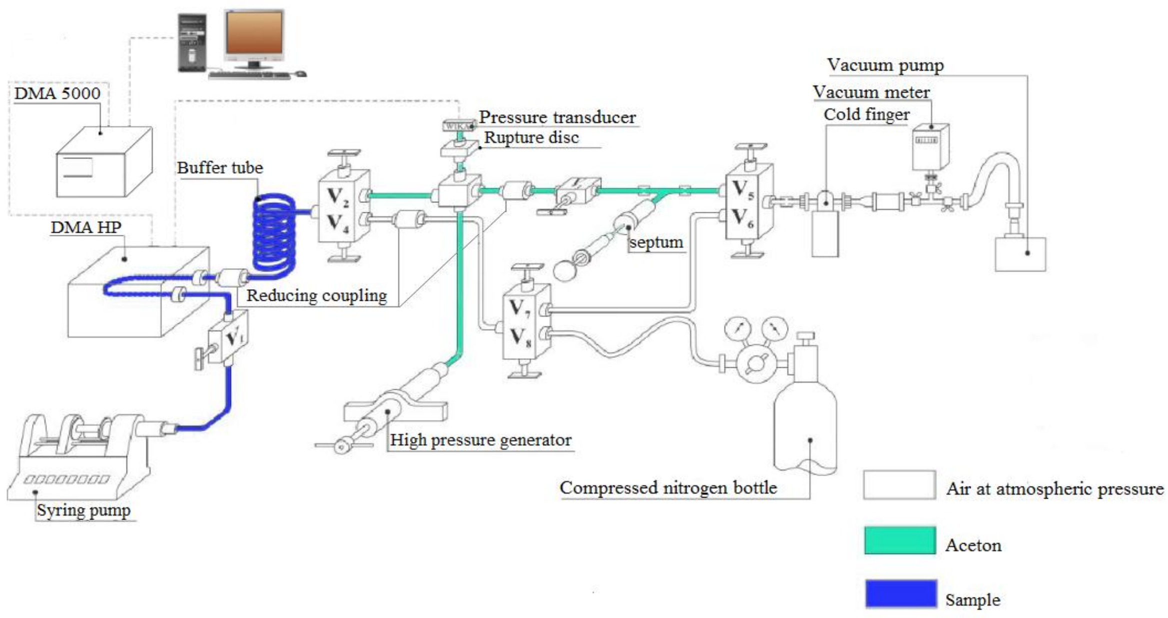


Figure 3.16 Schematic diagram used in this work for measuring compressed liquid densities at high pressures and elevated temperatures.

To avoid any micro-bubbles formation inside the capillary tube of the densimeter, the tube connecting valve V2 through V4 are slightly released and a few milliliters of the sample was allowed to run out before closing it. Once the apparatus was filled, the measurement was performed starting at 0.1 MPa and pressure was increased along an isotherm up to a maximum of 60 MPa[11]. The system was returned to 0.1 MPa after a sequence of measurements in order to equilibrate and reperform measurement at the initial state point. After completing an isotherm, the set point temperature was changed for the next set of measurements increasing to a maximum of 413.15 K in a similar manner[11]. During the experimental measurements, procedure for all pressures and temperatures is the same[11]. When temperature and pressure values reach stable/equilibrium values vibrating period is recorded in the file. Data for the vibrating period could be selected only when values are equal for three consecutive measurements. An example of the file with recorded measured data is shown in **Figure** 3.17.

As it can be seen in **Figure** 3.17, pressure values are recorder in mA, and it is necessary to convert those values into bars, using eq. 3.3:

$$p[barg] = p[mA] \cdot 37.5 - 150 \tag{3.3}$$

Since, measured values are in bar, absolute pressure could be obtained by adding of barometric pressure (1 bar) to the value obtained with equation (3.3)

Anton Paar SoftPrint V1.3										
Device	DMA Classic									
Settings	COM1; 9600,e,7,1		method:HP merenje							
act.per.ext.	ext.cell temp.	ext.cell set temp.	extcell analog inp.	method	ext.condition	pressure	Weekday	Date	Time	serial nr.
us	C	C	mA		adjustment					
2548.926	25	25	5.952	HP merenje	no	----------bar				
2548.927	25	25	5.955	HP merenje	no	234.589968bar	Mo	06.Jun.2016	10:31:40	
2548.927	25	25	5.953	HP merenje	no	234.412956bar	Mo	06.Jun.2016	10:31:55	
2548.928	24.999	25	5.955	HP merenje	no	234.594216bar	Mo	06.Jun.2016	10:32:11	
2548.928	25	25	5.956	HP merenje	no	234.713556bar	Mo	06.Jun.2016	10:32:27	
2548.935	25	25	5.966	HP merenje	no	234.730872bar	Mo	06.Jun.2016	10:32:43	
2548.941	24.999	25	5.975	HP merenje	no	235.860816bar	Mo	06.Jun.2016	10:37:25	
2548.941	25	25	5.975	HP merenje	no	237.000336bar	Mo	06.Jun.2016	10:41:07	
2548.941	25	25	5.976	HP merenje	no	237.088008bar	Mo	06.Jun.2016	10:41:23	
2548.941	24.998	25	5.977	HP merenje	no	237.223272bar	Mo	06.Jun.2016	10:41:40	
2548.941	25	25	5.974	HP merenje	no	236.887596bar	Mo	06.Jun.2016	10:41:56	
2548.942	25	25	5.979	HP merenje	no	237.449244bar	Mo	06.Jun.2016	10:42:11	
2548.943	24.999	25	5.979	HP merenje	no	237.486972bar	Mo	06.Jun.2016	10:42:27	
2548.945	25	25	5.981	HP merenje	no					
2548.946	24.999	25	5.982	HP merenje	no	237.885000bar	Mo	06.Jun.2016	10:44:02	
2548.945	24.999	25	5.981	HP merenje	no	237.746328bar	Mo	06.Jun.2016	10:44:18	
2548.946	24.999	25	5.983	HP merenje	no	237.998400bar	Mo	06.Jun.2016	10:44:33	
2548.947	24.999	25	5.983	HP merenje	no	238.008276bar	Mo	06.Jun.2016	10:44:49	
2548.947	24.999	25	5.984	HP merenje	no	238.110624bar	Mo	06.Jun.2016	10:45:05	
2548.952	25	25	5.993	HP merenje	no	239.100276bar	Mo	06.Jun.2016	10:45:51	
2550.667	25	25	8.611	HP merenje	no	553.330668bar	Mo	06.Jun.2016	10:46:07	
2550.553	25.001	25	8.385	HP merenje	no	526.214268bar	Mo	06.Jun.2016	10:46:23	
2550.461	25.001	25	8.282	HP merenje	no	513.889104bar	Mo	06.Jun.2016	10:46:39	
2550.422	25.001	25	8.239	HP merenje	no	508.713708bar	Mo	06.Jun.2016	10:46:56	
2550.4	25	25	8.218	HP merenje	no	506.179452bar	Mo	06.Jun.2016	10:47:12	
2550.388	25.001	25	8.207	HP merenje	no	504.868104bar	Mo	06.Jun.2016	10:47:28	
2550.379	25.001	25	8.2	HP merenje	no	503.978592bar	Mo	06.Jun.2016	10:47:44	

Measuring data / Sheet1 / Sheet2 / Sheet3

Figure 3.17 Display of the experimental data using software Anton Paar Softprint V1.3

3.7.1 Calibration of the apparatus DMA HP

For precise and reliable data, it was essential to calibrate accurately an Anton Paar DMA HP high pressure vibrating tube densimeter[11]. This required the use of calibration fluids with known densities in the wide ranges of temperature and pressure[11]. Therefore, the classical calibration method with one reference fluid was carried out in accordance with the procedure described by Comuñas et al.[92] which is the modification of the procedure previously suggested by Lagourette et al[93].

This method was carried out by measuring the oscillating period of the evacuated tube over the whole temperature range of interest. In addition, the period of the tube full of the chosen reference fluid (water), having the certified density, was measured in the whole temperature and pressure ranges of the experimental significance. For the measurements performed at ambient pressure and temperatures above the boiling point of water, water is not a good reference fluid, and in those cases *n*-decane was employed.

Based on the Comuñas *et al.* [92] calibration procedure, following equations are used:

1) at $(0.1 \leq p \leq 140)$ MPa and $(293.15 \leq T \leq 353.15)$ K

$$\rho(T,p) = \rho_{water}(T,p) + \rho_{water}(T, 0.1 \cdot MPa) \cdot \left[\frac{\tau^2(T,p) - \tau^2_{water}(T,p)}{\tau^2_{water}(T, 0.1MPa) - \tau^2_{air}(T)} \right] \quad (3.4)$$

2) at p = 0.1 MPa and $T \geq$ 373.15 K

Under these conditions water is no longer appropriate to be employed as the reference fluid because it exists in the gaseous state, and the n-decane has been used, as was suggested by Comuñas *et al*. [92]. The following relation has been used instead of eq. 3.4:

$$\rho(T, 0.1 \cdot MPa) = \rho_{decane}(T, 0.1 \cdot MPa) \cdot \left[1 + \frac{\tau^2(T, 0.1 \cdot MPa) - \tau^2_{decane}(T, 0.1 \cdot MPa)}{\tau^2_{decane}(T, 0.1MPa) - \tau^2_{air}(T)} \right] \quad (3.5)$$

3) at p> 0.1 MPa and $T \geq$ 373.15 K

In this case there is also the possibility of water evaporation, and there are two proposed procedures:

- using *n*-decane for B(T,0) calculation:

$$\rho(T,p) = \rho_{water}(T,p) + \rho_{decane}(T, 0.1 \cdot MPa) \cdot \left[\frac{\tau^2(T,p) - \tau^2_{voda}(T,p)}{\tau^2_{decane}(T, 0.1MPa) - \tau^2_{vaccum}(T)} \right] \quad (3.6)$$

where it is an essential to know the period of the U tube filled with water oscillation at each pressure where p>0.1 MPa and at each temperature, as well as the density of water. Also, it is necessary to know the period of U tube oscillation under vacuum, also for each temperature and the period of tube filled with n-decane oscillation, as well as the density of n-decane, at ambient pressure and at all examined temperatures.

- using B (T, 0) ≈ B (T, 1 MPa) instead of B (T, 0) ≈ B (T, 0.1MPa):

$$\rho(T,p) = \rho_{water}(T,p) + \rho_{water}(T, 0.1 \cdot MPa) \cdot \left[\frac{\tau^2(T,p) - \tau^2_{voda}(T,p)}{\tau^2_{water}(T, 0.1MPa) - \tau^2_{vacuum}(T)} \right] \quad (3.7)$$

where it is an essential to know the period of the tube oscillation under vacuum (in the whole temperature range) and a period of the U tube filled with water oscillation, along with the density of water. In this case data for only one reference fluid are enough for calibration [92].

To calculate the density using Eqs. (3.3-3.7) it is necessary to know U tube oscillation period for the investigated sample, as well as the U tube oscillation period for water in all ranges of pressure and temperature, and for the vacuum at all temperatures and for *n*-decane at atmospheric pressure and at T ≥ 373.15 K. Densities of water in all ranges of pressures and temperature and of *n*-decane at atmospheric pressure and at T ≥ 373.15 K, are also necessary. Periods of vibration for vacuum, water and *n*-decane were obtained by DMA HP, and density values for water at different pressures and temperatures were obtained using the equation suggested by Tumlirz [94]. Density of the other reference fluid, *n*-decane, is taken from literature and processed by a polynomial equation of the second order [95].

3.8 Data Reduction

Validation of an experimental technique requires that both model and data errors are proved to be within acceptable ranges. In order to show the dissipation of experimental points around the curves obtained in eqs. (2.18) and (2.19), standard deviation in equation (2.42) is used. It is recommended that the number of optimized parameters in the equation (2.18) and (2.19) is determined using the F-test [96]. The F-test calculates the probability that the sizes of the two sets do not differ significantly. The experimental obtained values of excess molar volume, viscosity deviation, deviation in the refractive index, deviation in isentropic compressibility and excess molar Gibbs energy of activation of viscous flow are compared with their calculated value by means of RK (2.18) or NT polynomial (2.19). As a result, the values of the parameters F and P are obtained. The value of parameter F should be as close as possible to the value of 1.0, and the value of parameter P as close as 0.5.

4 EXPERIMENTAL RESULTS

Density, speed of sound, viscosity and refractive index data over the entire composition range and at different temperatures for pure components and a variety of systems are available in the literature. Much fewer binary systems data are also available in the literature. Data on ternary systems are tremendously scarce in the literature. Our laboratory is the only laboratory that has been reporting density, speed of sound, viscosity and refractive index data for such investigated systems. Such data are valuable contributions to the literature for their own value and for use in developing and testing proposed models.

4.1 Results of Experimental Measurement of Pure Substances at ambient pressure

In this work, experimental data on densities, speeds of sound, viscosities and refractive indices in the temperature range T= (293.15 to 343.15) K of the1-butanol, 1-propanol, *n*-hexadecane, ethyl myristate, ethyl linoleate, ethyl oleate, ethyl laurate and methyl laurate were reported at atmospheric pressure. A comparison of the measured values with the literature data at 298.15 K is given in **Table** 4.1. This table shows that the agreement is very good; up to $9 \cdot 10^{-2}$ mPa · s for viscosity, 0.8 kg · m^{-3} for density and $6 \cdot 10^{-4}$ for refractive index. Densities and speeds of sound at ambient pressure show a linear decline with temperature increase (**Figure** 4.1). The ranked increase in density was found to be: *n*- hexadecane < 1-propanol < 1-butanol<ethyl myristate < ethyl laurate < methyl laurate < ethyl oleate< ethyl linoleate while speed of sound increases in the following sequence: 1-propanol < 1-butanol <ethyl laurate <*n*-hexadecane <methyl laurate < ethyl myristate < ethyl oleate< ethyl linoleate (**Table** A 6). The comparison between methyl and ethyl laurate shows that methyl laurate has higher density and speed of sound than ethyl laurate of the same fatty acid, at ambient pressure[11]. Concerning the dependences of viscosities on temperature, it decreases exponentially with temperature elevation, as expected[11] (**Figure** 4.1). The order of increasing viscosity at ambient pressure is: 1-propanol < 1-butanol <methyl laurate <*n*-hexadecane < ethyl laurate < ethyl myristate <ethyl linoleate <ethyl oleate (**Table** A 6)**.** The obtained viscosities are slightly higher for the ethyl esters than those of the methyl ester. The dependences of refractive indices of the studied components (**Table** A 6**)** at atmospheric pressure show a linear decline with temperature increase (**Figure** 4.1), indicating that refractive index of the methyl laurate is slightly higher than ethyl laurate and is almost independent of temperature for all examined esters[11].

Table 4.1 Experimental and literature values of densities ρ, viscosities η, speed of sounds u, and refractive indices n_D of pure components at (298.15, 303.15, and 308.15) K and 0.1MP.

Component	T[a]/K	ρ[b]/kg·m^{-3}		η[c]/mPa·s		u[d]/m·s^{-1}		n_D[e]	
		Exp.	Lit.	Exp.	Lit.	Exp.	Lit.	Exp.	Lit.
1-butanol	298.15	805.98	807.80[51] 805.91[53] 805.93[97] 805.90[98, 99] 806.00[100] 806.10[101] 805.77[102] 805.40[103, 104] 805.85[105] 805.81[106] 805.86[107] 805.71[108]	2.5306	2.5440[51] 2.5730[53] 2.5200[55] 2.5060[99] 2.5400[102] 2.5450[103]	1239.62	1260.00[51] 1240.50[53] 1240.09[105] 1240.37[106] 1239.29[107] 1240.00[98, 108] 1239.90[109] 1238.99[110] 1240.01[111]	1.3979	1.3975[97, 99] 1.3970[98] 1.3969[100] 1.3974[112] 1.3967[113]
	303.15	802.13	807.00[51, 52] 803.16[53] 802.09[97] 801.80[98, 104] 802.40[100] 802.10[101] 801.70[103] 802.01[105] 801.97[106] 802.04[113]	2.2321	2.2854[51] 2.2750[53] 2.2300[101] 2.2430[103] 2.2250[113]	1222.76	1226.00[51] 1224.00[98] 1223.25[105] 1223.64[106] 1222.08[110]	1.3959	1.3952[98, 99] 1.3951[100] 1.3947[104] 1.3953[112] 1.3956[114]
	308.15	798.25	809.00[51] 799.25[53] 798.21[97] 798.10[99] 798.20[100] 798.30[101] 798.06[102] 797.90[103, 104] 798.14[105] 798.10[106, 115] 798.04[107]	1.9745	2.0510[51] 1.9810[53] 1.9270[99] 1.9700[101] 1.9800[102] 1.9770[103]	1206.02	1204.00[51] 1206.56[105] 1206.95[106] 1205.50[107] 1206.60[109] 1205.79[110] 1206.62[111] 1205.90[115]	1.3938	1.3934[99] 1.3928[100] 1.3927[104] 1.3933[112] 1.3938[114]
1-propanol	298.15	799.93	800.01[97] 799.50[98, 104] 799.60[99] 799.47[106] 799.67[108] 799.75[116] 799.95[117] 799.76[118] 799.56[119] 799.62[120]	1.9262	1.8980[99] 1.9540[103] 1.9430[113] 1.9503[115]	1205.74	1205.64[106] 1206.00[98, 108] 1205.37[119] 1205.82[120] 1205.86[121] 1205.61[122]	1.3831	1.3833[97] 1.3831[98] 1.3830[99] 1.3832[104] 1.3838[114] 1.3834[116, 118] 1.3837[117, 123]
	303.15	795.89	795.50[124, 125] 795.97[65] 795.44[106] 795.72[116, 118] 795.92[117] 795.60[126]	1.7164	1.7340[103] 1.7250[116] 1.7270[117]	1188.64	1189.00[98] 1188.77[106] 1189.00[126]	1.3810	1.3813[97] 1.3810[98] 1.3814[104] 1.3820[114]
	308.15	791.82	791.89[97] 791.40[99] 791.30[104] 791.37[106]	1.5325	1.4860[99] 1.5450[103]	1171.64	1172.01[106] 1172.60[115] 1171.41[119] 1171.98[121]	1.3789	1.3793[97, 104] 1.3791[99] 1.3802[114]

			791.84[115] 791.64[118] 791.46[119]				1171.32[122]		
Ethyl laurate	298.15	858.15	858.50[24] 858.25[127] 858.19[128]	2.9862	3.0152[24]	1320.91	1321.00[127]	1.4294	1.4229[128] 1.4295[129]
	303.15	854.26	854.60[24] 854.35[127]	2.6777	2.7073[24]	1302.49	1302.65[127]	1.4273	1.4275[129]
	308.15	850.36	850.70[24] 850.45[127]	2.4139	2.4455[24]	1284.26	1284.48[127]	1.4252	1.4255[129]
Ethyl linoleate	298.15	873.22	876.83[24]	5.058	4.8073[24]	1383.72	1387.18[24]	1.4547	1.4574[130]
	303.15	869.57	873.17[24]	4.495	4.3074[24]	1365.92	1369.28[24]	1.4527	---
	308.15	865.93	869.53[24]	4.018	3.8539[24]	1348.3	1351.56[24]	1.4507	---
Ethyl myristate	298.15	856.97	857.20[24] 857.18[127] 857.10[128]	4.1452	4.1880[24]	1342.85	1342.60[127]	1.4340	1.4335[128] 1.4340[129]
	303.15	853.19	853.40[24] 853.39[127]	3.6726	3.7207[24]	1324.66	1324.34[127]	1.4319	1.4321[129]
	308.15	849.41	849.60[24] 849.62[127]	3.2828	3.3278[24]	1306.64	1306.23[127]	1.4299	1.4302[129]
Ethyl oleate	298.15	865.23	866.90[24] 865.24[131]	5.6740	6.0236[24]	1376.24	1378.54[131]	1.4481	1.4486[130] 1.4449[132]
	303.15	861.60	863.20[24] 861.62[131]	4.9989	5.3094[24]	1358.43	1360.67[131]	1.4461	---
	308.15	857.97	859.50[24] 858.00[131]	4.4351	4.7156[24]	1340.81	1342.98[131]	1.4441	---
n-hexadecane	298.15	769.87	773.30[51] 770.46[53] 769.97[133] 769.93[134] 769.96[135] 769.94[136] 769.80[137] 769.92[138] 769.82[139]	3.0355	3.0320[51] 3.0410[53] 3.0560[138] 3.0930[139] 3.0050[140] 3.0782[141]	1338.49	1181.00[51] 1338.60[53] 1338.00[133] 1338.80[137] 1342.00[140] 1339.22[142]	1.4318	1.4326[116] 1.4325[136] 1.4334[139] 1.4338[140] 1.4321[143] 1.4322[144] 1.4319[145]
	303.15	766.40	766.20[51] 766.98[53] 766.55[133] 766.43[135] 766.40[137] 766.51[138] 766.75[146]	2.7084	2.7180[51] 2.7060[53] 2.7270[138]	1319.81	1148.00[51] 1320.00[53] 1318.83[147] 1319.00[133] 1320.20[137, 148] 1319.60[146]	1.4296	1.4325[136] 1.4283[138] 1.4311[146]
	308.15	762.95	759.70[51] 763.52[53] 762.90[137] 763.06[138]	2.4319	2.5090[51] 2.4090[53] 2.4455[149] 2.4510[138]	1301.34	1121.00[51] 1301.70[53, 137] 1301.00[133] 1305.00[140]	1.4275	1.4293[140] 1.4270[150]

The combined expanded uncertainties: $^{a}U_c$ (T) = 0.01K, $^{b}U_c\,(\rho)$ = 0.8 kg·m^{-3}; $^{c}U_c\,(\eta)$ = 0.007 mPa·s, $^{d}U_c\,(u)$ =0.1m·s^{-1} and $^{e}U_c\,(n_D)$ = 2.8×10^{-3} with 0.95 level of confidence (k=2).

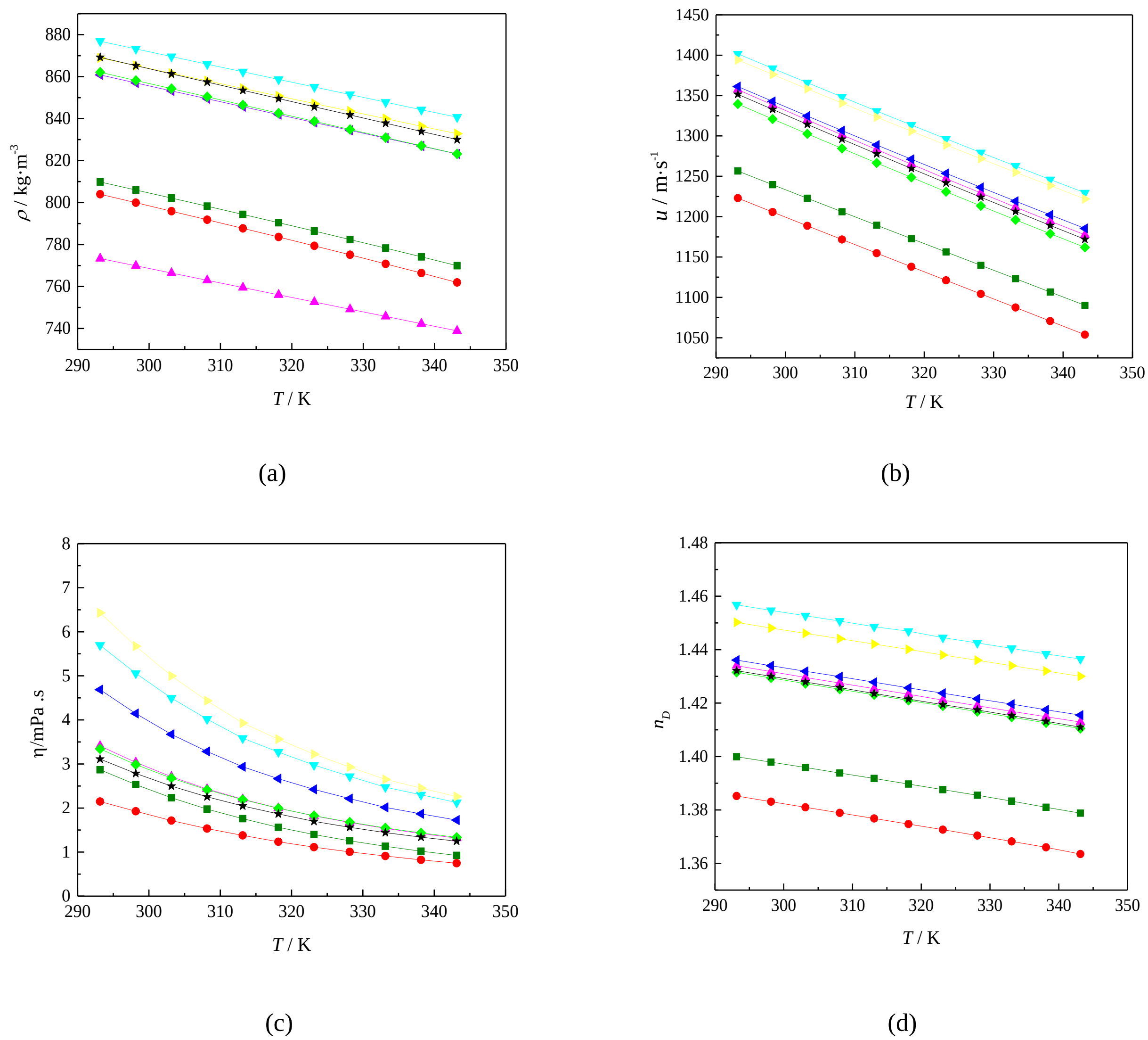


Figure 4.1 Experimental values of (a) density *ρ*, (b) speed of sound *u*, (c) viscosity *η* and (d) refractive index n_D of all pure components used in this work, over the whole temperature range and at atmospheric pressure:(■) 1-butanol, (●) 1-propanol,(◆) ethyl laurate, (▼) ethyl linoleate, (◀) ethyl myristate, (▶) ethyl oleate, (★) methyl laurate and (▲) *n*-hexadecane.

The trend of speed of sound and density is found to decrease as temperature increases. Hence, a corresponding increase in the isentropic compressibility i.e. a decrease in isentropic bulk modulus with temperature is observed[11] (**Table** A 7, **Figure** 4.2). The intermolecular free length behaves similar as the isentropic compressibility - it increases linearly when temperature rises at ambient pressure[11]. The differences in the isentropic bulk modulus between studied esters are approximately the same at all examined temperatures[11]. On the basis of literature,[151, 152] the isentropic bulk modulus is related to the free space between molecules. As it can be seen from **Table** A 7, the intermolecular free length decreases when temperature drops while the isentropic bulk modulus increases[11]. It means that the isentropic compressibility decreases under the same conditions, which is expected due to less free space to be consumed during compression[11]. The ranked increase in the isentropic bulk modulus of the studied components along the temperature range is the same as for speed of sound and it was found to be ethyl laurate < methyl laurate < ethyl myristate < ethyl oleate (**Table A 6**). A higher speed of sound and isentropic bulk modulus of biodisel compared to diesel fuel results in a quicker fuel pressure rise from the fuel pump towards the injectors which leads to earlier injection timing and, consequently, to a higher NO_x emission[11, 48, 71, 72].

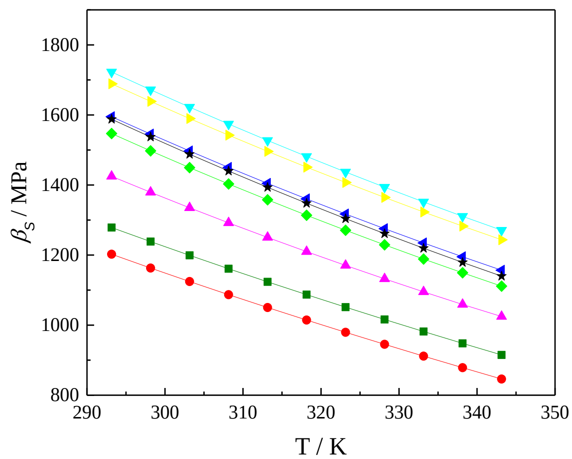


Figure 4.2 The isentropic bulk modulus, β_S, vs. temperature, T, for :(■) 1-butanol, (●) 1-propanol,(◆) ethyl laurate, (▼) ethyl linoleate, (◀) ethyl myristate, (▶) ethyl oleate, (★) methyl laurate and (▲) *n*-hexadecane at atmospheric pressure.

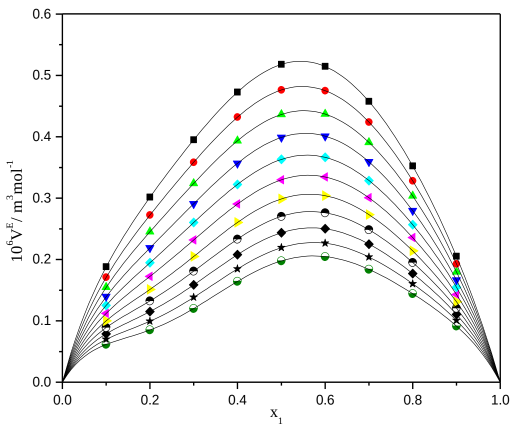
4.2 Results of experimental measurements of binary mixtures

Densities (ρ), viscosities (η), speed of sounds (u) and refractive indices (n_D) at temperature range (293.15-343.15) K, for binary systems investigated in the present study: ethyl oleate (1) + 1-butanol (2), ethyl oleate (1) + 1-propanol (2), ethyl oleate (1) + *n*-hexadecane (2), ethyl laurate (1) + 1-propanol (2), *n*-hexadecane (1) + 1-butanol (2) and *n*-hexadecane (1) + 1-propanol (2), are measured at atmospheric pressure and listed in **Table** A 8**.**

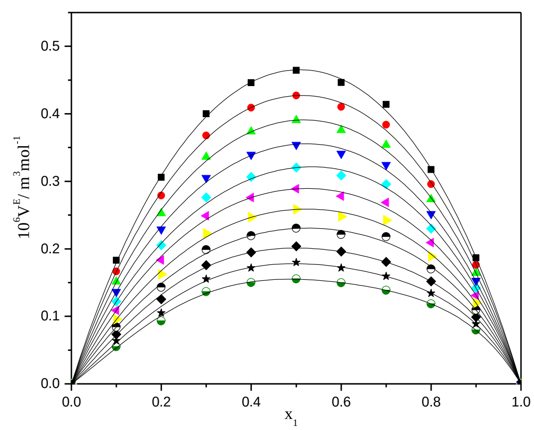
Excess molar volumes (V^E), viscosity deviations ($\Delta\eta$) and refractive index deviations (Δn_D) were calculated based on the corresponding experimental data. In addition to these properties, molar excess Gibbs free energies of activation of viscous flow (ΔG^{*E}) and deviation in isentropic compressibility ($\Delta\kappa_S$) were calculated based on the corresponding measured density, viscosity and speed of sound data. The excess/deviation functions were fitted to Redlich-Kister type polynomial equation.

4.2.1 Excess molar volume

Experimental excess molar volume for the examined mixtures are provided in **Table** A 9 and graphically presented in **Figure** 4.**.** The graphical presentation of the excess molar volumes (V^E) exhibits positive deviations over the entire scale of the mixtures composition for all examined systems[13]. The maximum of the curves occurs at equimolar compositions for all examined systems. It also can be noticed from Fig. 1 that the temperature has a great influence on excess molar volumes and results in systematic increase in V^E values with temperature rising from 293.15 to 343.15 K. The highest values of V^E are observed for the system of *n*-hexadecane +1-propanol[13].



(a)



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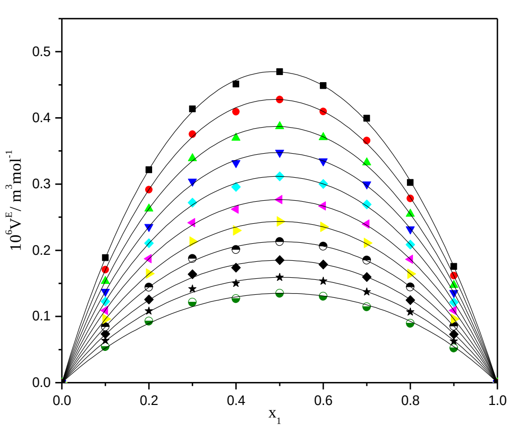

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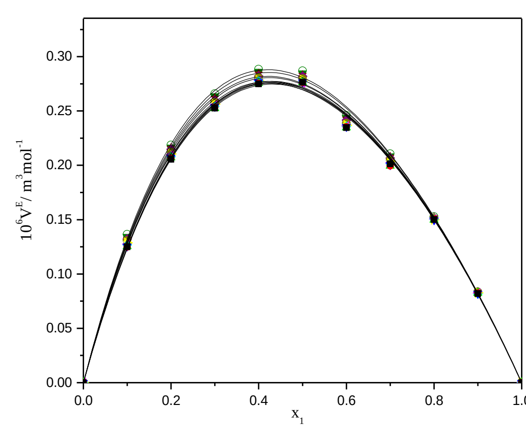

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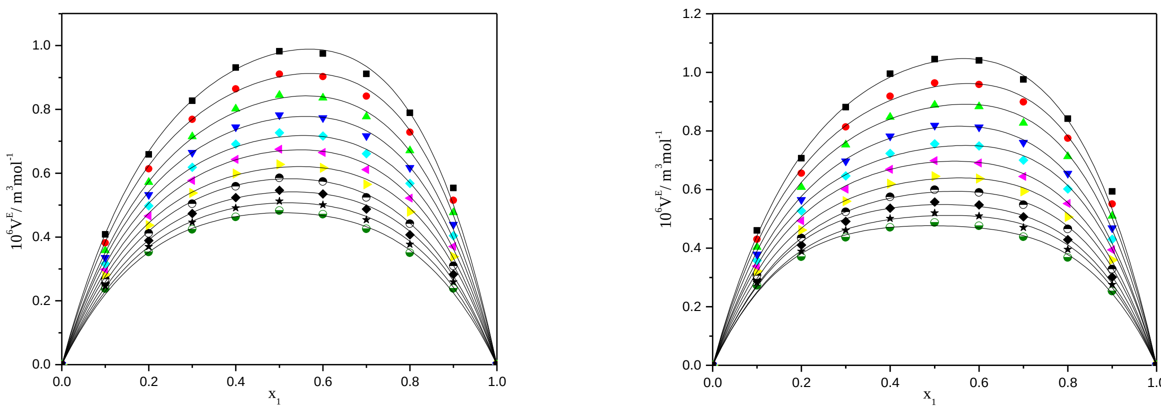


(e) (f)

Figure 4.3 Experimental values of excess molar volume V^E as a function of molar fraction x_1 for the systems: (a) ethyl laurate (1) + 1-propanol (2); (b) ethyl oleate (1) + 1-butanol(2); (c) ethyl oleate (1) + 1-propanol(2); (d) ethyl oleate (1) + *n*-hexadecane (2); (e) *n*-hexadecane (1) + 1-butanol (2); (f) *n*-hexadecane (1) + 1-propanol (2) at following temperatures: (◒) 293.15 K, (★) 298.15 K, (◆) 303.15 K, (◓) 308.15 K, (▶) 313.15 K, (◀) 318.15 K, (◆) 323.15 K, (▼) 328.15 K, (▲) 333.15 K, (●) 338.15 K, (■) 343.15 K, (—) RK equation.

Similar type of behavior in V^E values has also been observed in the polar-nonpolar systems reported by a number of researchers[53, 55, 56, 153-155]. The excess molar volume for the binary system of 1-butanol + *n*-hexadecane is compared with available literature data [52, 53] at 298.15 K, 303.15K, 308.15K and 313.15K present in the literature, and the comparison at 303.15K is shown on **Figure** 4.4. We found that our individual fitted values[13] at 298.15K, 303.15K and 308.15K are in reasonable agreement with the previously reported literature values [53] (Absolute average percentage deviation at equimolar composition (*AAD*) =22%). Larger discrepancies exist for the case of results reported by [52] where a reverse trend, i.e. negative V^E trend is observed[13]. Thus, those reported by [52] deviate by *ADD*=78 % from our $V^E_{0.5}$ values at 303.15K, 308.15K and 313.15K. Discrepancies between our findings and those reported by [52] could be due to the different experimental techniques used since the density values obtained for pure components highly deviate from ours as well as for all other literature values[13].

The variation of positive V^E values of *n*-hexadecane with both alcohols (1-propanol and 1-butanol) can be attributed to the predominance of long range dispersive forces upon mixing of alcohol with *n*-hexadecane[13]. This explanation is in good agreement with other polar-nonpolar systems reported by other researchers[153, 155] where positive values of V^E indicate dispersive interactions. For the 1-propanol with both ethyl oleate and ethyl laurate mixtures, similar type of behavior in V^E values has also been observed with other polar-polar systems [156-158] However, there are no literature data for this system. The observed volumetric behavior could be due to destruction of hydrogen bonds in strongly self-associated alcohol and the physical dipole-dipole interactions between polar molecules[13].

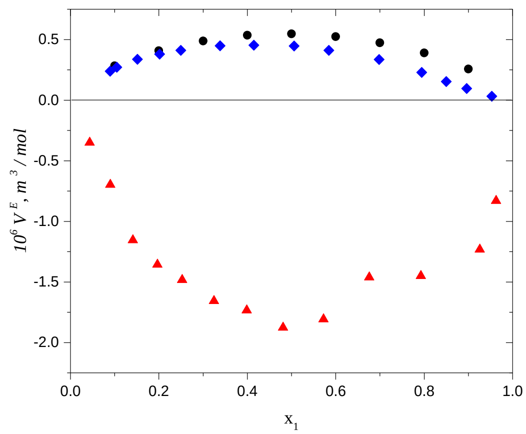


Figure 4.4 Comparison of excess molar volume for binary mixture of (*n*-hexadecane+ 1-butanol) at 303.15K present in the literature: (●) our work, (▲) Ref.[52], (◆) Ref. [53].

In addition, inappropriate interstitial accommodation of ethyl oleate and ethyl laurate within the hydrogen-bonded structure of 1-propanol and the impact of condensation due to restriction of rotational movement of 1-propanol molecules are expected to be significant in this investigation[13]. This interpretation is compatible with the analysis of interactions between *n*-alkanol and ester mixtures [159-163] based on the volumetric behavior. Phenomena above mainly could be due to the packing of the different molecules into each other's structure owing to its different molecular sizes (91.97cm^3 mol^{-1} for 1-butanol, 75.02 cm^{3}mol^{-1} for 1-propanol, 266.11 cm^{3}mol^{-1} for ethyl laurate and 358.87 cm^{3}mol^{-1} for ethyl oleate at 298.15 K). Increase of the V^E values (a positive effect) can be interpreted by the disruption of hydrogen bonds in self-associated alcohol molecules and the dipole-dipole interactions[13]. All the mentioned factors influence the magnitude of the non-ideality. This explanation is in accordance with the analysis of interactions for similar ester and *n*-alkanol mixtures [164-168]. In case of ethyl oleate + *n*-hexadecane system, the excess molar volumes are also positive over the whole composition range at all investigated temperatures. The molar volumes of ethyl oleate and *n*-hexadecane molecules are 358.87 and 294.13 cm^3 mol^{-1}, respectively. It is apparent that the accommodation of one component into the structure of the other is not favorable enough for ethyl oleate + *n*-hexadecane mixture. Thus, the observed behavior seems to propose that the break of dipole–dipole interactions between the ethyl oleate molecules predominated over the negative contributions associated both with the more effective molecular packing and the heteromolecular dipole-dipole interactions. Also, the temperature influence on excess molar volumes is significant for the ethyl oleate + 1-butanol mixture and V^E systematically increase with temperature rising from 293.15 to 343.15 K, while for the mixture of ethyl oleate with *n*-hexadecane V^E shows negligible temperature dependence. The weak temperature effect on the excess molar volumes of ethyl oleate with *n*-hexadecane could be interoperated by the insufficient increase in kinetic energy of molecules, i.e. molecules do not rotate in an appreciable manner, and hence, the negligible temperature effect occurs in this mixture.

4.2.2 Viscosity deviation

Experimental viscosity deviations for the investigated mixtures are provided in **Table** A 9 . Deviations in viscosity at temperature range T=(293.15 to 343.15 K)for *n*-hexadecane + 1-propanol, *n*-hexadecane + 1-butanol, ethyl oleate + 1-propanol and ethyl laurate + 1-propanol, shown in **Figure** 4.5 were found to be both negative and positive. Negative values of $\Delta\eta$ were observed from the graphs in the system of *n*-hexadecane + 1-butanol, ethyl laurate + 1-propanol and ethyl oleate + *n*-hexadecane while positive deviation was observed for ethyl oleate + 1- propanol mixture. An inversion of sign was observed for *n*-hexadecane + propanol system, where the $\Delta\eta$ curves at different temperatures intersect around x_1=0.35, indicating an inversion of their temperature dependence. In case of systems ethyl oleate + 1-butanol, there are both negative and positive trends at lower temperatures. With an increase in temperature, the negative region becomes less marked. In the work of Fort and Moore[169] positive viscosity deviations are contributed to strong interactions among dissimilar molecules whereas negative dynamic viscosity deviations are due to dispersion forces. The existence of dispersion forces is attributed to differences in molecular size and shape. The negative values in the *n*-hexadecane + propanol system might be due to breaking of hydrogen bonding of alcohols which show an easier mixture flow compared to pure components while positive deviation is found at 1-propanol rich-region because not all of the hydrogen bonds are broken owing to dominance of interstitial accommodation of small propanol molecules into the free volume of *n*-hexadecane[13]. It is observed that there is correlation between the sign of $\Delta\eta$ and V^E, usually having an opposite trend. In the case of ethyl oleate with both 1-butanol and 1-propanol, it was not the case. According to Rastogi et al. [170] the observed excess property for such systems is combined effect of a non-interaction and an interaction part. This indicates that the specific interactions are not the only factor influencing the deviations in viscosity[13] but also the molecular structure of the different molecules[171]. Based on this theory, the behavior of ethyl oleate + 1-butanol system indicates that the viscosities are less influenced by the strong intermolecular interactions than by their shape and size. In the case of ethyl oleate

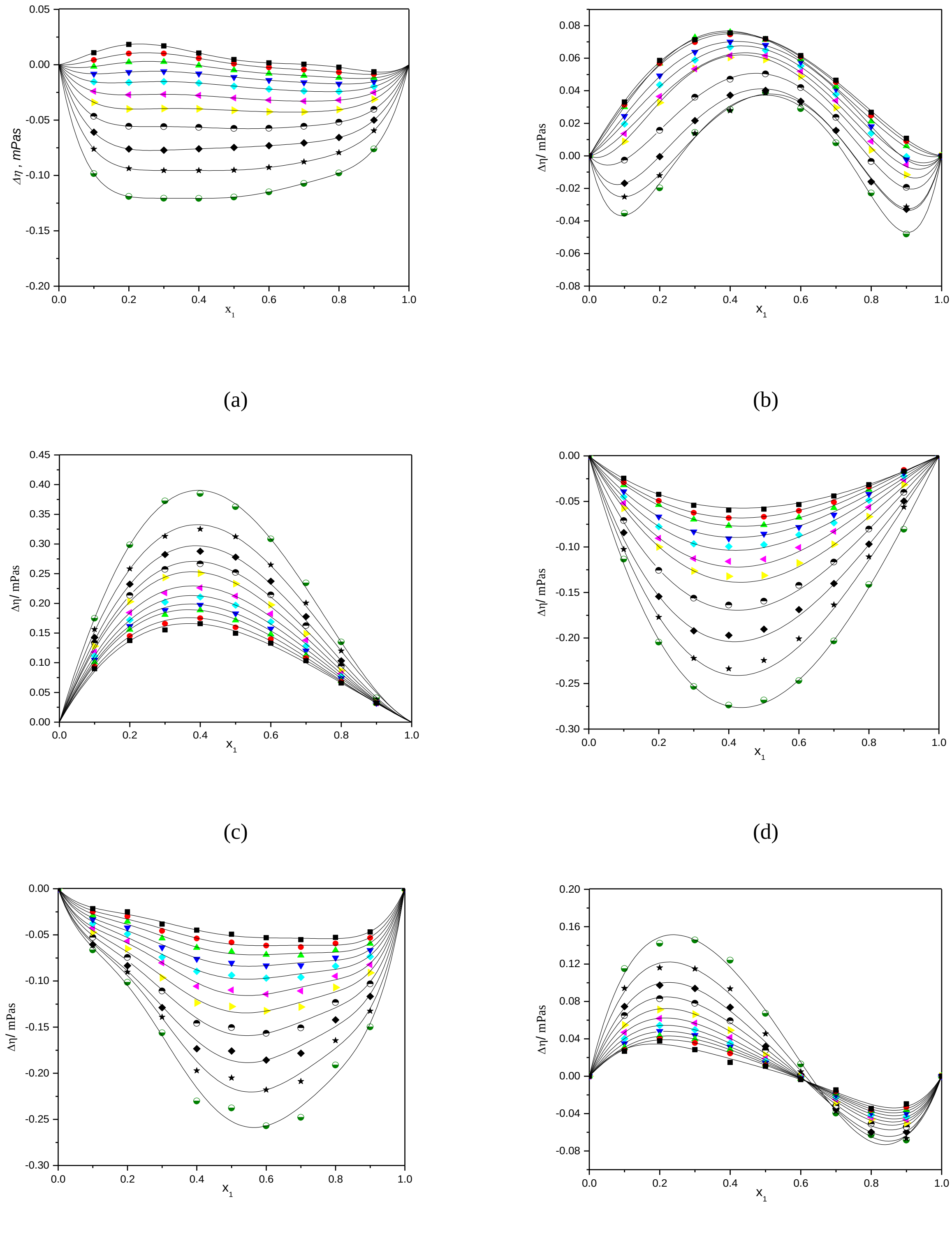
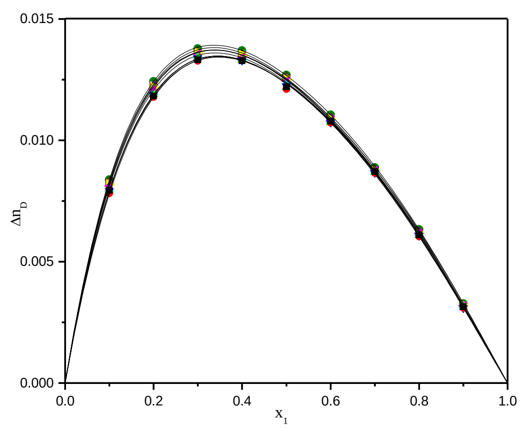


Figure 4.5 Viscosity deviations $\Delta\eta$ *vs*. molar fraction x_1 for the systems:(a) ethyl laurate (1) + 1-propanol (2); (b) ethyl oleate (1) + 1-butanol(2); (c) ethyl oleate (1) + 1-propanol(2); (d) ethyl oleate (1) + *n*-hexadecane (2); (e) *n*-hexadecane (1) + 1-butanol (2); (f) *n*-hexadecane (1) + 1-propanol (2) at following temperatures: : (◒) 293.15 K, (★) 298.15 K, (◆) 303.15 K, (◓) 308.15 K, (▶) 313.15 K, (◀) 318.15 K, (◆) 323.15 K, (▼) 328.15 K, (▲) 333.15 K, (●) 338.15 K, (■) 343.15 K, (—) RK equation.

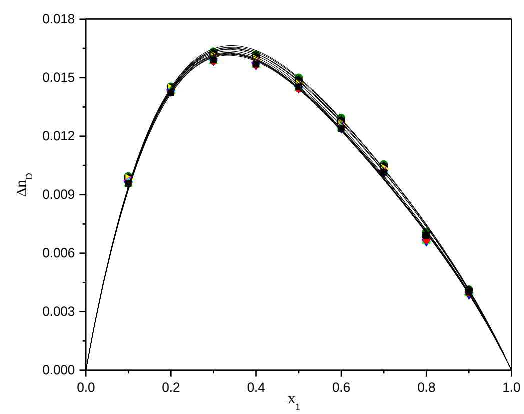
with *n*-hexadecane, negative deviations show that the addition of *n*-hexadecane leads to decrease in dipolar association of the components and greater mobility than within the pure components.

4.2.3 Deviation in refractive index

Deviations of refractive indices for all binary systems are given in **Table** A 9, and together with Redlich-Kister fits are plotted in **Figure** 4.6 as a function of the mole fraction. The Δn_D curves show positive trend over the entire scale of the mixtures composition for all examined systems. The temperature effect on refractive indices deviations is rather small[13]. Values of these deviations for measured systems are very small, especially for the systems *n*-hexadecane + 1- butanol and *n*-hexadecane + ethyl oleate where deviations of refractive indices are under 0.009 and 0.001 respectively. Positive deviations observed for all investigated mixtures suggest that the dispersion interactions between the dissimilar molecules are higher[13] than those in the pure components [172, 173].



(a)



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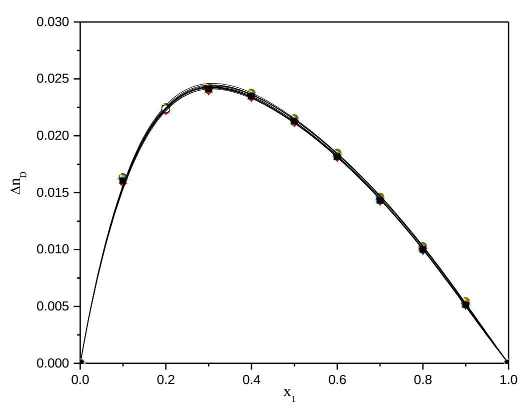

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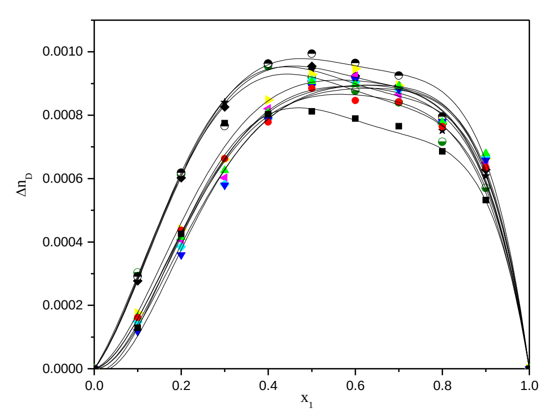

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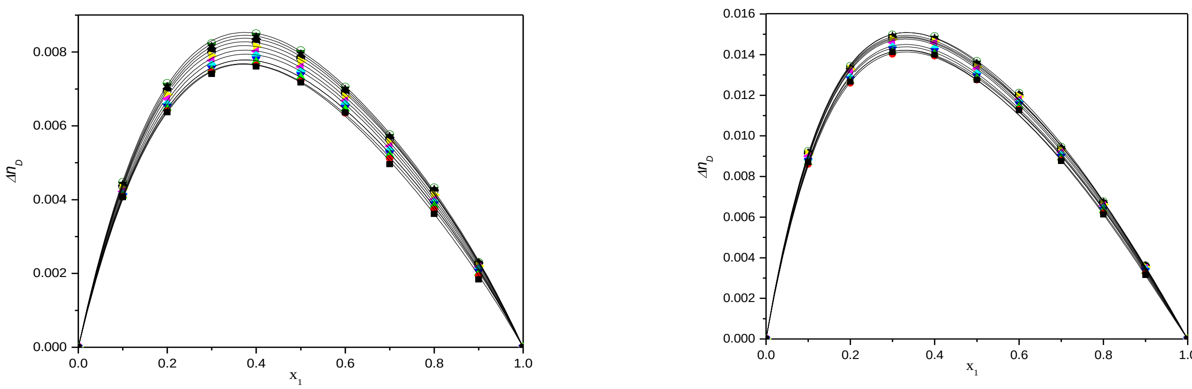


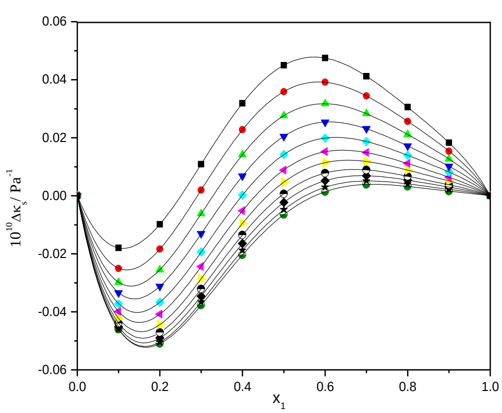
(e) (f)

Figure 4.6 Deviations in refractive index Δn_D *vs*. molar fraction x_1, for the systems: (a) ethyl laurate (1) + 1-propanol (2); (b) ethyl oleate (1) + 1-butanol(2); (c) Ethyl oleate (1) + 1-propanol(2); (d) ethyl oleate (1) + *n*-hexadecane (2); (e) *n*-hexadecane (1) + 1-butanol (2); (f) *n*-hexadecane (1) + 1-propanol (2) at following temperatures: (◒) 293.15 K, (★) 298.15 K, (◆) 303.15 K, (◓) 308.15 K, (▶) 313.15 K, (◀) 318.15 K, (◆) 323.15 K, (▼) 328.15 K, (▲) 333.15 K, (●) 338.15 K, (■) 343.15 K, (—) RK equation.

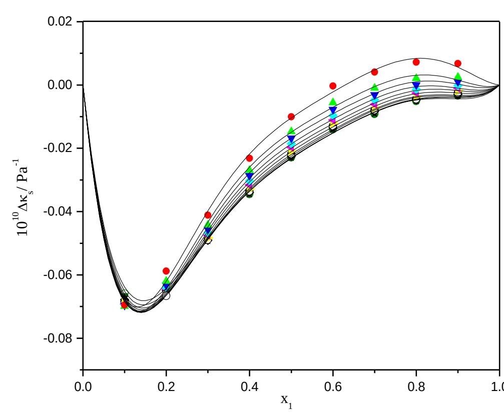
4.2.4 Deviation in isentropic compressibility

$\Delta\kappa_S$ values for the binary mixtures are given in **Table** A 9 and plotted in **Figure** 4.7 as a function of the mixtures' composition. For the ethyl oleate + *n*-hexadecane system the $\Delta\kappa_S$ curves show positive trend for all compositions. The curves are slightly skewed to the *n*-hexadecane rich-region; the maximum is around 0.4 mole fraction of ethyl oleate. A reverse trend is observed for ethyl oleate with alcohols systems. The $\Delta\kappa_S$ exhibits an initial negative trend at 1-butanol rich-region followed by small positive lobes at higher temperatures, 338.15 and 343.15 K. The addition of small amounts of 1-butanol or 1-propanol in ethyl oleate produces slightly positive $\Delta\kappa_s$ values at higher temperatures T=333.15, 338.15 and 343.15 K (see **Figure** 4.7), while by adding ethyl oleate to the pure 1-butanol or 1-propanol results in steeper decrease of compressibility in the mixture. For the *n*-hexadecane with alcohol systems, the $\Delta\kappa_S$ curves show positive trend for all compositions, where Δκs vs. composition curve is slightly skewed to the alcohol rich regions. Ethyl laurate + 1-propanol mixture exhibits both positive and negative $\Delta\kappa_S$ deviations, as shown at **Figure** 4.7. The curve exhibits initial steep negative lobes, followed by the positive regions toward the high concentration of ethyl laurate. The deviation in isentropic compressibility for the binary system of *n*-hexadecane + 1-butanol is compared with available literature data [51, 53] at 298.15K, 303.15K 308.15K and 313.15K present in the literature, and the comparison is shown at *T*=303.15 K at **Figure** 4.8. We found that our single fitted values[13] at equimolar composition (T=298.15-308.15K) are in quite good agreement with the previously reported values [53] with *ADD*=19% but which again differ by 77% from those of [52] at (T=298.15-313.15K) since their $\Delta\kappa_s$ values are negative.

The $\Delta\kappa_s$ data for the present investigation could be interpreted qualitatively as a results of several opposing effects[13]: *i*) a positive effect due to disruption of the hydrogen-bonded alkanol by non-polar or polar molecules and *ii*) the negative effect arises from several factors such as interstitial accommodation and geometrical fitting of molecules of two different sizes into each others' structure. It is apparent that the former contribution is quite large and predominates over the latter one in the mixtures of alcohols + *n*-hexadecane while it is obscured by the latter contribution owing to steric hindrance in 1-propanol + ethyl oleate system[13]. Similar results have also been published for *n*-alkanol + *n*-alkane [55] binary liquid mixtures. The positive $\Delta\kappa_s$ values observed of 1-propanol + *n*- hexadecane and 1-butanol + *n*- hexadecane mixtures support the inference drawn from the volumetric and viscometric behaviors[13]. On the other hand, the obtained negative $\Delta\kappa_s$ values in the 1-propanol + ethyl oleate mixture are a sign of inappropriate interstitial accommodation between dissimilar molecules which lead to the predominance of long range packing effect of the self–associated pure components upon mixing of 1-propanol with ethyl oleate[13]. Therefore, the breaking of the hydrogen bond association of the 1-propanol in our mixture, which produces slightly positive $\Delta\kappa_s$ values at higher temperatures, will decrease as a result of a steric hindrance, thereby resulting in lower compressibility in the mixture[13].



(a)



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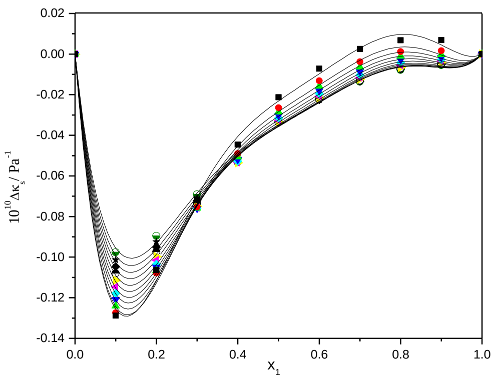

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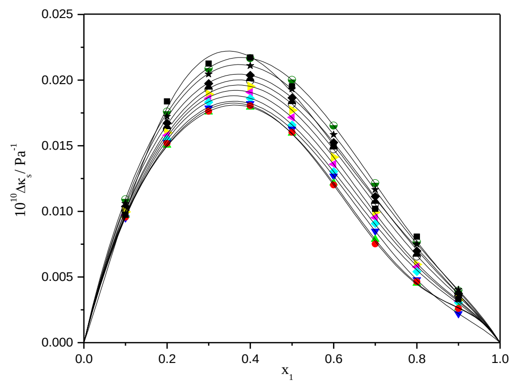

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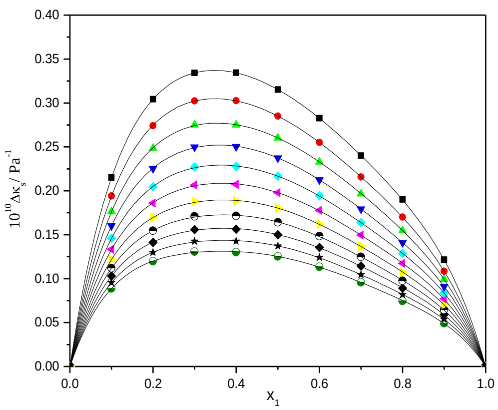

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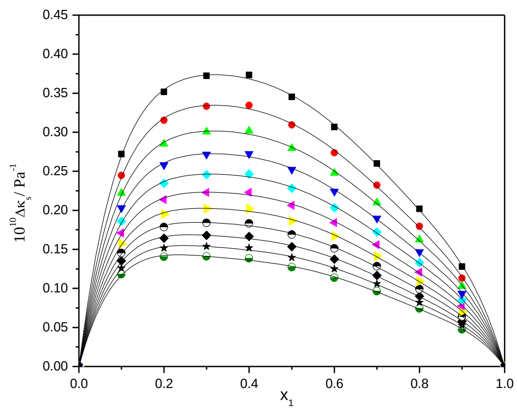


(f)

Figure 4.7 deviation in isentropic compressibility, $\Delta\kappa_s$ *vs*. molar fraction x_1, for the systems:(a) ethyl laurate (1) + 1-propanol (2); (b) ethyl oleate (1) + 1-butanol(2); (c) ethyl oleate (1) + 1-propanol(2); (d) ethyl oleate (1) + *n*-hexadecane (2); (e) *n*-hexadecane (1) + 1-butanol (2); (f) *n*-hexadecane (1) + 1-propanol (2) at following temperatures: (◒) 293.15 K, (★) 298.15 K, (◆) 303.15 K, (◓) 308.15 K, (▶) 313.15 K, (◀) 318.15 K, (◆) 323.15 K, (▼) 328.15 K, (▲) 333.15 K, (●) 338.15 K, (■) 343.15 K, (—) RK equation.

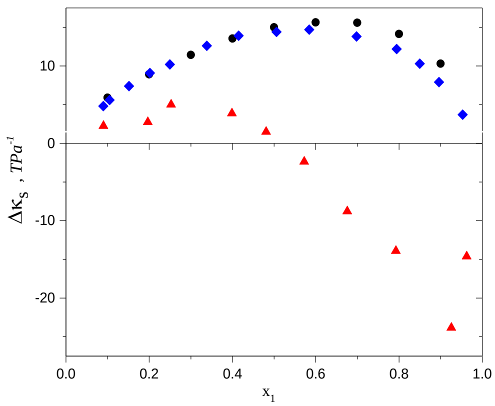
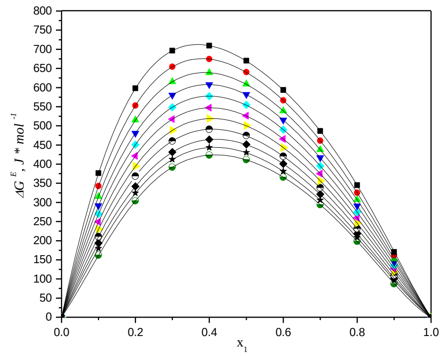


Figure 4.8 Comparison of the deviation in isentropic compressibility $\Delta\kappa_s$ for binary mixture of (1-butanol + *n*-hexadecane) at 303.15K present in the literature: (●) our work, (▲) Ref. [15], (◆) Ref. [17].

4.2.5 Molar Excess Gibbs Free Energies Of Activation Of Viscous Flow (ΔG^{*E})

The excess molar Gibbs energy of activation of the viscous flow ΔG^{*E} were also determined (see **Table** A **9**) and shown in **Figure** 4.9. The magnitude of ΔG^{*E} additionally reflects the degree of interaction between dissimilar molecules[174, 175]. ΔG^{*E} are positive for all compositions and temperatures for the ethyl laurate + 1-propanol, ethyl oleate + alcohols and *n*-hexadecane + alcohols systems, where ΔG^{*E} vs. composition curve is slightly skewed to the high concentration of alcohol. Ethyl oleate + *n*-hexadecane exhibits both positive and negative ΔG^{*E} deviations, as shown at **Figure** 4.9. The curve exhibits initial steep negative lobes, followed by the positive regions toward ethyl oleate rich regions. Meyer et al. [176]proposed that the excess molar Gibbs energy of activation of the viscous flow ΔG^{*E} should be used to detect molecular interactions. Namely, it takes into account both volumetric and viscosity effects. Large positive ΔG^{*E} values are a sign of strong attractive interactions, which is not the case in the ethyl oleate + alcohol systems. The assumable reason for the discrepancy is large difference in molecular size of the pure components, i.e. the ratio between molar volumes is around 4. The influence of temperature on the ΔG^{*E} for all studied systems is slightly more positive with increasing temperature[13]. In the case of ethyl oleate + *n*-hexadecane system, ΔG^{*E} vs. x_1 is S-shaped, but due to the small obtained ΔG^{*E} values (±0.03 KJ mol^{-1}), it is difficult to make any conclusions about the nature of interactions between these two compounds.



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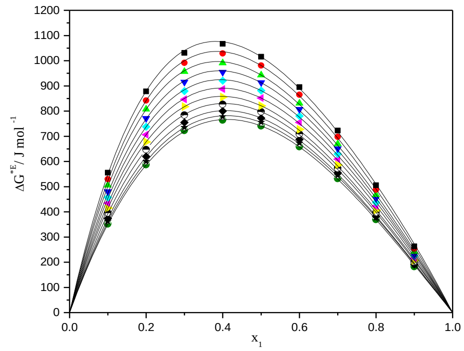

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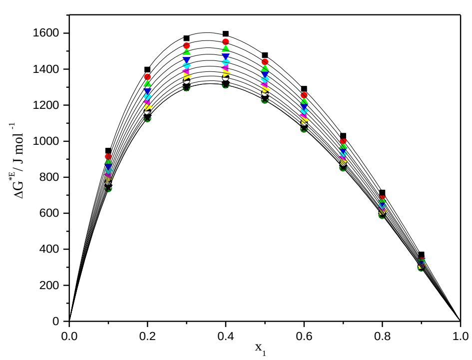

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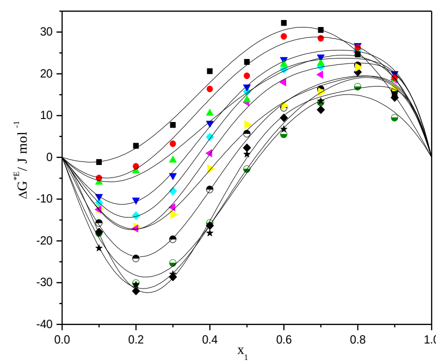

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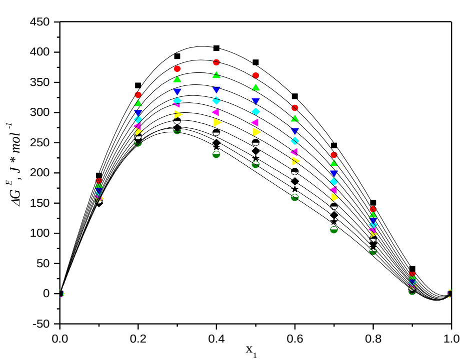

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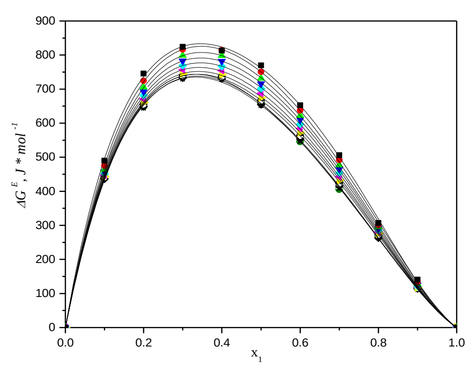


(f)

Figure 4.9 Excess molar Gibbs energy of activation of the viscous flow ΔG^{*E} *vs*. molar fraction x_1, for the systems: (a) Ethyl laurate (1) + 1-propanol (2); (b) Ethyl oleate (1) + 1-butanol(2); (c) Ethyl oleate (1) + 1-propanol(2); (d) Ethyl oleate (1) + *n*-hexadecane (2); (e) *n*-hexadecane (1) + 1-butanol (2); (f) *n*-hexadecane (1) + 1-propanol (2) at following temperatures: (◒) 293.15 K, (★) 298.15 K, (◆) 303.15 K, (◓) 308.15 K, (▶) 313.15 K, (◀) 318.15 K, (◆) 323.15 K, (▼) 328.15 K, (▲) 333.15 K, (●) 338.15 K, (■) 343.15 K, (—) RK equation.

4.3 Results of the experimental measurement of a ternary system

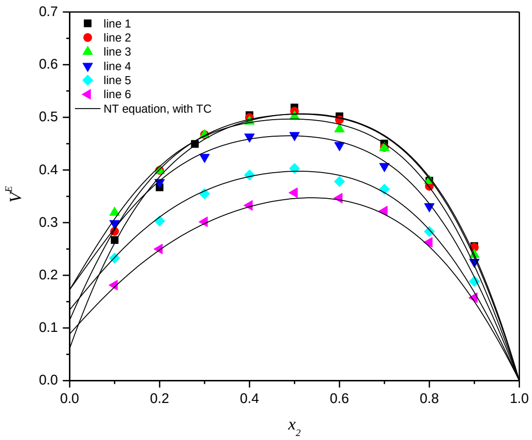
Density (ρ),viscosity (η), speed of sound (u) and refractive index (n_D) of the ternary system ethyl oleate (1) + *n*-hexadecane (2) + 1-butanol (3), were measured over the wide temperature range from 293.15 to 343.15 K at atmospheric pressure, are listed in appendix (**Table** A 11). From the experimental data obtained, the excess molar volumes (V^E), viscosity deviations ($\Delta\eta$), refractive index deviations (Δn_D), and deviation in isentropic compressibility ($\Delta\kappa_s$) of the binary and ternary mixtures at different temperatures and atmospheric pressure were calculated. The calculated values at each temperature are summarized in **Table** A 12**.** Data of excess molar volumes, refractive index deviations and viscosity deviations for the investigated ternary system ethyl oleate+ *n*-hexadecane + 1-butanol at investigated temperature range along with the RK and NT correlation results are presented in **Figure** 4.10(a-d), respectively. Lines 1-6 present the lines of constant ratio of molar fractions of first and third component in the mixture: x_1/x_3= 0.111 (line 1), x_1/x_3 = 0.250 (line 2), x_1/x_3 = 0.667 (line 3), x_1/x_3 = 1.500 (line 4), x_1/x_3 = 4.000 (line 5), x_1/x_3 = 9.000 (line 6).

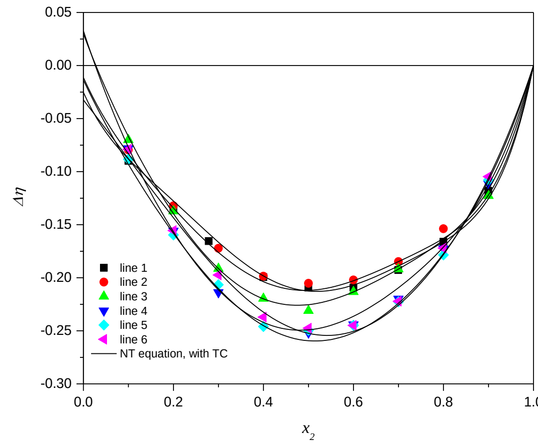
From **Figure** 4.10a , it is apparent that a large amount of the 1-butanol (lines *L*1, *L*2 and *L*3) gives the high approximately symmetrical expansion V^E with respect to x2 mole fraction due to the cross association between 1-butanol and *n*-hexadecane molecules. Minimum obtained for *L*6 is close to the minimum of the binary mixture ethyl oleate + 1-butanol.

Viscosity deviations for ternary system ethyl oleate (1) +*n*-hexadecane (2) + 1-butanol (3) (**Figure** 4.10b) are negative over the whole range of mole fraction of *n*-hexadecane and for all six lines. These deviations become less negative as the contribution of binary system *n*-hexadecane + 1-butanol increases (*L*1, *L*2 and *L*3).

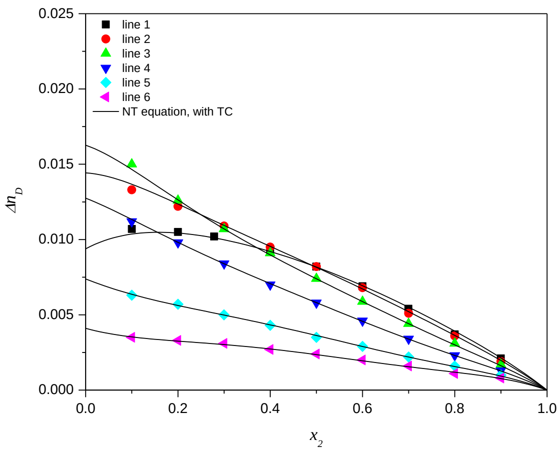
The refractive index deviations, presented in **Figure** 4.10c, have positive values over the whole range of mole fraction of *n*-hexadecane and for all six lines. These deviations increase as the quantity of 1-butanol (*L*1) in mixture is rising.

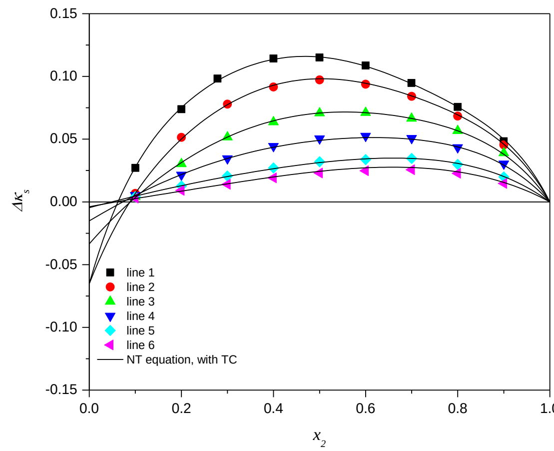
In a wide region of this ternary mixture, the $\Delta\kappa_s$ values are positive **Figure** 4.10d, finding the negative values in the region close to the binary ethyl oleate + 1-butanol. Among the factors that produce positive value of excess molar volume is the fact that distraction of hydrogen bonds in strongly self-associated alcohol, physical dipole-dipole interactions between polar molecules, and also steric barrieries as a result of inappropriate interstitial accommodation[13]of ethyl oleate within the hydrogen-bonded structure of 1-butanol. The general behavior of this ternary mixture indicates that dispersive forces predominate and there are no strong specific interactions between the components of this ternary mixture.





(a) (b)





(c) (d)

Figure 4.10 Experimental values of (a) V^E, (b) $\Delta\eta$, (c) Δn_D, and (d) $\Delta\kappa_s$ at 298.15 K for the ternary system ethyl oleate (1) + *n*-hexadecane (2) + 1-butanol (3), along the curves of constant ratio L = x_1/x_3, as a function of *n*-hexadecane molar fraction x_2: (■) x_1/x_3 = 0.11, (●) x_1/x_3 = 0.25, (▲) x_1/x_3 = 0.67, (▼) x_1/x_3= 1.5, (◆) x_1/x_3= 4.0, and (◀) x_1/x_3= 9.0. (—) NT equation.

Three dimensional surfaces a−d of Figure 6 present the ternary surface of V^E, $\Delta\eta$, Δn_D, and $\Delta\kappa_s$ respectively, for the investigated ternary system at 298.15 K, calculated by the Nagata−Tamura polynomial. At **Figure** 4.11 on each side the sign and the value of every calculated property for the corresponding binary system at 298.15 K can be seen. From this graphic representation the same conclusions could be drawn since the behavior observed seems to suggest that the properties obtained for the ternary system are dominated by the binary mixtures effects. Also, from

Figure 4.11 can be observed the impact of the ternary contribution, which can be quantitatively confirmed by calculating the parts of Eq. 2.1 related to the ternary contribution.

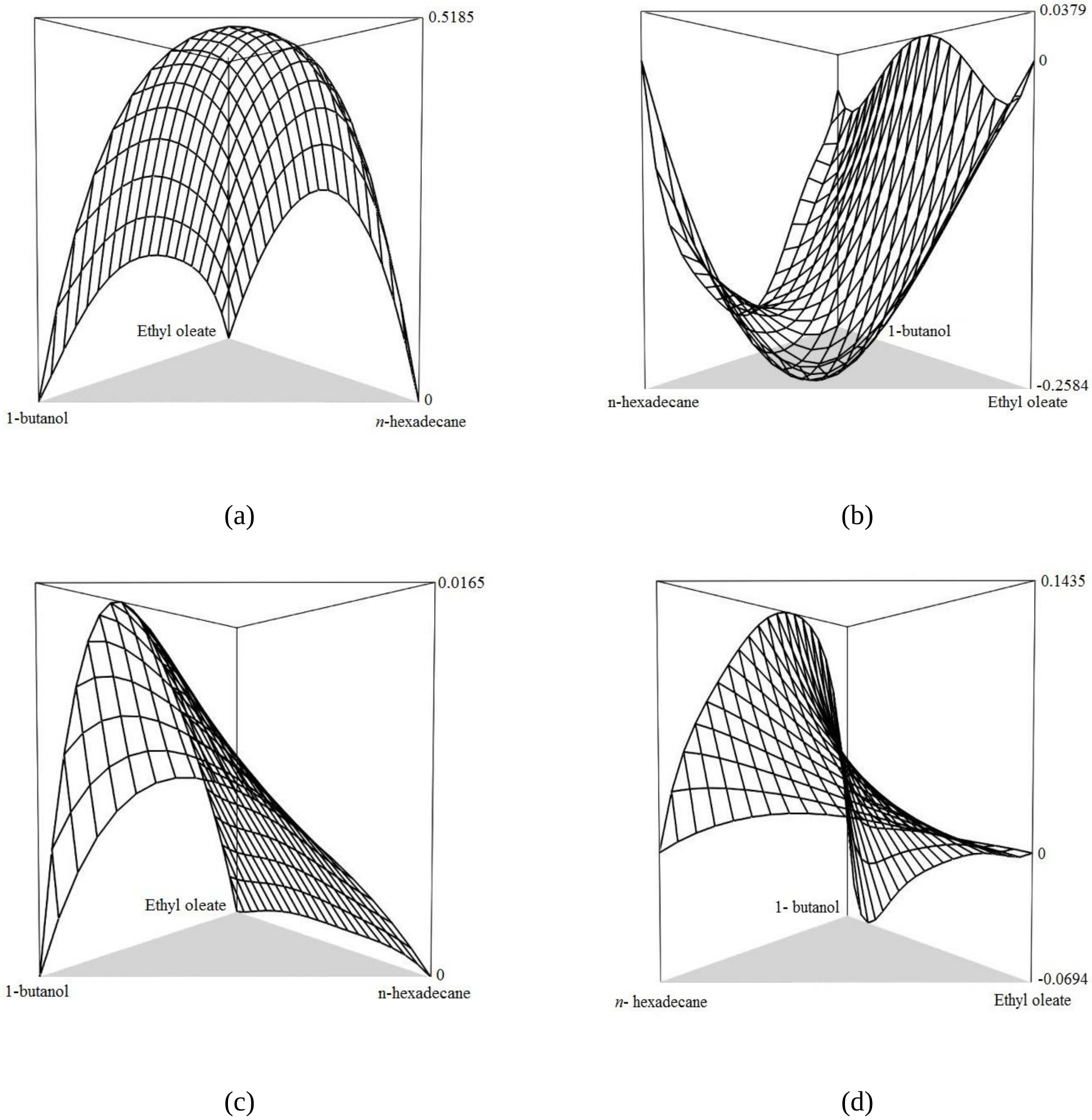
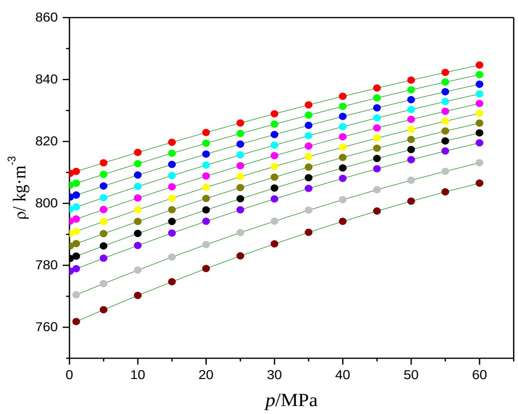


Figure 4.11 Three-dimensional surface for the (a) V^E, (b) $\Delta\eta$, (c) Δn_D, and (d) $\Delta\kappa_s$ for the ternary system ethyl oleate (1) + *n*-hexadecane (2) + 1-butanol (3) at 298.15 K, generated by NT equation.

The ternary contribution term is positive for excess molar volumes, where negative values occur in mixtures rich with butanol; for viscosity deviations and deviations in isentropic compressibility the values are negative with positive values; and for the refractive index deviation negative values are obtained.

4.4 High-Pressure density Measurement of pure components

The (*p, ρ, T*) properties of mentioned esters and alcohols were measured along 15 isotherms from 293.15 to 413.15 K and at pressures up to 60 MPa. The experimental results are presented in **Table** A 14 and shown graphically in **Figs**. 4.12 and 4.13. **Figure** 4.12 shows measured densities of the pure compounds as a function of pressure at different temperatures and the variation of density versus pressure is almost linear[11]. Each of the pure components showed an increase in density when pressure rises and decrease in density with temperature elevation (**Figure** 4.13), as expected due to the compression of molecules and reduction of molecular vibration[11]. Comparison of densities at the atmospheric pressure obtained using DSA 5000 M densimeter and those measured by means of DMA HP densimeter shows a good agreement, the absolute average percentage deviation is less than 0.03% (about 0.2 kg·m^{-3}) for all of the examined samples (**Figure** 4.14). This confirms the precision of the measurement procedure and the reliability of the selected calibration method for DMA HP densimeter[11].



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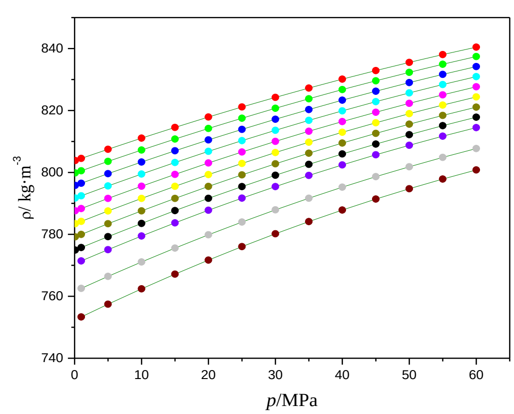

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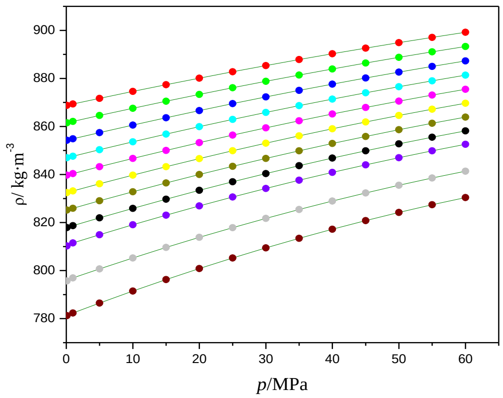

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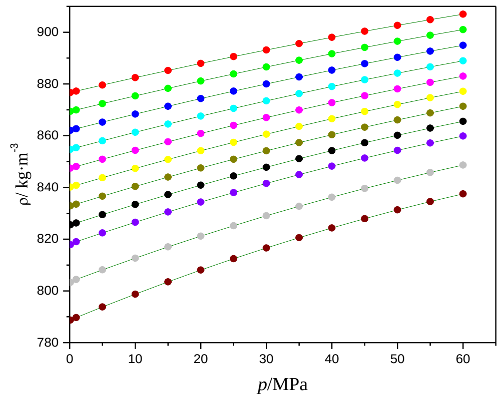

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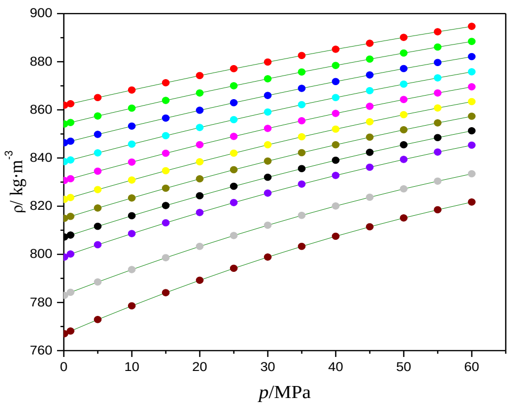

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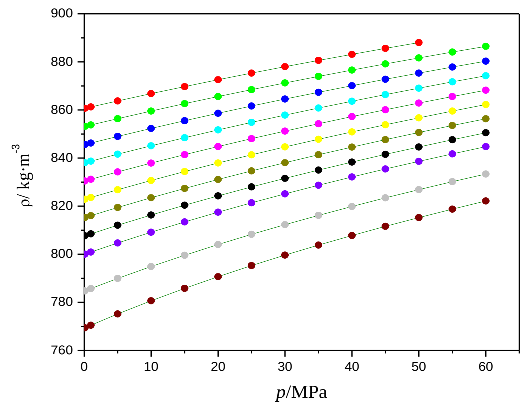

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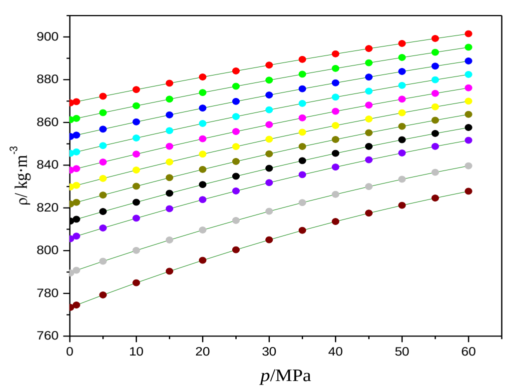
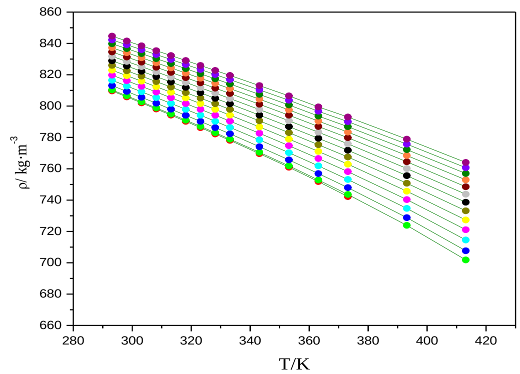


(g)

Figure 4.12 Densities of (a) 1-butanol, (b) 1-propanol, (c) ethyl laurate, (d) ethyl linoleate, (e) ethyl myristate (f) ethyl oleate and (g) methyl laurate vs. pressure at (●) 293.15 K,(●) 303.15 K, (●) 313.15 K,(●) 323.15 K, (●) 333.15 K, (●) 343.15 K , (●)353.15 K, (●)363.15 K, (●)373.15 K , (●)393.15 K, and (●) 413.15 K.



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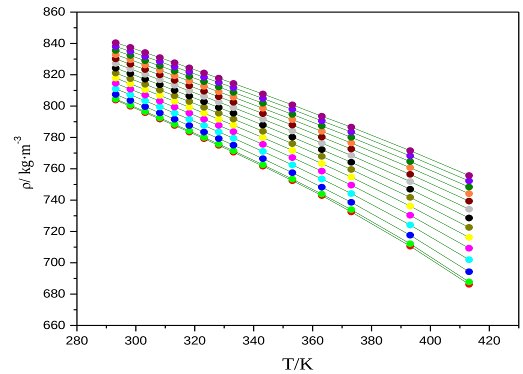

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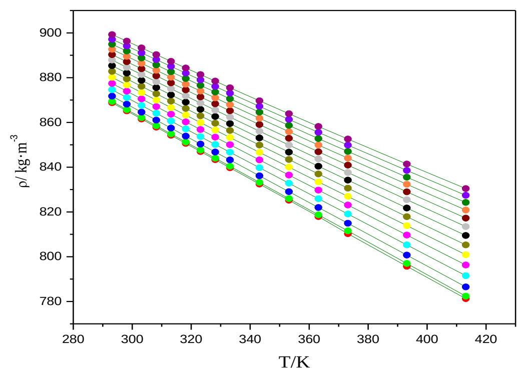

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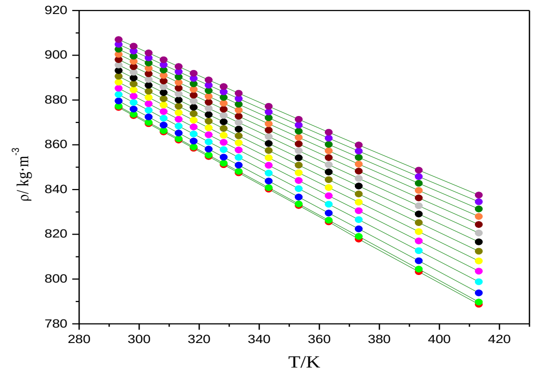

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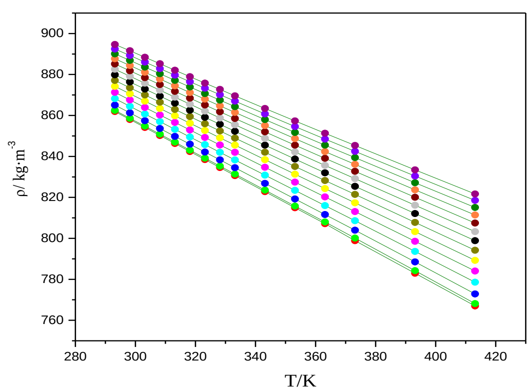

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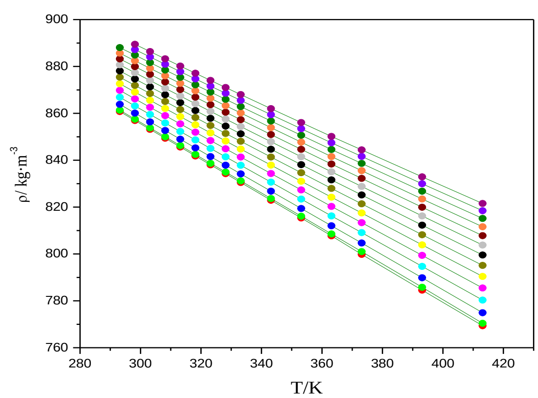

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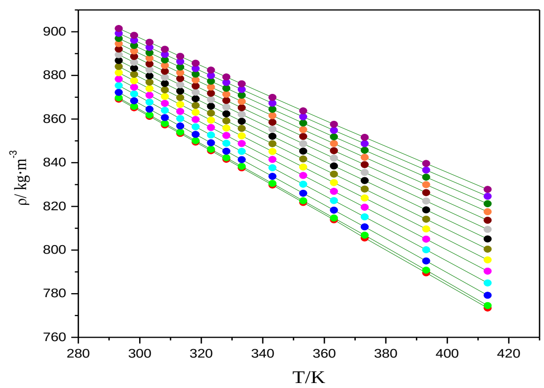


(g)

Figure 4.13 Densities of (a) 1-butanol, (b) 1-propanol, (c) ethyl laurate, (d) ethyl linoleate, (e) ethyl myristate (f) ethyl oleate and (g) methyl laurate vs. temperature at (●) 0.1 MPa,(●) 1 MPa, (●) 5 MPa, (●)10 MPa, (●) 15 MPa, (●) 20 MPa , (●) 25 MPa, (●) 30 MPa, (●) 35 MPa , (●) 40 MPa,(●) 45 MPa, (●) 50 MPa, (●) 55 MPa, and (●) 60 MPa.

4.4.1 Comparison of the alcohols, ethyl and methyl esters samples at high pressure

The measured data of pure 1-butanol, 1-propanol, ethyl and methyl esters are also compared with those reported previously in open literature (**Figure** 4.15). An absolute average percentage deviation, together with the maximum percentage deviation, is used to estimate the level of agreement between measured and literature values[11]. In some cases, the literature values had to be interpolated in order to obtain the data corresponding to a certain pressures and temperature considered in this study.

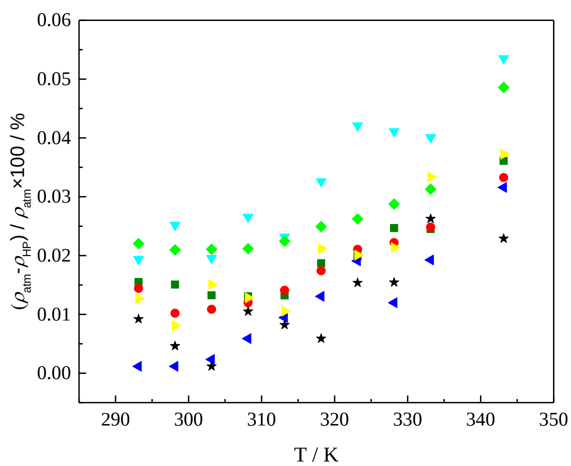
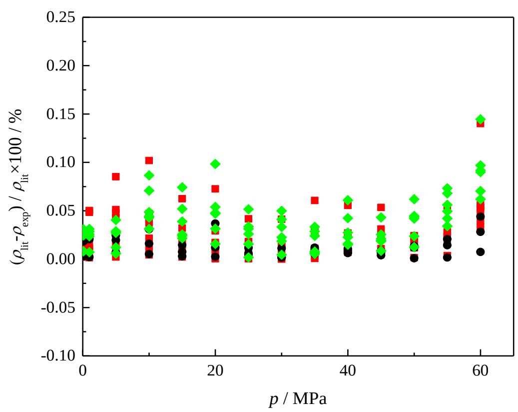


Figure 4.14 Comparison between density values obtained by means of DSA 5000 M (atm) densimeter and those measured by means of DMA HP densimeter at atmospheric pressure: (■)1-butanol, (●) 1-propanol, (◆) ethyl laurate , (▼) ethyl linoleate, (◀) ethyl myristate, (▶) ethyl oleate and (★) methyl laurate.

Experimental high pressure densities for studied 1-butanol and 1-propanol were compared to data published by various authors [44-47] under different temperature and pressure conditions and the obtained absolute average percentage deviations were less than 0.03% (*MD*=0.14%) for 1-butanol and 0.05% (*MD*=0.11%) for 1-propanol (**Figure** 4.15a and b) over the temperature range (293.15-413.15) K. The data from literature[46] (**Figure** 4.15a and b) are slightly and systematically higher than the present data and other published values of density at high pressures and high temperatures, 0.14%(*MD*= 0.30%) for 1-butanol and 0.13 %(*MD*= 0.30%) for 1-propanol. As for ethyl and methyl ester, densities studied by[26, 49, 50, 177, 178] were considered. The obtained absolute average percentage deviations were less than 0.06% (*MD*=0.11%) for ethyl laurate (**Figure** 4.15c) along 12 isotherm ranging from 293.15 to 393.15K, 0.05% (*MD*=0.10%) for ethyl myristate (**Figure** 4.15d) at temperatures ranging from 293.15 to 318.15 K and 0.08% (*MD*=0.22%) for methyl laurate (**Figure** 4.15e) over the temperature range (293.15-373.15) K.



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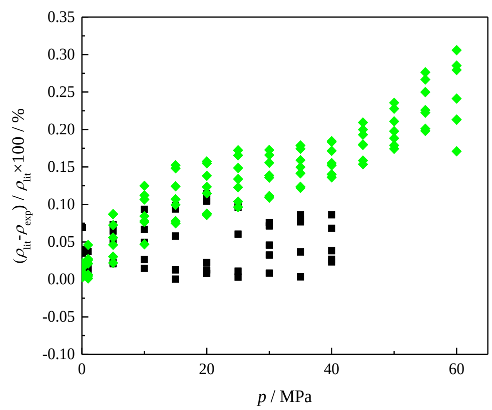

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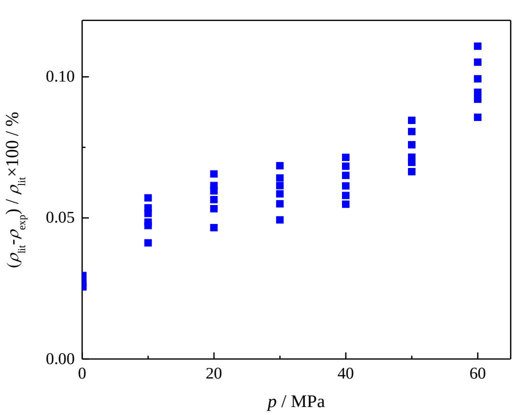

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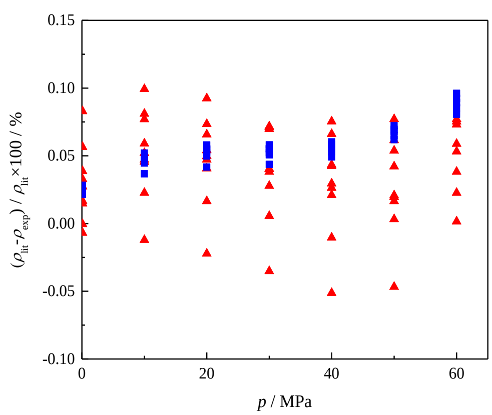

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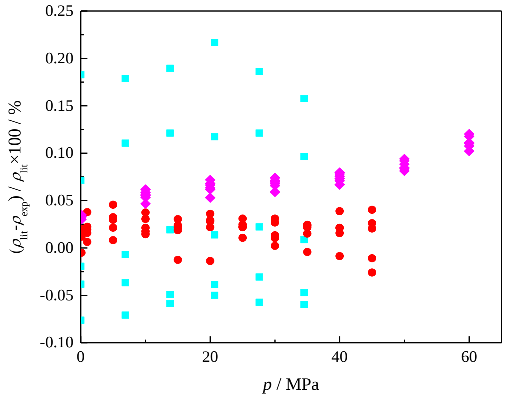


(e)

Figure 4.15 Comparison of the experimental densities with literature data for a) 1-butanol with (■)Safarovet al.[44], (●) Alaoui et al.[45] and (◆)Davila et al.[46], b)1-propanol with (■)Abdulagatov et al.[47] and (◆) Davila et al.[46] c) ethyl laurate with (■) Dzida et al.[49], d) ethyl myristate with (▲) Ndiaye et al.[177] and (■) Dzida et al.[49] e) methyl laurate with (■) Tat and Van Gerpen[178], (●) Pratas et al. [26]and (◆) Zarska et al.[50]

5 Modeling experimental data

5.1 Modeling viscosity at ambient pressure

As regards viscosity data as a function of temperature, they were correlated by means of the Vogel-Fulcher-Tammann (VFT) equation:

$$\ln \eta = A + \frac{B}{T - C} \tag{5.1}$$

where *A*, *B* and *C* are the fitting parameters obtained by linearization of the equation (5.1) along with an optimization algorithm based on the least-square method. The obtained model parameters, together with the values of comparison criteria, are presented in **Table 5.1**. Obtained criteria values of the absolute average percentage deviation, *AAD*, the percentage maximum deviation, *MD*, the average percentage deviation, *Bias*, and the standard deviation, *σ*,[92, 93, 179] are pretty low which validates the application of this model in viscosity modeling.

Table 5.1. The parameters of the Vogel-Fulcher-Tammann (VFT) model

	1-butanol	1-propanol	Ethyl laurate	Ethyl linoleate	Ethyl myristate	Ethyl oleate	Methyl laurate	*n*-hexadecane
A	-7.5020	-10.9341	-3.0125	-2.5645	-2.8036	-2.5935	-2.9378	-3.0786
B / K	2799.4260	5882.7910	753.4941	721.3530	723.2488	718.8809	699.1822	757.9350
C / K	-33.9754	-209.6012	114.7339	125.6801	126.9956	132.0481	121.6821	117.1340
AAD / %	0.10	0.17	0.15	0.30	0.23	0.34	0.20	0.06
MD / %	0.1771	0.3597	0.2686	0.2967	0.3373	0.3259	0.2943	0.2039
Bias / %	0.0148	0.0001	-0.0496	-0.0007	-0.0522	-0.0628	-0.0485	0.0001
σ / mPa·s	0.003	0.004	0.006	0.015	0.011	0.023	0.007	0.003

5.2 Dynamic viscosity modeling of binary mixtures

Viscosity modeling was carried out using predictive and correlative models. The advantage of using predictive models is that the viscosity of mixtures can be calculated based on the knowledge of the viscosity of the pure components and the contributions of the corresponding functional groups. The drawback of this approach is that the contributions of individual groups must be very precisely defined in order to obtain satisfactory results. They are suitable for application under different conditions i.e. temperature, pressure and composition. However, it is possible that the interaction parameters of certain groups present in the examined mixtures are not known, and therefore, with a number of similar systems and certain optimization techniques, they can be obtained to be applied later on as purely predictive. Correlative models yield better results than predictive ones, but involve optimization of one or more interaction parameters, which requires experimental data, reduces the flexibility of the model and limits its application to the pressure and temperature conditions at which the interaction parameters are determined.

5.2.1 PREDICTIVE MODELS - Group contribution models

Group contribution models contain binary interaction parameters of groups, which are determined by correlating relevant experimental data of the binary systems containing those functional groups. Once determined, these interaction parameters can be used to predict the properties of all systems containing given groups, for which no experimental data are available. Thus, the number of experimental data necessary for thermodynamic calculations is significantly reduced, since the number of functional groups present in solution is much smaller than the number of possible components of the solution. Also, on the basis of a relatively small number of groups (50-100), thousands of various solutions can be thermodynamically processed.

UNIFAC-VISCO model

In UNIFAC–VISCO model [124, 149], the relationship between the viscosity and the excess Gibbs energy of activation, ($\Delta^* G^E$ is calculated as the sum of two parts) can be expressed as follows:

$$\ln \eta_m = \sum_i x_i \ln(\eta_i V_i) - \ln V_m + \frac{\Delta^* g^{EC}}{RT} + \frac{\Delta^* g^{ER}}{RT} \tag{5.2}$$

Here η_i and V_i are viscosity and volume of pure substances, and η_m and V_m are mixture viscosity and volume, respectively, and x_i is mole fraction.

$\Delta^* G^E$ is excess Gibbs energy of activation and calculated as the sum of two parts. The first part is the the combinatorial $(\Delta * G^{EC}/RT)$, which depends on the molecular structure of the components. The second part is residual contribution $(\Delta * G^{EC}/RT)$, which depends on interactions of the functional groups within the mixture (α_{nm}).

ASOG-VISCO model

ASOG-VISCO model is also a group contribution model [63]. It uses a number of interaction parameters (m_{kl} and n_{kl}) as input to calculate various thermo-physical properties at different conditions of temperature, pressure and composition. Viscosity of binary systems using this model is calculated:

$$\ln(vM) = \sum_i x_i \ln(v_i M_i) - \frac{\Delta^* G^E}{RT} \tag{5.3}$$

in which v is kinematic viscosity and M is molar mass of mixture, x_i, M_i and v_i are mole fraction, molar mass and kinematic viscosity of pure component i, respectively.

Excess Gibbs energy (ΔG^E) is calculated as the sum of two parts, which were defined in the similar manner as in the UNIFAC-VISCO model.

5.2.2 Correlative approach

Correlative models for calculating the viscosity of liquid mixtures contain interaction parameters. The interaction parameters are calculated by optimization from the experimental mixture data. For each mixture the parameters are calculated separately. In this paper, one-parameter Teja-Rice [64, 65], two-parameter McAllister-3 [66] and three-parameter McAllister-4 [66] model were used.

Teja-Rice model

Teja and Rice [64, 65] proposed the following liquid mixture viscosity model based on the corresponding-states fundamental rule. According to proposed procedure, viscosity of binary systems is calculated using:

$$\ln(\eta_m \varepsilon_m) = \ln(\eta\varepsilon)^{(R1)} + \ln(\eta\varepsilon)^{(R2)} - \ln(\eta\varepsilon)^{(R1)} \frac{\omega_m - \omega^{(R1)}}{\omega^{(R2)} - \omega^{(R1)}} \tag{5.4}$$

in which labels $R1$ and $R2$ refer to two reference fluids, η is dynamic viscosity; ω is a centric factor, ε parameter that includes critical molar volume, critical temperature and molar mass of pure component and ε_m parameter for mixture which contains interaction parameter ψ_{ij}.

McAllister Multibody models

McAllister's multibody interaction model [66] was introduced to correlate kinematic viscosity (v) data. On the basis of the Eyring's theory of absolute reaction rates, the two-parameters McAllister equation was derived by taking into consideration interaction of both like and unlike molecules by two-dimensional three-body model. The McAllister three-body (McAllister-3 model) interaction model for binary systems can be expressed as follows:

$$\ln v_m = x_1^3 \ln v_1 + 3x_1^2 x_2 \ln v_{12} + 3x_1 x_1^2 \ln v_{12} + x_2^3 \ln v_2 - \ln\left(x_1 + \frac{x_2 M_2}{M_1}\right) + 3x_1^2 x_2 \ln\left[\frac{2 + \frac{M_2}{M_1}}{3}\right] + 3x_1 x_2^2 \ln\left[\frac{1 + \frac{2M_2}{M_1}}{3}\right] + x_2^3 \ln(M_2/M_1) \tag{5.5}$$

Here v_m is the kinematic viscosity of mixture, v_{12} and v_{21} are interaction parameters, and M_i, v_i, x_i are molar mass, kinematic viscosity and mole fraction of pure components i, respectively.

If there is much difference in size of two molecules then the McAllister four-body (McAllister-4 model) interaction model can be derived to represent the viscosity data. In which v_{1112}, v_{1122} and v_{2221} are the binary interaction parameters:

$$\ln v_m = x_1^4 \ln v_1 + 4x_1^3 x_2 \ln v_{1112} + 6x_1^2 x_2^2 \ln v_{1122} + 4x_1 x_2^3 \ln v_{2221} + x_2^4 \ln v_2 - \ln\left(x_1 + \frac{x_2 M_2}{M_1} \right)$$
$$+4x_1^3 x_2 \ln\left[\frac{3+\frac{M_2}{M_1}}{4}\right] + 6x_1^2 x_2^2 \ln\left[\frac{1+\frac{M_2}{M_1}}{2}\right] + 4x_1 x_2^3[\ln(1+3M_2/M_1)/4] + x_2^4 \ln[M_2/M_1] \quad (5.6)$$

5.3 OPTIMIZATION - DETERMINATION OF INTERACTION PARAMETERS

It is often not possible to calculate the viscosity of a system using predictive models because there are no values of the interaction parameter α_{nm}, nor the constants Q_k and R_k, for the UNIFAC-VISCO model, or the interaction parameters $m_{k,l}$ and $n_{k,l}$ for the ASOG-VISCO model, for groups existing in compounds of the desired mixtures. New parameters can be obtained by the Marquardt optimization technique [180] from the corresponding experimentally measured mixture viscosity values using the equation to minimize the OF function:

$$OF = \frac{1}{m}\sum_{i=1}^{m}\left(\frac{\eta_{\exp} - \eta_{cal}}{\eta_{\exp}}\right)^2 \rightarrow \min \quad (5.7)$$

In which m is the number of data points; η_{exp} and η_{cal} are the experimental and calculated viscosity data, respectively. The percentage deviations (PD_{max}), between the experimental results and the calculated values, from Eq. 5.7, was calculated to check the ability of these models, where η_{exp} and η_{cal} represents experimental results and calculated values of dynamic viscosity and $(\eta_{exp})_{\max}$ is the maximum of experimental obtained values. The results obtained with these models for all studied binary systems[13] over the investigated temperature range are given in **Table** 5.2.

$$PD_{\max} = \frac{100}{m} . \sum_{i=1}^{m}\left|\frac{\eta_{i,\exp} - \eta_{i,cal}}{\eta_{i,\exp,\max}}\right|_i \quad (5.8)$$

The new UNIFAC-VISCO (α_{nm}) and ASOG-VISCO (m_{kl}, n_{kl}) interaction parameters are summarized in **Table** 5.3 and **Table** 5.4, respectively, together with the parameters taken from original papers [63, 124, 149]. The values of model parameters for correlative models at all studied temperatures are presented in Appendix (**Table** A 15).

Table 5.2 Results of viscosity prediction, and viscosity correlation for the investigated binary mixtures.

T/(K)	***PD/PD$_{max}$* (%)**				
	Predictive Models		Correlative Models		
	UNIFAC-VISCO	ASOG-VISCO	Teja-Rice	McAllister-3	McAllister-4
Ethyl laurate (2) + 1-propanol (2)					
293.15	20.0/8.7	23.8/19.6	23.7/20.4	10.5/9.2	7.0/6.1
298.15	20.4/9.0	29.8/22.2	20.6/18.3	8.1/9.2	5.4/6.2
303.15	20.7/9.3	32.4/21.8	18.2/16.1	8.0/7.0	5.3/4.6
308.15	21.1/9.7	33.0/20.1	15.7/13.9	7.0/6.1	4.5/3.9
313.15	21.6/10.1	28.3/15.6	13.2/11.7	5.8/5.1	3.8/3.2
318.15	22.0/10.3	29.0/14.7	10.7/9.4	4.7/4.0	3.0/2.6
323.15	22.5/10.7	25.0/11.6	8.2/7.2	3.7/3.1	2.1/1.9
328.15	23.0/11.0	19.5/8.3	5.8/5.1	2.6/2.2	1.5/1.3
333.15	23.5/11.4	12.4/4.9	3.3/2.9	1.4/1.2	0.8/0.7
338.15	24.0/11.6	3.5/1.2	0.9/0.8	0.7/0.6	0.4/0.3
343.15	15.6/7.4	2.7/7.9	1.6/1.4	0.6/0.5	0.8/0.7
Ethyl oleate (2) + 1-butanol (2)					
293.15	23.3/17.6	3.0/2.0	1.4/1.0	0.1/0.1	0.1/0.1
298.15	23.4/17.7	1.2/0.8	1.4/1.0	0.1/0.1	0.1/0.1
303.15	23.5/17.8	1.1/0.7	1.4/10	0.1/0.1	0.1/0.1
308.15	23.9/18.1	1.1/0.7	1.3/1.0	0.2/0.2	0.1/0.1
313.15	24.2/18.4	1.3/0.8	1.2/0.9	0.3/0.2	0.1/0.1
318.15	24.6/18.6	2.3/1.5	1.3/0.9	0.4/0.3	0.1/0.1
323.15	25.0/18.9	3.9/2.7	1.3/0.9	0.4/0.3	0.1/0.1
328.15	25.4/19.2	6.1/4.3	1.3/0.9	0.5/0.3	0.2/0.1
333.15	25.8/19.5	9.0/6.4	1.2/0.9	0.6/0.4	0.1/0.1
338.15	26.3/19.8	12.4/8.9	1.5/0.9	0.7/0.5	0.2/0.1
343.15	16.8/12.2	11.7/8.5	1.4/1.0	0.1/0.1	0.1/0.1
Ethyl oleate (1) + 1-propanol (2)					
293.15	13.4/8.3	9.7/7.0	2.0/1.3	1.5/1.0	0.4/0.3
298.15	13.5/8.5	11.0/7.9	1.9/1.3	1.5/1.0	0.5/0.3
303.15	13.7/8.7	11.4/8.2	1.9/1.3	1.5/1.0	0.5/0.3
308.15	14.0/8.9	11.1/8.1	1.8/1.3	1.5/1.0	0.5/0.3
313.15	14.2/9.1	10.3/7.5	1.7/1.2	1.6/1.0	0.5/0.3
318.15	14.6/9.4	9.2/6.7	1.8/1.2	1.6/1.1	0.5/0.4
323.15	15.0/9.6	7.6/5.6	1.7/1.2	1.7/1.1	0.5/0.4
328.15	15.5/9.9	5.4/4.0	1.7/1.2	1.7/1.1	0.6/0.4
333.15	15.9/10.2	2.7/2.0	1.6/1.1	1.8/1.2	0.6/0.4
338.15	16.5/10.5	0.5/0.3	1.7/1.2	1.8/1.2	0.6/0.4
343.15	6.4/4.9	0.3/0.3	1.7/1.2	1.9/1.3	0.7/0.4
Ethyl oleate (1) + *n*-hexadecane(2)					
293.15	1.0/0.7	1.7/1.2	0.6/0.5	0.1/0.1	0.1/0.04
298.15	1.1/0.8	1.6/1.1	0.7/0.6	0.1/0.1	0.1/0.1
303.15	1.0/0.7	1.6/1.1	0.7/0.6	0.1/0.1	0.1/0.1
308.15	0.9/0.6	1.6/1.2	0.6/0.5	0.1/0.1	0.1/0.1
313.15	0.8/0.6	1.7/1.2	0.5/0.4	0.1/0.1	0.1/0.1
318.15	0.7/0.5	1.6/1.2	0.6/0.4	0.1/0.1	0.1/0.1
323.15	0.7/0.5	1.6/1.2	0.5/0.4	0.1/0.1	0.1/0.1
328.15	0.6/0.5	1.6/1.2	0.5/0.4	0.1/0.1	0.1/0.1
333.15	0.5/0.4	1.6/1.2	0.4/0.3	0.1/0.1	0.1/0.04
338.15	0.5/0.4	1.6/1.2	0.4/0.3	0.1/0.1	0.1/0.04
343.15	0.3/0.3	2.3/1.8	0.3/0.3	0.1/0.1	0.1/0.04
n-hexadecane (1) + 1-butanol (2)					
293.15	11.2/10.5	22.0/20.3	2.4/2.2	0.4/0.4	0.4/0.3
298.15	11.0/10.3	22.7/20.9	2.2/2.1	0.4/0.4	0.3/0.3

303.15	10.9/10.1	23.2/21.3	2.0/1.8	0.4/0.3	0.3/0.3
308.15	10.5/9.8	23.6/21.7	1.8/1.7	0.3/0.3	0.3/0.3
313.15	10.2/9.5	24.0/21.8	1.7/1.6	0.3/0.3	0.3/0.3
318.15	9.9/9.1	24.1/21.8	1.6/1.5	0.3/0.3	0.3/0.3
323.15	9.5/8.8	24.0/21.6	1.5/1.3	0.4/0.3	0.3/0.3
328.15	9.1/8.4	23.7/21.2	1.4/1.3	0.4/0.3	0.3/0.3
333.15	8.7/8.0	23.2/20.7	1.3/1.2	0.4/0.3	0.3/0.3
338.15	8.3/7.6	22.6/19.9	1.2/1.1	0.3/0.3	0.3/0.3
343.15	7.9/7.2	21.6/18.9	1.2/1.0	0.3/0.3	0.3/0.3
n-hexadecane (1) + 1-propanol (2)					
293.15	6.4/5.8	29.2/25.8	1.5/1.4	0.8/0.6	0.3/0.2
298.15	6.8/6.2	29.5/26.2	1.5/1.3	0.8/0.6	0.3/0.3
303.15	7.1/6.4	29.9/26.4	1.4/1.3	0.7/0.6	0.3/0.3
308.15	7.1/6.4	30.2/26.6	1.4/1.2	0.7/0.6	0.4/0.3
313.15	7.2/6.5	30.3/26.6	1.3/1.1	0.7/0.6	0.4/0.3
318.15	7.2/6.4	30.4/26.5	1.2/1.1	0.7/0.6	0.4/0.4
323.15	7.2/6.4	30.2/26.2	1.2/1.1	0.7/0.5	0.4/0.4
328.15	7.1/6.2	29.9/25.7	1.2/1.0	0.6/0.5	0.4/0.4
333.15	7.0/6.1	29.3/25.1	1.1/1.0	0.6/0.5	0.4/0.3
338.15	6.8/5.9	28.6/24.3	1.1/1.0	0.7/0.5	0.5/0.4
343.15	6.6/5.8	27.6/23.1	1.0/0.9	0.7/0.6	0.6/0.5

An individual examination of each model shows that three parameters of the McAllister4 model yiel ded excellent fitting results with maximum percentage deviations (PD_{max}) from experimental viscosity values less than 0.8 % for most systems and temperatures except ethyl laurate + 1-propanol system from T=293.15 to 328.15K, when the deviation was around 5 %. Two parameters McAllister-3 model generated very good results for all investigated systems and at all temperatures with maximum percentage deviation (PD_{max}) around 1 %. The Teja–Rice model produced results of lower quality[13] than the above-mentioned models, but below 2% for all considered systems except the ethyl laurate + 1-propanol system at the lowest temperature or in the middle of studied temperature, when the deviation was around 10 %. Much better results for predictive models than Teja-Rice model are obtained in the mixture of ethyl oleate + *n*-hexadecane with maximum percentage deviation (PD_{max}) bellow 1 % and 0.6 %, respectively, for all investigated temperatures. They are also of similar quality as three and Four-body McAllister models in the mentioned system[13] while the difference becomes significant for other systems. Poor results for ASOG–VISCO model were observed in the case *n*-hexadecane with 1-butanol or 1 –propanol systems, with maximum percentage deviation (PD_{max}) less than 25%, while the highest percentage deviation values (PD_{max}), up to 27 %, are obtained for *n*-hexadecane with 1-propanol system. In both systems, the largest deviations were observed at the lowest temperature or in the middle of studied temperature[13].

Table 5.3 The UNIFAC-VISCO interaction parameters used in this paper.

α_{nm}					
n/m	CH_3	CH_2	OH	COO	CH=CH
CH_3	0	-709.5[a]	594.4[a]	-172.4[a]	82.6002[b]
CH_2	66.53[a]	0	498.6[a]	1172[a]	-3518.40[b]
OH	1209[a]	-634.5[a]	0	68.35[a]	4148.841[b]
COO	-44.25[a]	541.6[a]	186.8[a]	0	-131.143[b]
CH=CH	189.263[b]	-586.574[b]	14865.512[b]	240.402[b]	0

[a]Original UNIFAC-VISCO interaction parameters from [149-124].
[b]New UNIFAC-VISCO interaction parameters optimized in this work.

Table 5.4 The ASOG-VISCO interaction parameters used in this paper.

m_{kl}				
k/l	CH_2	OH	COO	CH=CH
CH_2	0	-0.357[a]	0.3682[a]	1.9382[b]
OH	14.146[a]	0	-40.200[a]	1.9299[b]
COO	0.0952[a]	19.131[a]	0	2.9843[b]
CH=CH	0.5992[b]	-2.1326[b]	1.9391[b]	0
n_{kl}				
CH_2	0	469.65[a]	112.59[a]	-0.016[b]
OH	-6137[a]	0	11583[a]	1.048[b]
COO	-383.6[a]	-5747[a]	0	-0.323[b]
CH=CH	2.006[b]	0.004[b]	0.003[b]	0

[a]Original ASOG-VISCO interaction parameters [63].
[b]New ASOG-VISCO interaction parameters optimized in this work.

5.4 High-pressure density modeling and calculation of derived properties

To make the present results immediately usable for engineering and design purposes, the modified Tammann-Tait [26] equation was applied in this work to correlate the experimental density data under high pressure and also to calculate various derived properties. Optimized parameters of the mentioned equation, together with quality criteria, are given in **Table** 5.5.

The obtained values of the isothermal compressibility, the isobaric thermal expansivity, the internal pressure and the difference between the specific heat capacity at constant pressure and the specific heat capacity at constant volume for all examined components, at the temperature and pressure ranges investigated in this study, were calculated using the coefficients of modified Tammann–Tait equation and given in appendix (**Table** A 16- **Table** A 23). Additionally, some selected derived properties are shown in Figs. 5.1 – 5.5.

Table 5.5 Adjusted parameters of Esq. (2.40)–(2.43), average percentage deviation (*AAD*) and standard deviation (σ) for the pure 1-butanol, 1- propanol, and ethyl and methyl esters.

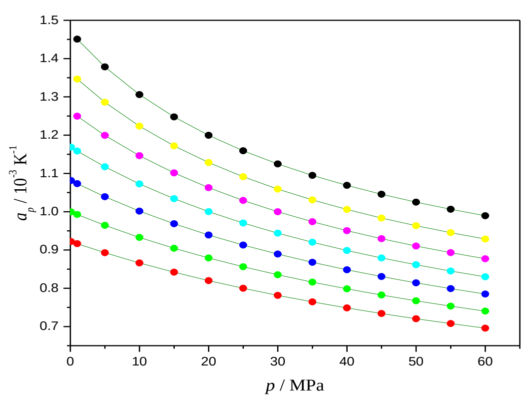
	1-butanol	1-propanol	Ethyl laurate	Ethyl linoleate	Ethyl myristate	Ethyl oleate	Methyl laurate
a_0 /kg·m^{-3}	927.1246	922.8273	1080.4288	1088.6922	1075.9984	1078.9133	1087.5713
a_1 /kg·m·K^{-1}	-0.05992	-0.03253	-0.7130	-0.7162	-0.7155	-0.7078	-0.7086
a_2/kg·m·K^{-2}	-0.116×10^{-2}	-0. 127×10^{-2}	-0.11047×10^{-3}	-0.23828×10^{-4}	-0.65×10^{-4}	-0.30612×10^{-4}	-0.12519×10^{-3}
b_0 /MPa	337.2031	400.2364	430.6415	449.0035	424.90314	431.567937	358.927660
b_1/MPa·K^{-1}	-1.195363	-1.48768	-1.483353	-1.492648	-1.437830	-1.427711	-1.251321
b_2/MPa·K^{-2}	0.1104×10^{-2}	0. 1467×10^{-2}	0.1367×10^{-2}	0.1347×10^{-2}	0.1308×10^{-2}	0.1275×10^{-2}	0.1157×10^{-2}
c_0	0.7662×10^{-1}	0.8803×10^{-1}	0.8693×10^{-1}	0.8716×10^{-1}	0.8596×10^{-1}	0.8569×10^{-1}	0.7316×10^{-1}
AAD (%)	0.03	0.06	0.009	0.006	0.008	0.006	0.0179
MD (%)	0.09	0.09	0.084	0.048	0.051	0.055	0.164
Bias (%)	-0.007	-0.003	-0.004	-0.003	-0.003	-0.003	0.013
σ (kg·m^{-3})	0.32	0.30	0.117	0.081	0.091	0.082	0.278

In terms of isobaric thermal expansivity variation with pressure, the obtained values decrease with increasing pressure up to 60 MPa at a constant temperature. As it can be seen from **Figure 5.1**, the isotherms of the isobaric thermal expansivity for all the studied components illustrate a clear intersection point[11] at the pressure of about 45 MPa for methyl and ethyl laurate, 40 MPa for the ethyl myristate and around 35 MPa for ethyl oleate. This point is consistent with the condition $\left(\frac{\partial \alpha_p}{\partial T}\right)_p = 0$, meaning that the isobaric thermal expansivity of the examined esters is temperature independent at those pressures[11]. At the pressures lower than those at intersection points, the abovementioned components show increase in thermal expansivity with temperature elevation, while their values decrease as the temperature rises at pressures higher than those of intersection points[11]. On the other hand, the isobaric thermal expansivity for alcohols increases with the temperature along isobars and decreases with pressure along isotherms.The obtained isobaric thermal expansivity values of ethyl laurate are higher than those of methyl laurate[11]. A larger isobaric thermal expansivity causes a larger engine power loss due to fuel heating[26, 179].

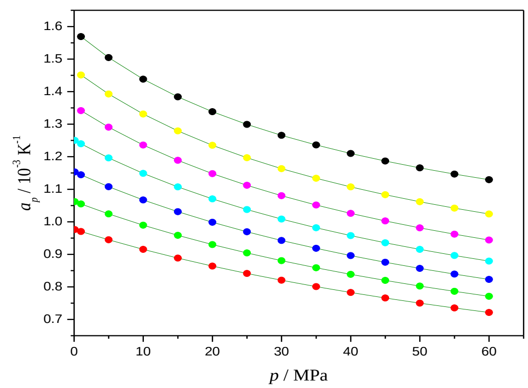
The isothermal compressibilities of the studied components increase with the increasing temperature at a constant pressure and decrease when pressure rises along the isotherms (**Figure** 5.2), as expected, and thus, the trends with temperature and pressure are the opposite of those trends for the density[11] (**Figure** 4.12 and **Figure** 4.13). The obtained values are higher for alcohols than other components while they are slightly higher for ethyl than for methyl laurate but differences are very small though growing with increasing temperature.

With regard to the internal pressure of the studied esters, it decreases with temperature elevation at constant pressure while for alcohols show a clear intersection point at the pressure of about 20 MPa for 1-butanol and around 15 MPa for 1-propanol. At the pressures lower than those at intersection points, alcohols show decrease in the internal pressure with temperature elevation, while their values increase as the temperature rises at pressures upper than those of intersection points. (**Table** A 16-**Table** A 23). On the other hand, its dependence on pressure is a bit more complex[11]. The internal pressure of methyl laurate increases monotonically as pressure rises on all isotherms. For the ethyl esters internal pressure is almost constant or slightly decreases at temperatures below 323.15 K while above 323.15 K it starts to increase with pressure rise on all isotherms[11] (**Figure** 5.4). The pressure influence is most pronounced at the highest isotherm (413.15 K) for all compounds.

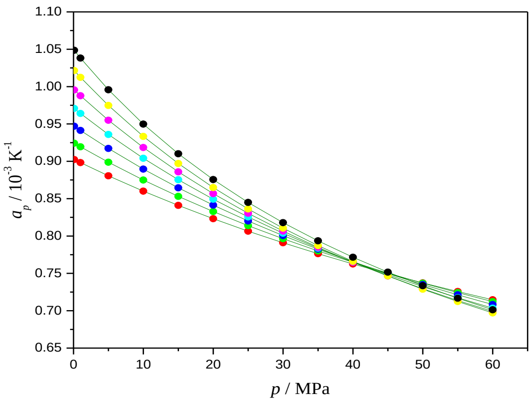
The difference between the specific heat capacity at constant pressure and at constant volume decreases with both, temperature and pressure increase (**Table** A 16-**Table** A 23). Both, isobaric and isochoric molar heat capacity, increase with temperature rise at atmospheric pressure and their values (**Table** A 23) of ethyl and methyl esters are higher than those of alcohols and this is one of the disadvantages of biodiesel that could be overcome by mixing it with diesel or alcohol. It was observed in **Figure** 5.5 that the isochoric molar heat capacity is lower than the isobaric molar heat capacity, indicating that the component is allowed to expand performing thermal expansion if the heat is added at constant pressure. Therefore, it will need more heat to increase the temperature at constant pressure than at constant volume.



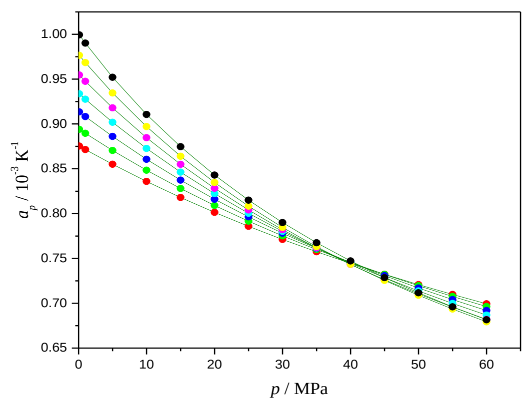
(a)



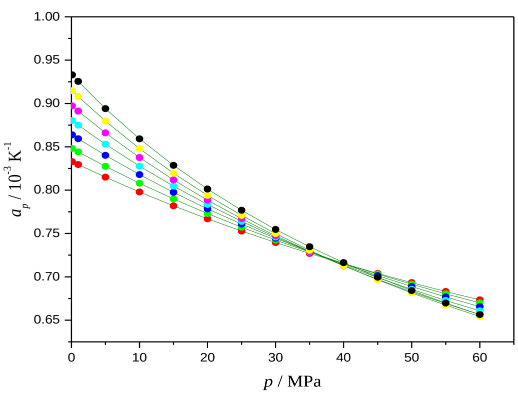
(b)



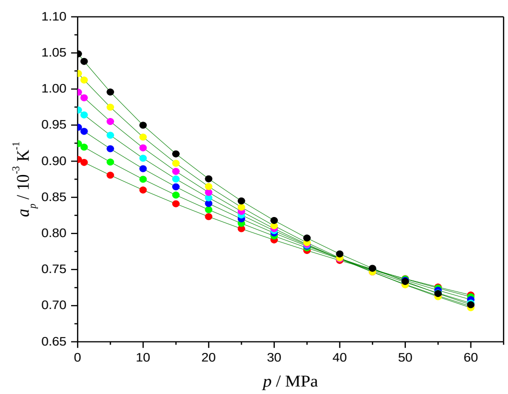
(c)



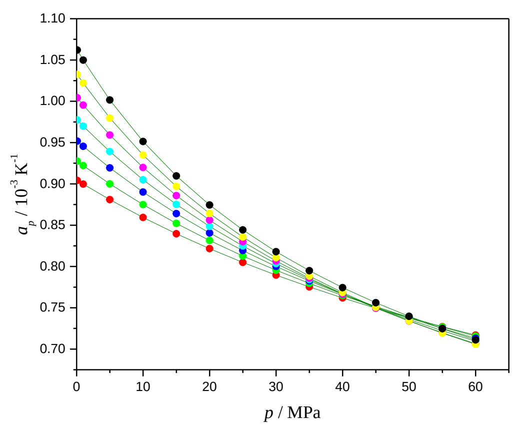
(d)



(e)

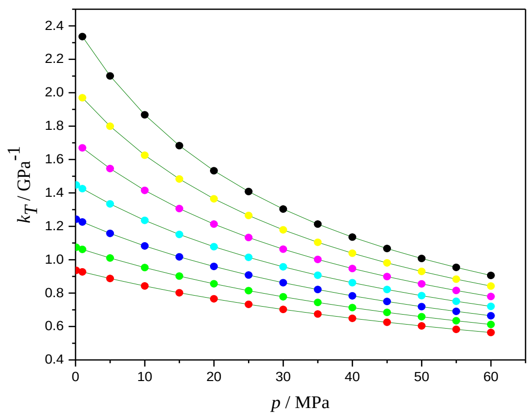


(f)

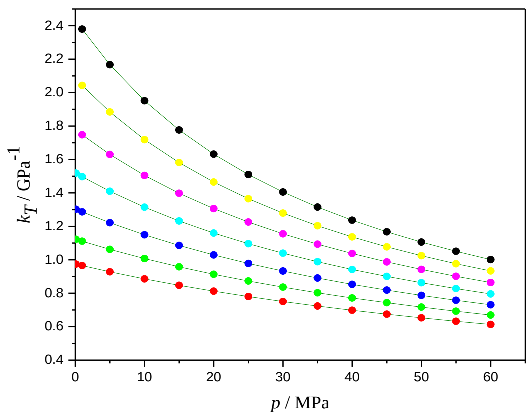


(g)

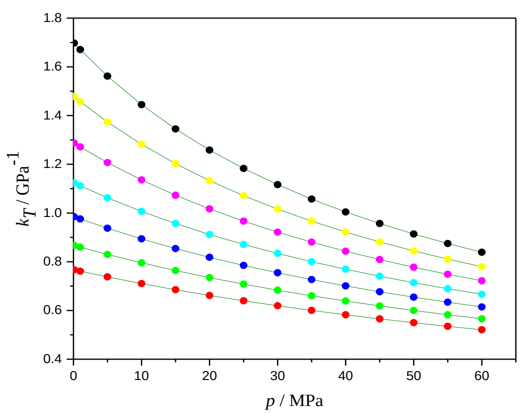
Figure 5.1 The isobaric thermal expansivity of (a) 1-butanol, (b) 1-propanol, (c) ethyl laurate, (d) ethyl linoleate, (e) ethyl myristate (f) ethyl oleate and (g) methyl laurate vs. pressure at (●) 293.15 K, (●) 313.15 K, , (●) 323.15 K, (●) 353.15 K, (●) 373.15 K, (●) 393.15 K, (●) 413.15 K .


k_T / GPa^{-1}
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
10
20
30
40
50
60
p / MPa

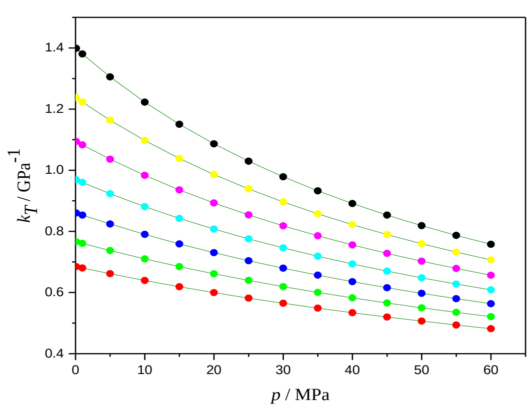
(a)


k_T / GPa^{-1}
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
10
20
30
40
50
60
p / MPa

(b)


k_T / GPa^{-1}
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
10
20
30
40
50
60
p / MPa

(c)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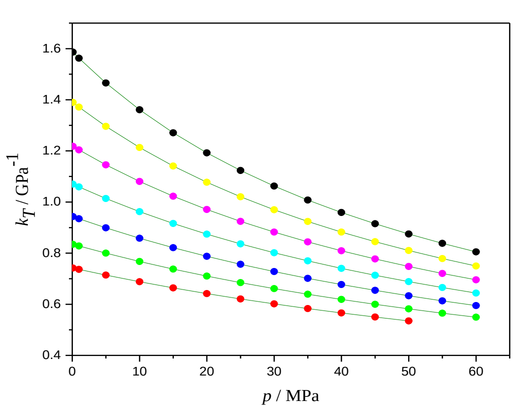
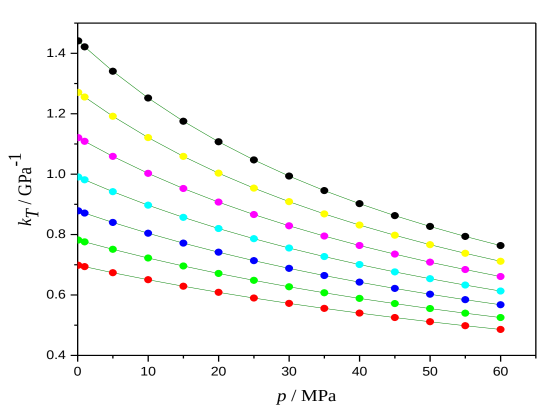
1.0
0.8
0.6
0.4
0
10
20
30
40
50
60
p / MPa

(d)


k_T / GPa^{-1}
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
10
20
30
40
50
60
p / MPa

(e)


k_T / GPa^{-1}
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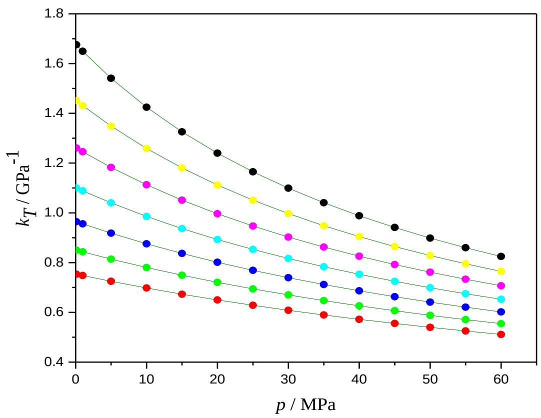
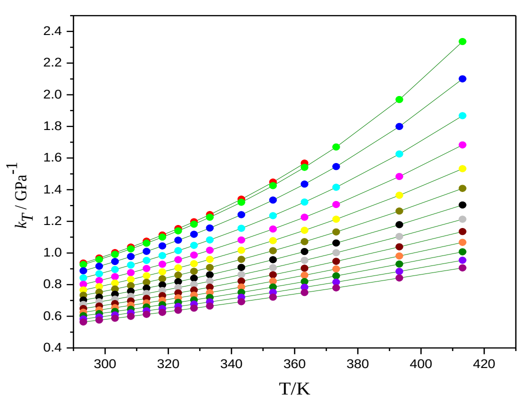
0.6
0.4
0
10
20
30
40
50
60
p / MPa

(f)

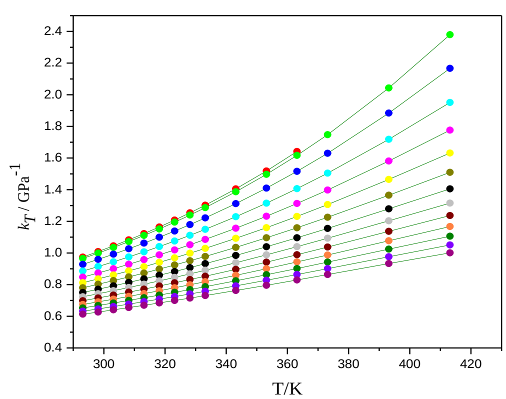


(g)

Figure 5.2 The isothermal compresibilities of (a) 1-butanol, (b) 1-propanol, (c) ethyl laurate, (d) ethyl linoleate, (e) ethyl myristate (f) ethyl oleate and (g) methyl laurate at (●) 293.15 K,(●) 313.15 K, , (●) 323.15 K, (●)353.15 K, (●) 373.15 K, (●) 393.15 K, and (●) 413.15 K .



(a)



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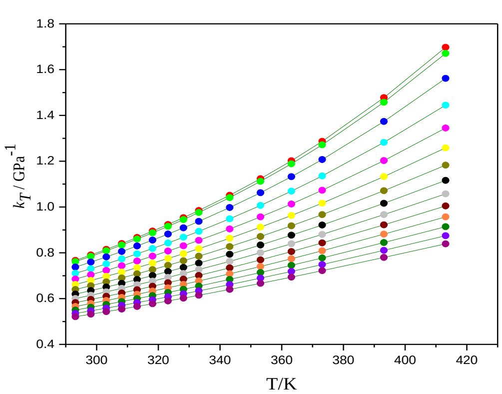

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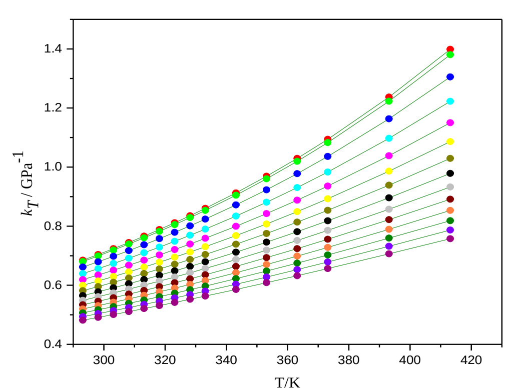

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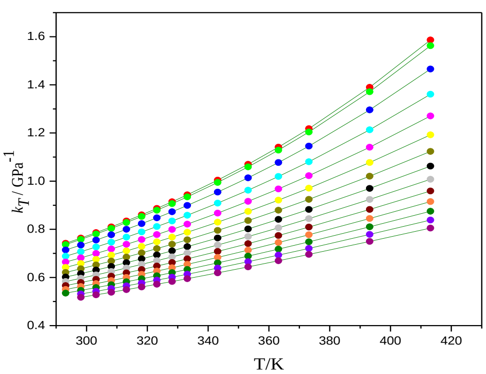
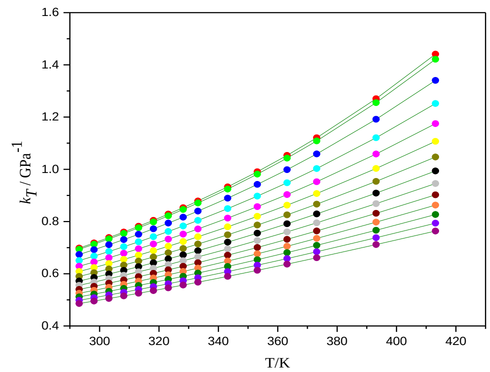


(e)



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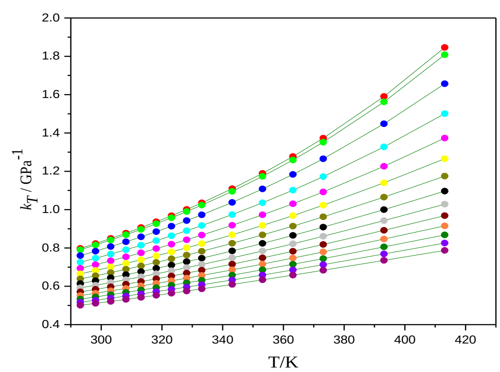
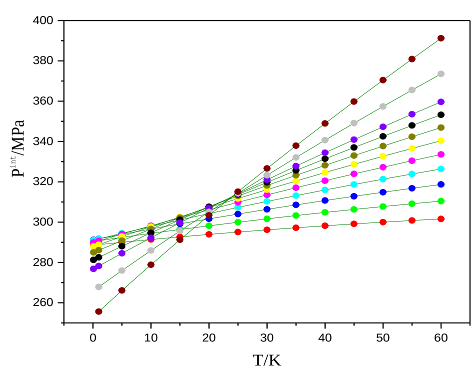
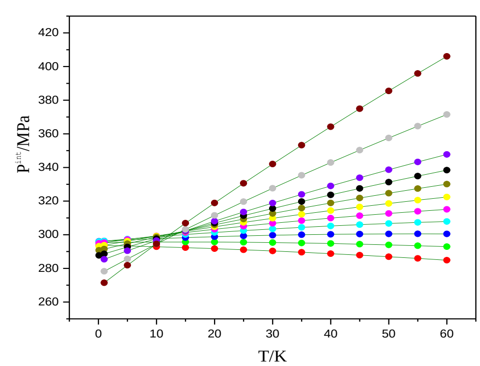


(g)

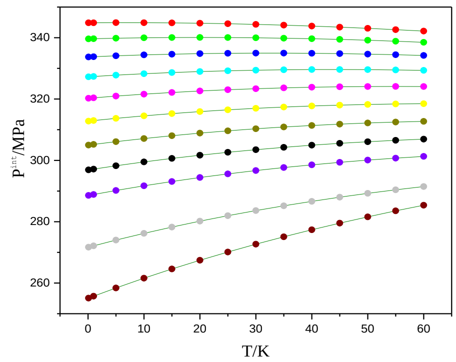
Figure 5.3 The isothermal compresibilities of (a) 1-butanol, (b) 1-propanol, (c) ethyl laurate, (d) ethyl linoleate, (e) ethyl myristate (f) ethyl oleate and (g) methyl laurate vs. temperature at (●) 0.1 MPa,(●) 1 MPa, (●) 5 MPa, (●) 10 MPa, (●) 15 MPa, (●) 20 MPa , (●) 25 MPa, (●) 30 MPa, (●) 35 MPa , (●) 40 MPa,(●) 45 MPa, (●) 50 MPa, (●) 55 MPa and (●) 60 MPa.



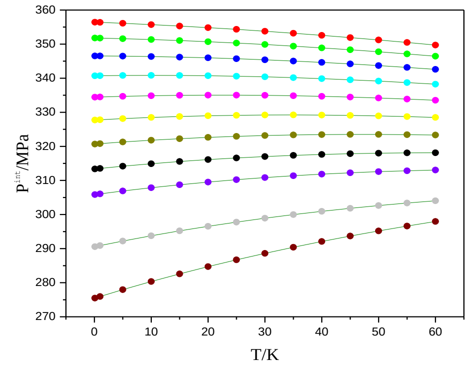
(a)



(b)



(c)



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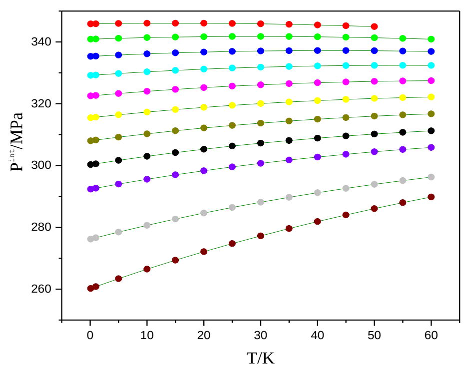

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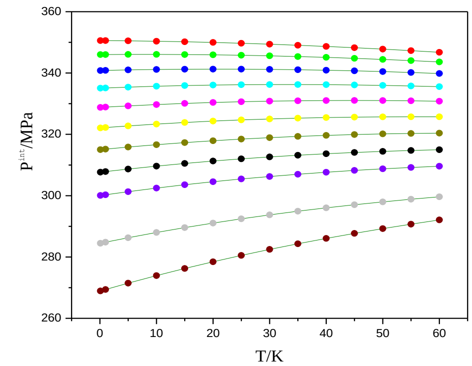
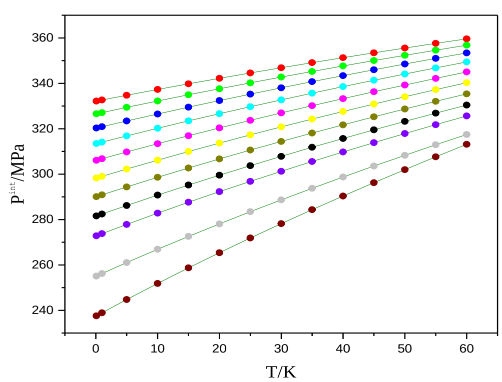


(f)



(g)

Figure 5.4 The internal pressure of (a) 1-butanol, (b) 1-propanol, (c) ethyl laurate, (d) ethyl linoleate, (e) ethyl myristate (f) ethyl oleate and (g) methyl laurate vs. temperature at (●) 293.15 K, (●) 303.15 K, (●) 313.15 K,(●) 323.15 K, (●) 333.15 K, (●) 343.15 K , (●) 353.15 K, (●) 363.15 K, (●) 373.15 K , (●) 393.15 K, and (●) 413.15 K

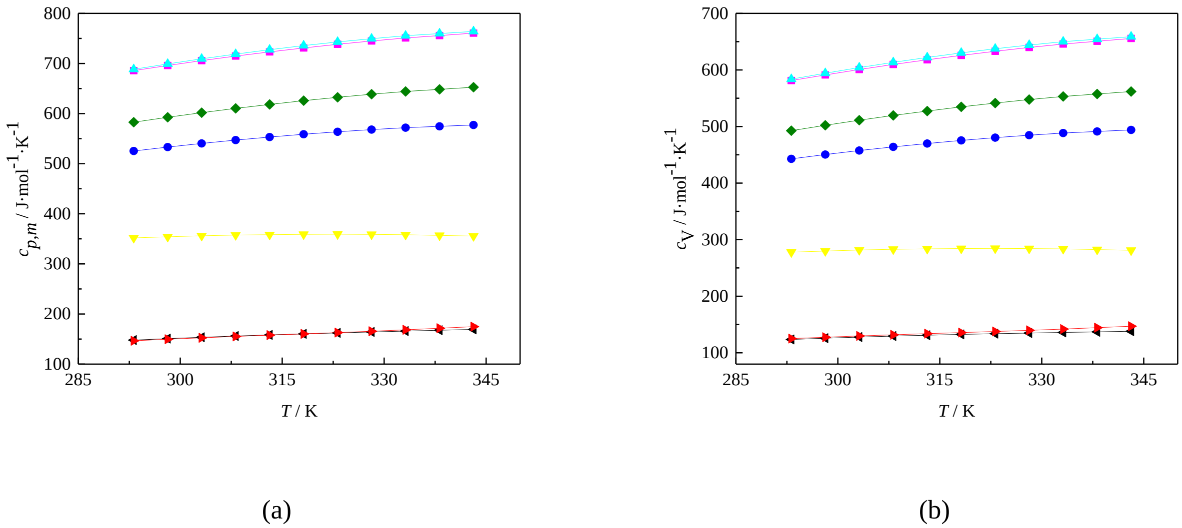


Figure 5.5 Molar heat capacities at 0.1MPa a) constant pressure, $c_{P,m}$, and b) constant volume, $c_{V,m}$, for (◀) 1-butanol, (▶) 1-propanol, (●) ethyl laurate, (■) ethyl linoleate, (◆) ethyl myristate, (▲) ethyl oleate and (▼) methyl laurate, at atmospheric pressure.

6 Conclusion

The strategy of reducing fuel consumption, together with the increasing awareness on environmental concerns, have prompted extensive research around the world on alternative fuel development, and an improvement in the performance of existing engines. Biodiesel and alcohols have attracted much attention for current and future utilization because of their benefits as promising alternative, ecological and economical viable fuels. However, the replacement of diesel fuel by biodiesel still significantly affects on the fuel injection process in the engine and the speed of ignition. One of the ways used to overcome disadvantage of using biodiesel is to blend it with diesel or additives of lower viscosities, such as alcohols. Mixing of biodiesel with alcohols of lower viscosity improves the biofuels content in a blend and preserves the desired properties of the commercial diesel. This allows the engine fuel system to handle biodiesel with none additional modification. Thus, the precise knowledge of thermo-physical properties of pure alcohols and biodiesel at different operational conditions is critically important in predicting the behavior of fuel injection and combustion systems as well as for the optimization of such system. Also, the properties of the blend are directly influenced by the engine operating condition, i.e. temperature, pressure and biofuel composition. For this reason, it is vital to determine the fundamental thermodynamic properties of these blends.

Research methods include experimental measurements and modeling in order to test the efficiency of existing models, with the following steps and conclusions were drawn:

1. Densities, speeds of sound, viscosities and refractive indices of pure components were determined experimentally: 1-butanol, 1-propanol, ethyl laurate, ethyl linoleate, ethyl myristate, ethyl oleate, methyl laurate and *n*-hexadecane. The results obtained were compared with previously reported values and very good agreement was observed. It is very important to note that for ethyl oleate and ethyl linoleate, the refractive index data cannot be found in the literature except at 298.15K, while viscosity is known only at 298.15, 303.15 K and 308.15K from a single source. The results of densities and speeds of sound at ambient pressure show a linear decline with temperature increase. The ranked increase in density was found to be: *n*- hexadecane < 1-propanol < 1-butanol<ethyl myristate < ethyl laurate < methyl laurate < ethyl oleate< ethyl linoleate while speed of sound increases in the following sequence: 1-propanol < 1-butanol <ethyl laurate <*n*-hexadecane <methyl laurate < ethyl myristate < ethyl oleate< ethyl linoleate. The comparison between methyl and ethyl

laurate shows that methyl laurate has higher density and speed of sound than ethyl laurate of the same fatty acid, at ambient pressure. As for the dependence of viscosity on temperature, it decreases exponentially with temperature elevation. The order of increasing viscosity at ambient pressure is: 1-propanol < 1-butanol <methyl laurate < *n*-hexadecane < ethyl laurate < ethyl myristate < ethyl linoleate < ethyl oleate. The obtained viscosities are slightly higher for the ethyl esters than those of the methyl ester. The dependences of refractive indices of the studied components at ambient pressure show a linear decline with temperature increase, indicating that refractive index of the methyl laurate is slightly higher than ethyl laurate and is almost independent of temperature for all examined esters.

2. Density, speed of sound, viscosity and refractive index measurements of six binary and one ternary systems were performed: ethyl laurate + 1-propanol, ethyl oleate +1-butanol, ethyl oleate + 1-propanol, ethyl oleate + *n*-hexadecane, *n*-hexadecane + 1-butanol, *n*-hexadecane + 1- propanol and ethyl oleate + *n*-hexadecane + 1-butanol. All measurements were made at a temperature interval of (293.15-343.15) K and at atmospheric pressure. From experimental data, excess molar volumes V^E, deviation functions $\Delta\eta$, ΔnD, and $\Delta\kappa_s$ as well as molar excess Gibbs free energies of activation of viscous flow ΔG^{*E} were calculated for the binary and ternary mixtures. The binary and ternary properties were correlated as a function of molar fraction of the mixture by using the Redlich–Kister and Nagata and Tamura equations, respectively. The size $\Delta\eta$ for all binary systems was processed with four RK parameters, Δn_D with three parameters also for all systems, while polynomials with four and three parameters and for a pair of systems with five parameters were chosen for the excess molar volume and the molar excess Gibbs free energies of activation of viscous flow. The Nagata-Tamura correlation with nine parameters was chosen for the excess properties of the ternary system. The positive V^E values and positive deviation of viscosity alongside negative deviation of the isentropic compressibility from their ideal behavior for ethyl laurate + 1-propanol, ethyl oleate + 1-butanol and ethyl oleate + 1-propanol system could be attributed to the packing of the different molecules into each other's structure due to its different molecular sizes. Increase of the V^E values (a positive effect) can be interpreted by the disruption of hydrogen bonds in self-associated alcohol molecules and the dipole-dipole interactions, and also steric hindrances as a result of improper interstitial accommodation of ethyl laurate or ethyl oleate within the hydrogen-bonded structure of 1-butanol or 1-propanol for such systems. In case of the system ethyl oleate + *n*-hexadecane, it shows that the

accommodation of one component into the structure of the other is not favorable enough for ethyl oleate + *n*-hexadecane mixture. Thus, the observed behavior seems to suggest that the break of dipole–dipole interactions between the ethyl oleate molecules predominated over the negative contributions associated both with the more effective molecular packing and the heteromolecular dipole-dipole interactions. On the other hand, the observed positive V^E and $\Delta\kappa_s$ values concurrently with viscosity deviations, in the *n*-hexadecane + 1-butanol and *n*-hexadecane + 1-propanol systems show support for the existence of dispersive forces among the unlike molecules. For the analyzed ternary system system, V^E data shows high approximately symmetrical expansion V^E with respect to $x2$ mole fraction due to the cross association between 1-butanol and *n*-hexadecane molecules. This makes sense since for the systems of *n*-hexadecane with 1-butanol these values are positive. Minimum obtained for *L*6 is close to the minimum of the binary mixture ethyl oleate + 1-butanol. Viscosity deviations are negative over the whole range of mole fraction of *n*-hexadecane and for all six lines. These deviations become less negative as the contribution of binary system *n*-hexadecane + 1-butanol increases. In a wide region of this mixture, the $\Delta\kappa_s$ values are positive, finding the negative values in the region close to the binary ethyl oleate + 1-butanol. This reveals that the breaking of intramolecular hydrogen bonds, physical dipole-dipole interactions between polar molecules, and also steric hindrances as a result of improper interstitial accommodation of ethyl oleate within the hydrogen-bonded structure of 1-butanol, produce positive value of excess molar volume. The general behavior of this ternary mixture indicates that dispersive forces predominate and there are no strong specific interactions among the components of this ternary mixture.

3. The densities of the mentioned pure 1-butanol, 1-propanol, ethyl laurate, ethyl linoleate, ethyl myristate, ethyl oleate and methyl laurate were measured along 15 isotherms from (293.15K to 413.15 K) and at pressures (0.1–60) MPa. The results obtained were compared with those reported in literature and very good agreement was observed. Also, comparison of densities at the atmospheric pressure obtained using DSA 5000 M densimeter and those measured by means of DMA HP were made. Each of the pure components showed an increase in density when pressure rises and decrease in density with temperature elevation.
4. Viscosity modeling were carried out using models, Vogel-Fulcher-Tammann (VFT) for pure components and predictive (UNIFAC-VISCO, ASOG-VISCO) and correlative (Teja-

Rice, McAllister-3 and McAllister-4) for binary systems. The quality assessment of the results obtained by each of the mentioned models was determined by comparison with the experimentally measured values. The modeling results show the following:

- The Vogel-Fulcher-Tammann (VFT) equation generated excellent fitting results for all pure components which justifies the application of this model in viscosity modeling.
- Three parameter McAllister-4 model generated excellent fitting results for most systems and temperatures. Furthermore, Two parameters McAllister-3 model gave very good results for all analyzed systems while Teja–Rice model gives results of lower quality than the above-mentioned models. Much better results for predictive models than Teja-Rice model are observed in the mixture of ethyl oleate + *n*-hexadecane with maximum percentage deviation (PD_{max}) bellow 1 % and 0.6 %, respectively, for all studied temperatures. They are also of similar quality as three and Four-body McAllister models in the mentioned system while the difference becomes significant for other systems. Poor results are obtained with ASOG–VISCO model in the case *n*-hexadecane with 1-butanol or 1 –propanol systems. The largest deviations were observed at the lowest temperature or in the middle of studied temperature in both systems
- The obtained high pressure density values were correlated using modified Tammann-Tait equation and the optimized parameters were used to determine isothermal compressibility, the isobaric thermal expansivity and thermal pressure coefficientt. In terms of isobaric thermal expansivity variation with pressure, the obtained values decrease with increasing pressure up to 60 MPa at a constant temperature. A clear intersection point at the pressure of about 45 MPa for methyl and ethyl laurate, 40 MPa for the ethyl myristate and around 35 MPa for ethyl oleate, was observed. At the pressures lower than those at intersection points, the abovementioned components show an increase in thermal expansivity with temperature elevation, while their values decrease as the temperature rises at pressures higher than those of intersection points. On the other hand, the isobaric thermal expansivity for alcohols increases with the temperature along isobars and decreases with pressure along isotherms. The obtained isobaric thermal expansivity values of ethyl laurate are higher than those of methyl laurate. As for the isothermal compressibility, it increases with the increasing temperature at a constant pressure and decreases when pressure rises along the isotherms as expected, and thus, the trends with temperature and pressure are the opposite of those for the

density. The obtained values are higher for alcohols than other components while they are slightly higher for ethyl than for methyl laurate but differences are very small though growing with increasing temperature. With regard to the internal pressure, it decreases with temperature elevation at constant pressure while for alcohols show a clear intersection point at the pressure of about 20 MPa for 1-butano and around 15 MPa for 1-propanol. At the pressures lower than those at intersection points, alcohols show decrease in the internal pressure with temperature elevation, while their values increase as the temperature rises at pressures upper than those of intersection points. The internal pressure of methyl laurate increases monotonically as pressure rises on all isotherms. For the ethyl esters internal pressure is almost constant or slightly decreases at temperatures below 323.15 K while above 323.15 K. The difference between the specific heat capacity at constant pressure and at constant volume decreases with both, temperature and pressure increase. Both, isobaric and isochoric molar heat capacity, increase with temperature rise at atmospheric pressure and their values of ethyl esters are higher than those methyl laurate.

- Organized experimental measurements of thermodynamic and transport properties of pure components, binary and ternary mixtures of esters and alcohol, as well as modeling of binary viscosities, will help to better understand the complex structures and behavior of non-ideal systems and will provide the necessary data for the design of processes and equipment in the chemical industries. Properties of pure components which make up diesel and biodiesel were measured and compared to properties of biodiesel and diesel and a significant difference was noted. So, it is necessary to find their optimal ratio in mixtures in order to extract the best properties of mixture with similar thermodynamic properties as diesel. It is recommened to carry out high pressure density measurements for abovementioned mixtures to get deep insight into molecular interaction and mixing behaviour since fuel injection and combustion take place at moderate temperatures and high pressures and are strongly influenced by the volumetric and transport properties of the fuel.

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8 APPENDIX

Table A 1 Specifications of DMA 5000 density meters

Density:	0 to 3 g·cm^{-3}
Operating temperature range:	0 to +90 ° C (32-194 ° F)
Heavy duty pressures:	0 to 10 bar (0 to 150 psi)
Resolution:	up to 1·10^{-6} g / cm^{3}
Density accuracy:	to 0.00001 g / cm^{3}
Temperature accuracy:	0.001 ° C
Repeatability of s.d .:	up to 1·10^{-6} g / cm^{3}
Tube material:	borosilicate glass
Measurement cell volume:	about 1 ml
Dimensions / weight:	440 x 315 x 220 mm / 24 kg
Charging:	AC 100 to 240 V, 50 to 60 Hz
Consumption:	50 VA
Interfaces:	RS 232 C computer interface, S-BUS interfaces and external analog input

Table A 2 Specifications of SVM 3000 viscometer

Dynamic Viscosity Range:	0.2-20000 mPa ·s
Cinematic Viscosity Range:	0.2-20000 mm^{2} ·s^{-1}
Density:	0.65 to 3 g·cm^{-3}
Operating temperature range:	10 to +105 ° C (without external cooling)
Viscosity precision:	± 0.35% of the measured value
Density accuracy:	± 0.0005g / cm^{3}
Temperature accuracy:	0.02 ° C (0.09 ° F)
Viscosity repeatability:	± 0.1% of the measured value
Tube material:	Hastelloy C-276
Measurement cell volume:	about 1 ml
Dimensions / weight:	440 x 315 x 220 mm / 16 kg
Charging:	AC 100 to 240 V, 50 to 60 Hz
Consumption:	330 VA
Interfaces:	RS 232 C computer interface, S-BUS interfaces, external analog input

Table A 3 Specifications of DSA 5000 M device

Density:	0 to 3 g / cm^3
Sound Speed:	1000-2000 $m \cdot s^{-1}$
Operating temperature range:	0 to 70 ° C
Axial pressure:	0-3 bar
Density repeatability:	to 0.000001 g / cm^3
Repeatable speed of sound:	0.1 $m \cdot s^{-1}$
Repeatability of temperature:	0.001 ° C
Tube material:	Hastelloy C-276 / borosilicate glass
Measurement cell volume:	about 3 ml
Dimensions / weight:	495 x 330 x 230 mm / 22.5 kg
Charging:	AC 100 to 240 V, 50 to 60 Hz
Consumption:	190 VA
Interfaces:	RS 232 C computer interface, S-BUS interfaces, external analog input

Table A 4 Specifications of RXA 156 refractometer

Axial refractive index:	1.32-1.56
Operating temperature range:	+10 to +70 °C (50-158 °F)
Light source:	LED lamp, 589.3 nm
Refractive index precision:	2·10-5
Temperature accuracy:	0.03 °C (0.09 °F)
Tube material:	Hastelloy C-276
Measurement cell volume:	0.3-1 ml
Dimensions / weight:	250 x 160 x 180 mm / 6 kg
Charging:	AC 100 do 240 V, 50 to 60 Hz
Consumption:	330 VA
Interfaces:	RS 232 C computer interface, S-BUS interfaces, external analog input

Table A 5 Specifications of 5000 DMA HP

Density:	0 do 3 g/cm^3
Operating temperature range:	-10 do +200 °C (14-392 °F)
Heavy duty pressures:	0 do 700 bar (0 do 10000 psi)
Resolution:	0.000001 g/cm^3
Density accuracy:	do 0.0001 g/cm^3
Temperature accuracy:	0.05 °C (0.09 °F)
Repeatability of s.d .:	do 0.00001 g/cm^3
Tube material:	Hastelloy C-276
Measurement cell volume:	približno 2 ml
Dimensions / weight:	440 x 315 x 220 mm / 24 kg
Charging:	AC 100 do 240 V, 50 do 60 Hz
Consumption:	330 VA
Interfaces:	RS 232 C computer interface, S-BUS interfaces, external analog input

Table A 6 Densities ρ, speeds of sound u, viscosities η, and refractive indices n_D of examained pure components in this work at temperature T = (293.15 to 343.15) Kand pressure P = 0.1 MPa.

T/K	1-butanol	1-propanol	Ethyl laurate	Ethyl linoleate	Ethyl myristate	Ethyl oleate	Methyl laurate	*n*-hexadecane
				ρ^a/ kgm^{-3}				
293.15	809.80	803.95	862.09	876.87	860.81	868.91	869.18	773.35
298.15	805.98	799.93	858.18	873.22	857.01	865.27	865.24	769.87
303.15	802.13	795.89	854.28	869.57	853.22	861.63	861.31	766.40
308.15	798.25	791.82	850.38	865.93	849.45	858.01	857.39	762.94
313.15	794.35	787.71	846.49	862.30	845.68	854.39	853.47	759.49
318.15	790.41	783.56	842.61	858.68	841.91	850.78	849.55	756.05
323.15	786.42	779.36	838.72	855.06	838.16	847.17	845.63	752.61
328.15	782.39	775.10	834.84	851.45	834.40	843.58	841.73	749.18
333.15	778.30	770.78	830.96	847.84	830.66	839.98	837.82	745.74
338.15	774.15	766.40	827.08	844.24	826.91	836.39	833.90	742.31
343.15	769.94	761.93	823.20	840.65	823.16	832.81	829.99	738.88
				u^a/ m.s^{-1}				
293.15	1256.59	1222.99	1339.53	1401.67	1361.25	1394.15	1351.62	1357.37
298.15	1239.62	1205.74	1321.00	1383.72	1342.85	1376.17	1332.9	1338.49
303.15	1222.76	1188.64	1302.65	1365.92	1324.66	1358.36	1314.36	1319.81
308.15	1206.02	1171.64	1284.48	1348.3	1306.64	1340.73	1295.97	1301.34
313.15	1189.36	1154.73	1266.49	1330.86	1288.82	1323.26	1277.76	1283.07
318.15	1172.77	1137.89	1248.62	1313.57	1271.14	1305.94	1259.70	1264.98
323.15	1156.22	1121.08	1230.94	1296.42	1253.64	1288.81	1241.81	1247.06
328.15	1139.68	1104.3	1213.41	1279.44	1236.31	1271.83	1224.07	1229.32
333.15	1123.16	1087.48	1196.05	1262.64	1219.15	1255.01	1206.49	1211.77
338.15	1106.63	1070.64	1178.87	1246.00	1202.18	1238.38	1189.08	1194.43
343.15	1090.14	1053.84	1161.91	1229.58	1185.44	1221.99	1171.91	1177.55
				η^a / mPa·s				
293.15	2.868	2.147	3.342	5.695	4.685	6.430	3.110	3.408
298.15	2.531	1.926	2.986	5.058	4.145	5.674	2.786	3.036
303.15	2.232	1.716	2.678	4.495	3.673	4.999	2.497	2.708
308.15	1.975	1.533	2.414	4.018	3.283	4.435	2.254	2.432
313.15	1.758	1.379	2.191	3.586	2.936	3.928	2.048	2.199
318.15	1.563	1.234	1.995	3.270	2.666	3.563	1.865	1.996
323.15	1.399	1.112	1.827	2.975	2.422	3.222	1.698	1.823
328.15	1.256	1.005	1.680	2.718	2.212	2.929	1.562	1.671
333.15	1.131	0.9109	1.549	2.473	2.015	2.650	1.442	1.537
338.15	1.021	0.8241	1.436	2.300	1.867	2.454	1.340	1.421
343.15	0.9250	0.7468	1.335	2.126	1.726	2.259	1.247	1.316
				n_D				
293.15	1.3999	1.3852	1.4315	1.4568	1.4361	1.4502	1.4321	1.4340
298.15	1.3979	1.3831	1.4294	1.4547	1.4340	1.4481	1.4300	1.4318
303.15	1.3959	1.3810	1.4273	1.4527	1.4319	1.4461	1.4279	1.4296
308.15	1.3938	1.3789	1.4252	1.4507	1.4299	1.4441	1.4258	1.4275
313.15	1.3918	1.3768	1.4231	1.4486	1.4278	1.4421	1.4236	1.4254
318.15	1.3897	1.3747	1.4210	1.4469	1.4257	1.4401	1.4215	1.4233

323.15	1.3876	1.3726	1.4189	1.4445	1.4237	1.4380	1.4194	1.4211
328.15	1.3855	1.3704	1.4168	1.4425	1.4216	1.4360	1.4174	1.4190
333.15	1.3833	1.3682	1.4147	1.4405	1.4196	1.4340	1.4153	1.4169
338.15	1.3810	1.3660	1.4126	1.4384	1.4175	1.4320	1.4132	1.4149
343.15	1.3788	1.3635	1.4105	1.4365	1.4155	1.4300	1.4110	1.4129

The combined expanded uncertainties are: [a]U_c (T) = 0.01K, [b]U_c (ρ) = 0.8 kg·m^{-3}; [c]U_c (η) = 0.007 mPa·s, [d]U_c (u) =0.1m·s^{-1} and [e]U_c (n_D) = $2.8\times10^{-3}$with 0.95 level of confidence (k=2).

Table A 7 The isentropic bulk modulus, β_S, and the intermolecular free length, L_f, ofthe examined methyl and ethyl esters at atmospheric pressure

T/K	1-butanol	1-propanol	Ethyl laurate	Ethyl linoleate	Ethyl myristate	Ethyl oleate	Methyl laurate	*n*-hexadecane
				β_S / MPa				
293.15	1278.7	1202.5	1546.9	1722.8	1595.1	1688.9	1587.9	1424.9
298.15	1238.5	1162.9	1497.6	1671.9	1545.4	1638.7	1537.2	1379.3
303.15	1199.3	1124.5	1449.6	1622.4	1497.2	1589.8	1487.9	1335.0
308.15	1161.0	1087.0	1403.0	1574.2	1450.3	1542.3	1440.0	1292.0
313.15	1123.7	1050.3	1357.8	1527.3	1404.7	1496.1	1393.4	1250.3
318.15	1087.1	1014.5	1313.7	1481.6	1360.4	1451.0	1348.1	1209.8
323.15	1051.3	979.5	1270.8	1437.1	1317.3	1407.2	1304.0	1170.4
328.15	1016.2	945.2	1229.2	1393.8	1275.3	1364.5	1261.2	1132.2
333.15	981.8	911.5	1188.7	1351.7	1234.6	1323.0	1219.5	1095.0
338.15	948.0	878.5	1149.4	1310.7	1195.1	1282.7	1179.1	1059.0
343.15	915.0	846.2	1111.3	1271.0	1156.8	1243.6	1139.9	1024.5
				L_f / 10^{-12} m				
293.15	1.8023	1.8586	1.6387	1.5528	1.6137	1.5683	1.6174	1.7074
298.15	1.8482	1.9073	1.6807	1.5907	1.6545	1.6067	1.6589	1.7513
303.15	1.8953	1.9573	1.7239	1.6295	1.6963	1.6461	1.7015	1.7964
308.15	1.9436	2.0088	1.7681	1.6692	1.7391	1.6864	1.7452	1.8425
313.15	1.9934	2.0618	1.8134	1.7098	1.7829	1.7276	1.7901	1.8897
318.15	2.0446	2.1165	1.8600	1.7514	1.8278	1.7698	1.8361	1.9382
323.15	2.0974	2.1729	1.9077	1.7939	1.8738	1.8129	1.8832	1.9878

Table A 8 Densities ρ (kg·m^{-3}), Dynamic Viscosities η (mPa·s), speeds of sound u (m·s^{-1}) and Refractive Indices n_D for the Binary Mixtures : ethyl laurae (1) + 1-propanol (2),ethyl oleate (1) + 1-butanol (2), ethyl oleate (1) + 1-propanol (2), ethyl oleate (1) + *n*-hexadecane (2), *n*-hexadecane (1) + 1-butanol (2) and *n*-hexadecane (1) + 1-propanol (2), at T = 293.15−343.15 K and p = 0.1 MPa[a]

x_1	ρ / (kg·m^{-3})	η / (mPa.s)	u / (m·s^{-1})	n_D /
		ethyl laurate (1) + 1-propanol (2)		
		293.15K		
0.0000	803.7	2.1470	1222.99	1.3852
0.1000	819.6	2.1682	1254.76	1.3982
0.2000	831.1	2.2671	1275.39	1.4069
0.3000	838.1	2.3850	1290.59	1.4129
0.4000	844.7	2.5045	1300.85	1.4174
0.5000	848.2	2.6251	1310.33	1.4210
0.6000	852.8	2.7494	1317.05	1.4240
0.7000	855.0	2.8765	1324.32	1.4265
0.8000	858.2	3.0055	1329.69	1.4286
0.9000	860.0	3.1467	1335.19	1.4302
1.0000	862.1	3.3424	1339.53	1.4315
		298.15K		
0.0000	799.7	1.9262	1205.74	1.3831
0.1000	815.6	1.9560	1237.04	1.3961
0.2000	827.1	2.0444	1257.32	1.4047
0.3000	834.1	2.1487	1272.42	1.4107
0.4000	840.8	2.2547	1282.50	1.4152
0.5000	844.2	2.3610	1291.98	1.4189
0.6000	848.9	2.4694	1298.60	1.4218
0.7000	851.0	2.5804	1305.89	1.4244
0.8000	854.3	2.6948	1311.18	1.4264
0.9000	856.0	2.8206	1316.67	1.4280
1.0000	858.2	2.9862	1321.00	1.4294
		303.15K		
0.0000	795.6	1.7164	1188.64	1.3810
0.1000	811.5	1.7516	1219.43	1.3939
0.2000	823.2	1.8326	1239.35	1.4026
0.3000	830.0	1.9276	1254.37	1.4085
0.4000	836.8	2.0250	1264.26	1.4131
0.5000	840.2	2.1223	1273.76	1.4168
0.6000	845.0	2.2201	1280.28	1.4197
0.7000	847.0	2.3186	1287.60	1.4222
0.8000	850.4	2.4197	1292.82	1.4243
0.9000	852.1	2.5316	1298.31	1.4259
1.0000	854.3	2.6777	1302.65	1.4273
		308.15K		
0.0000	791.6	1.5325	1171.64	1.3789
0.1000	807.4	1.5740	1201.93	1.3918
0.2000	819.2	1.6533	1221.49	1.4004
0.3000	825.9	1.7410	1236.44	1.4064
0.4000	832.9	1.8285	1246.15	1.4109
0.5000	836.1	1.9156	1255.68	1.4146
0.6000	841.0	2.0040	1262.10	1.4175
0.7000	843.0	2.0938	1269.47	1.4201
0.8000	846.5	2.1857	1274.64	1.4221
0.9000	848.2	2.2854	1280.14	1.4238
1.0000	850.4	2.4139	1284.48	1.4252
		313.15K		
0.0000	787.5	1.3786	1154.73	1.3768
0.1000	803.3	1.4258	1184.52	1.3896

0.2000	815.1	1.5010	1203.72	1.3982
0.3000	821.7	1.5826	1218.59	1.4043
0.4000	828.9	1.6635	1228.12	1.4088
0.5000	832.0	1.7432	1237.70	1.4124
0.6000	837.1	1.8232	1244.02	1.4154
0.7000	839.0	1.9043	1251.45	1.4179
0.8000	842.6	1.9875	1256.57	1.4200
0.9000	844.2	2.0780	1262.11	1.4217
1.0000	846.5	2.1905	1266.49	1.4231
		318.15K		
0.0000	783.3	1.2337	1137.89	1.3747
0.1000	799.1	1.2857	1167.16	1.3874
0.2000	811.1	1.3587	1186.00	1.3960
0.3000	817.6	1.4353	1200.83	1.4021
0.4000	824.9	1.5104	1210.20	1.4066
0.5000	827.9	1.5842	1219.84	1.4103
0.6000	833.1	1.6584	1226.06	1.4132
0.7000	835.0	1.7336	1233.56	1.4158
0.8000	838.6	1.8106	1238.61	1.4179
0.9000	840.3	1.8935	1244.21	1.4195
1.0000	842.6	1.9948	1248.62	1.4210
		323.15K		
0.0000	779.1	1.1118	1121.08	1.3726
0.1000	794.8	1.1679	1149.87	1.3852
0.2000	807.0	1.2388	1168.36	1.3938
0.3000	813.4	1.3110	1183.15	1.3999
0.4000	820.9	1.3812	1192.36	1.4044
0.5000	823.8	1.4499	1202.07	1.4081
0.6000	829.2	1.5187	1208.21	1.4111
0.7000	830.9	1.5884	1215.79	1.4137
0.8000	834.7	1.6595	1220.81	1.4157
0.9000	836.3	1.7354	1226.46	1.4174
1.0000	838.7	1.8266	1230.94	1.4189
		328.15K		
0.0000	774.8	1.0045	1104.30	1.3704
0.1000	790.5	1.0638	1132.59	1.3830
0.2000	802.9	1.1329	1150.74	1.3916
0.3000	809.2	1.2011	1165.52	1.3977
0.4000	816.9	1.2667	1174.58	1.4023
0.5000	819.6	1.3311	1184.39	1.4058
0.6000	825.2	1.3958	1190.46	1.4090
0.7000	826.9	1.4614	1198.14	1.4116
0.8000	830.8	1.5276	1203.13	1.4136
0.9000	832.4	1.5972	1208.85	1.4153
1.0000	834.7	1.6800	1213.41	1.4168
		333.15K		
0.0000	770.5	0.9109	1087.48	1.3682
0.1000	786.2	0.9730	1115.35	1.3808
0.2000	798.7	1.0408	1133.18	1.3894
0.3000	804.9	1.1049	1147.96	1.3956
0.4000	812.8	1.1654	1156.88	1.4001
0.5000	815.5	1.2251	1166.80	1.4037
0.6000	821.2	1.2858	1172.80	1.4069
0.7000	822.8	1.3477	1180.60	1.4094
0.8000	826.8	1.4096	1185.57	1.4115
0.9000	828.4	1.4733	1191.38	1.4132
1.0000	830.8	1.5490	1196.05	1.4147
		338.15K		

0.0000	766.0	0.8241	1070.64	1.3660
0.1000	781.8	0.8897	1098.09	1.3785
0.2000	794.5	0.9567	1115.62	1.3871
0.3000	800.6	1.0179	1130.45	1.3933
0.4000	808.7	1.0748	1139.24	1.3980
0.5000	811.3	1.1311	1149.30	1.4014
0.6000	817.2	1.1890	1155.25	1.4047
0.7000	818.7	1.2483	1163.18	1.4073
0.8000	822.9	1.3071	1168.16	1.4093
0.9000	824.4	1.3665	1174.08	1.4110
1.0000	826.9	1.4364	1178.87	1.4126
		343.15K		
0.0000	761.5	0.7468	1053.84	1.3635
0.1000	777.3	0.8165	1080.82	1.3761
0.2000	790.3	0.8827	1098.13	1.3847
0.3000	796.2	0.9401	1113.07	1.3909
0.4000	804.6	0.9925	1121.77	1.3956
0.5000	807.0	1.0454	1131.96	1.3992
0.6000	813.2	1.1012	1137.86	1.4025
0.7000	814.6	1.1588	1145.94	1.4051
0.8000	818.9	1.2148	1150.95	1.4072
0.9000	820.5	1.2695	1156.99	1.4090
1.0000	823.0	1.3347	1161.91	1.4105
		ethyl oleate (1) + 1-butanol (2)		
		293.15K		
0.0000	809.8	2.8682	1256.59	1.3999
0.1000	827.3	3.1874	1297.40	1.4148
0.2000	838.5	3.5576	1322.50	1.4243
0.3000	846.1	3.9462	1339.91	1.4311
0.4000	851.9	4.3148	1352.91	1.4359
0.5000	856.3	4.6800	1363.16	1.4396
0.6000	859.8	5.0244	1371.46	1.4425
0.7000	862.6	5.3579	1378.61	1.4451
0.8000	865.0	5.6815	1384.65	1.4466
0.9000	867.1	6.011	1389.98	1.4486
1.0000	868.9	6.4135	1394.21	1.4494
		298.15K		
0.0000	806.0	2.5306	1239.62	1.3979
0.1000	823.5	2.8177	1280.02	1.4127
0.2000	834.7	3.1431	1304.90	1.4222
0.3000	842.3	3.4811	1322.19	1.4290
0.4000	848.1	3.8075	1335.11	1.4338
0.5000	852.5	4.1306	1345.31	1.4376
0.6000	856.0	4.4366	1353.61	1.4405
0.7000	858.9	4.7324	1360.74	1.4431
0.8000	861.3	5.0129	1366.72	1.4445
0.9000	863.4	5.3098	1371.98	1.4466
1.0000	865.3	5.6534	1376.24	1.4474
		303.15K		
0.0000	802.1	2.2321	1222.76	1.3959
0.1000	819.6	2.4907	1262.75	1.4107
0.2000	830.8	2.7824	1287.42	1.4201
0.3000	838.5	3.0798	1304.60	1.4269
0.4000	844.3	3.3708	1317.46	1.4317
0.5000	848.7	3.6492	1327.64	1.4355
0.6000	852.3	3.9179	1335.91	1.4384
0.7000	855.2	4.1754	1343.00	1.4410
0.8000	857.6	4.4192	1348.96	1.4424

0.9000	859.7	4.6777	1354.19	1.4445
1.0000	861.6	4.9859	1358.43	1.4454
		308.15K		
0.0000	798.3	1.9745	1206.02	1.3938
0.1000	815.7	2.2169	1245.58	1.4086
0.2000	826.9	2.4802	1270.06	1.4182
0.3000	834.7	2.7455	1287.14	1.4249
0.4000	840.5	3.0015	1299.93	1.4296
0.5000	845.0	3.2498	1310.10	1.4334
0.6000	848.5	3.4864	1318.34	1.4363
0.7000	851.4	3.7131	1325.42	1.4389
0.8000	853.9	3.931	1331.36	1.4403
0.9000	856.1	4.1601	1336.56	1.4425
1.0000	858.0	4.4244	1340.81	1.4433
		313.15K		
0.0000	794.3	1.7579	1189.36	1.3918
0.1000	811.8	1.9828	1228.50	1.4065
0.2000	823.1	2.2227	1252.80	1.4161
0.3000	830.8	2.4597	1269.80	1.4228
0.4000	836.7	2.6826	1282.55	1.4275
0.5000	841.2	2.8974	1292.68	1.4313
0.6000	844.8	3.1031	1300.92	1.4342
0.7000	847.7	3.2999	1307.98	1.4368
0.8000	850.2	3.49	1313.92	1.4383
0.9000	852.4	3.6908	1319.06	1.4404
1.0000	854.4	3.9185	1323.34	1.4414
		318.15K		
0.0000	790.4	1.5634	1172.77	1.3897
0.1000	807.9	1.7761	1211.51	1.4044
0.2000	819.2	1.9980	1235.62	1.4140
0.3000	827.0	2.2140	1252.56	1.4206
0.4000	832.8	2.4213	1265.28	1.4254
0.5000	837.4	2.6203	1275.38	1.4292
0.6000	841.0	2.8097	1283.61	1.4321
0.7000	844.0	2.9908	1290.68	1.4348
0.8000	846.6	3.1649	1296.58	1.4362
0.9000	848.8	3.3495	1301.71	1.4384
1.0000	850.8	3.5541	1306.04	1.4395
		323.15K		
0.0000	786.4	1.3990	1156.2200	1.3876
0.1000	803.9	1.6001	1194.5800	1.4022
0.2000	815.2	1.8056	1218.5400	1.4119
0.3000	823.1	2.0024	1235.4100	1.4185
0.4000	829.0	2.1919	1248.1000	1.4233
0.5000	833.6	2.3714	1258.2100	1.4271
0.6000	837.3	2.5433	1266.4600	1.4300
0.7000	840.3	2.7073	1273.5000	1.4327
0.8000	842.9	2.8649	1279.3900	1.4341
0.9000	845.1	3.0320	1284.5300	1.4364
1.0000	847.2	3.2140	1288.9100	1.4375
		328.15K		
0.0000	782.4	1.2559	1139.6800	1.3855
0.1000	799.9	1.4469	1177.6900	1.4000
0.2000	811.3	1.6383	1201.5200	1.4098
0.3000	819.2	1.8194	1218.3600	1.4164
0.4000	825.2	1.9922	1231.0300	1.4211
0.5000	829.8	2.1568	1241.1600	1.4250
0.6000	833.5	2.3130	1249.4000	1.4279

0.7000	836.5	2.4628	1256.4400	1.4306
0.8000	839.2	2.6065	1262.3500	1.4321
0.9000	841.5	2.7527	1267.5000	1.4344
1.0000	843.6	2.9215	1271.9400	1.4355
		333.15K		
0.0000	778.3	1.1311	1123.1600	1.3833
0.1000	795.9	1.3123	1160.8500	1.3979
0.2000	807.3	1.4902	1184.5600	1.4076
0.3000	815.3	1.6574	1201.4000	1.4142
0.4000	821.3	1.8119	1214.0600	1.4190
0.5000	826.0	1.9585	1224.2100	1.4228
0.6000	829.7	2.0978	1232.4600	1.4258
0.7000	832.8	2.2321	1239.5300	1.4286
0.8000	835.5	2.3620	1245.4500	1.4301
0.9000	837.9	2.4980	1250.6100	1.4324
1.0000	840.0	2.6432	1255.1500	1.4335
		338.15K		
0.0000	774.2	1.0213	1106.6300	1.3810
0.1000	791.8	1.1952	1144.0600	1.3957
0.2000	803.3	1.3633	1167.6600	1.4054
0.3000	811.3	1.5190	1184.5300	1.4120
0.4000	817.4	1.6664	1197.2200	1.4169
0.5000	822.1	1.8061	1207.3900	1.4207
0.6000	826.0	1.9381	1215.6700	1.4237
0.7000	829.1	2.0649	1222.7600	1.4265
0.8000	831.8	2.1871	1228.7000	1.4281
0.9000	834.2	2.3140	1233.9100	1.4304
1.0000	836.4	2.4476	1238.5600	1.4315
		343.15K		
0.0000	769.9	0.9250	1090.14	1.3788
0.1000	787.7	1.0910	1127.37	1.3934
0.2000	799.3	1.2494	1150.86	1.4031
0.3000	807.4	1.395	1167.82	1.4099
0.4000	813.5	1.5322	1180.57	1.4148
0.5000	818.3	1.6616	1190.76	1.4187
0.6000	822.2	1.7841	1199.06	1.4217
0.7000	825.4	1.9018	1206.21	1.4245
0.8000	828.2	2.015	1212.18	1.4263
0.9000	830.6	2.132	1217.47	1.4285
1.0000	832.8	2.2541	1222.46	1.4296
		ethyl oleate (1) + 1-propanol (2)		
		293.15K		
0.0000	803.95	2.1470	1222.99	1.3852
0.1000	826.05	2.7485	1278.95	1.4080
0.2000	838.72	3.2988	1312.39	1.4205
0.3000	846.96	3.7996	1333.75	1.4287
0.4000	852.82	4.2384	1349.20	1.4346
0.5000	857.13	4.6430	1360.65	1.4388
0.6000	860.50	5.0155	1370.01	1.4422
0.7000	863.20	5.3679	1377.62	1.4448
0.8000	865.42	5.6952	1384.07	1.4468
0.9000	867.29	6.0277	1389.77	1.4484
1.0000	868.91	6.4135	1394.21	1.4494
		298.15K		
0.0000	799.93	1.9262	1205.74	1.3831
0.1000	822.08	2.4550	1261.31	1.4058
0.2000	834.80	2.9299	1294.59	1.4184
0.3000	843.08	3.3575	1315.86	1.4267

0.4000	848.98	3.7422	1331.25	1.4325
0.5000	853.33	4.1021	1342.67	1.4367
0.6000	856.73	4.4273	1352.05	1.4401
0.7000	859.46	4.7358	1359.65	1.4427
0.8000	861.71	5.0279	1366.09	1.4448
0.9000	863.62	5.3178	1371.76	1.4464
1.0000	865.27	5.6534	1376.24	1.4474
		303.15K		
0.0000	795.89	1.7164	1188.64	1.3810
0.1000	818.09	2.1859	1243.85	1.4037
0.2000	830.87	2.6028	1276.92	1.4163
0.3000	839.19	2.9796	1298.07	1.4246
0.4000	845.14	3.3118	1313.44	1.4305
0.5000	849.52	3.6289	1324.84	1.4347
0.6000	852.96	3.9155	1334.22	1.4381
0.7000	855.72	4.1828	1341.83	1.4406
0.8000	858.01	4.4354	1348.26	1.4427
0.9000	859.95	4.6933	1353.93	1.4444
1.0000	861.63	4.9859	1358.43	1.4454
		308.15K		
0.0000	791.82	1.5325	1171.64	1.3789
0.1000	814.08	1.9550	1226.45	1.4016
0.2000	826.92	2.3244	1259.36	1.4142
0.3000	835.29	2.6573	1280.44	1.4225
0.4000	841.28	2.9557	1295.74	1.4284
0.5000	845.71	3.2304	1307.15	1.4326
0.6000	849.18	3.4821	1316.54	1.4360
0.7000	851.98	3.7193	1324.16	1.4386
0.8000	854.30	3.9402	1330.60	1.4407
0.9000	856.28	4.1671	1336.28	1.4423
1.0000	858.01	4.4244	1340.81	1.4433
		313.15K		
0.0000	787.71	1.3786	1154.73	1.3768
0.1000	810.04	1.7605	1209.16	1.3994
0.2000	822.94	2.0895	1241.90	1.4121
0.3000	831.37	2.3841	1262.92	1.4204
0.4000	837.41	2.6451	1278.17	1.4262
0.5000	841.89	2.8816	1289.60	1.4305
0.6000	845.40	3.1001	1298.98	1.4339
0.7000	848.24	3.3052	1306.62	1.4365
0.8000	850.61	3.4970	1313.09	1.4386
0.9000	852.62	3.6974	1318.76	1.4403
1.0000	854.39	3.9185	1323.34	1.4414
		318.15K		
0.0000	783.56	1.2337	1137.89	1.3747
0.1000	805.97	1.5837	1191.92	1.3973
0.2000	818.94	1.8821	1224.51	1.4099
0.3000	827.44	2.1474	1245.48	1.4183
0.4000	833.53	2.3881	1260.71	1.4241
0.5000	838.06	2.6060	1272.14	1.4284
0.6000	841.62	2.8083	1281.56	1.4318
0.7000	844.50	2.9960	1289.23	1.4344
0.8000	846.91	3.1715	1295.68	1.4366
0.9000	848.97	3.3540	1301.38	1.4382
1.0000	850.78	3.5541	1306.04	1.4395
		323.15K		
0.0000	779.36	1.1118	1121.08	1.3726
0.1000	801.87	1.4333	1174.78	1.3952

0.2000	814.91	1.7044	1207.21	1.4078
0.3000	823.48	1.9445	1228.11	1.4161
0.4000	829.63	2.1635	1243.35	1.4220
0.5000	834.21	2.3599	1254.80	1.4263
0.6000	837.83	2.5420	1264.25	1.4297
0.7000	840.76	2.7117	1271.95	1.4323
0.8000	843.22	2.8707	1278.43	1.4345
0.9000	845.32	3.0362	1284.17	1.4362
1.0000	847.17	3.2140	1288.91	1.4375
		328.15K		
0.0000	775.10	1.0045	1104.30	1.3704
0.1000	797.72	1.3012	1157.67	1.3930
0.2000	810.86	1.5498	1189.96	1.4057
0.3000	819.50	1.7681	1210.84	1.4139
0.4000	825.72	1.9687	1226.08	1.4199
0.5000	830.37	2.1460	1237.58	1.4242
0.6000	834.04	2.3121	1247.06	1.4276
0.7000	837.01	2.4668	1254.79	1.4303
0.8000	839.52	2.6118	1261.32	1.4325
0.9000	841.67	2.7621	1267.11	1.4341
1.0000	843.58	2.9215	1271.94	1.4355
		333.15K		
0.0000	770.78	0.9109	1087.48	1.3682
0.1000	793.52	1.1848	1140.56	1.3907
0.2000	806.76	1.4131	1172.77	1.4035
0.3000	815.49	1.6114	1193.63	1.4118
0.4000	821.79	1.7922	1208.89	1.4178
0.5000	826.50	1.9485	1220.46	1.4220
0.6000	830.24	2.0980	1229.97	1.4255
0.7000	833.26	2.2358	1237.75	1.4282
0.8000	835.83	2.3660	1244.35	1.4304
0.9000	838.03	2.5020	1250.18	1.4321
1.0000	839.98	2.6432	1255.15	1.4335
		338.15K		
0.0000	766.40	0.8241	1070.64	1.3660
0.1000	789.27	1.0801	1123.45	1.3884
0.2000	802.63	1.2939	1155.60	1.4013
0.3000	811.45	1.4768	1176.49	1.4096
0.4000	817.84	1.6486	1191.80	1.4156
0.5000	822.62	1.7955	1203.46	1.4199
0.6000	826.42	1.9380	1213.01	1.4234
0.7000	829.51	2.0686	1220.86	1.4261
0.8000	832.14	2.1910	1227.53	1.4284
0.9000	834.39	2.3174	1233.42	1.4301
1.0000	836.39	2.4476	1238.56	1.4315
		343.15K		
0.0000	761.93	0.7468	1053.84	1.3635
0.1000	784.97	0.9873	1106.35	1.3861
0.2000	798.46	1.1854	1138.50	1.3991
0.3000	807.39	1.3541	1159.45	1.4074
0.4000	813.87	1.5154	1174.87	1.4134
0.5000	818.73	1.6499	1186.63	1.4178
0.6000	822.60	1.7839	1196.23	1.4213
0.7000	825.76	1.9051	1204.15	1.4241
0.8000	828.45	2.0183	1210.93	1.4264
0.9000	830.76	2.1353	1216.89	1.4281
1.0000	832.81	2.2541	1222.46	1.4296
		ethyl oleate (1) + *n*-hexadecane (2)		

		293.15K		
0.0000	773.4	3.4079	1357.37	1.4340
0.1000	784.4	3.5950	1359.46	1.4361
0.2000	795.1	3.8045	1362.05	1.4378
0.3000	805.5	4.0563	1365.10	1.4394
0.4000	815.5	4.3364	1368.53	1.4410
0.5000	825.1	4.6425	1372.34	1.4426
0.6000	834.5	4.9644	1376.42	1.4442
0.7000	843.5	5.3085	1380.76	1.4456
0.8000	852.3	5.6711	1385.20	1.4469
0.9000	860.7	6.0323	1389.65	1.4482
1.0000	868.9	6.4135	1394.21	1.4494
		298.15K		
0.0000	769.9	3.0355	1338.49	1.4318
0.1000	780.9	3.1946	1340.74	1.4340
0.2000	791.6	3.3819	1343.46	1.4357
0.3000	802.0	3.5986	1346.62	1.4374
0.4000	811.9	3.8489	1350.16	1.4390
0.5000	821.6	4.1198	1354.07	1.4405
0.6000	831.0	4.4054	1358.23	1.4421
0.7000	840.0	4.7044	1362.62	1.4436
0.8000	848.7	5.0190	1367.10	1.4449
0.9000	857.1	5.3353	1371.60	1.4461
1.0000	865.3	5.6534	1376.24	1.4474
		303.15K		
0.0000	766.4	2.7084	1319.81	1.4296
0.1000	777.4	2.8519	1322.21	1.4318
0.2000	788.1	3.0094	1325.07	1.4336
0.3000	798.4	3.1995	1328.35	1.4353
0.4000	808.4	3.4224	1331.99	1.4369
0.5000	818.0	3.6569	1335.97	1.4385
0.6000	827.4	3.9060	1340.20	1.4401
0.7000	836.4	4.1625	1344.65	1.4415
0.8000	845.1	4.4335	1349.20	1.4428
0.9000	853.5	4.7084	1353.75	1.4441
1.0000	861.6	4.9859	1358.43	1.4454
		308.15K		
0.0000	762.9	2.4319	1301.34	1.4275
0.1000	774.0	2.5602	1303.89	1.4297
0.2000	784.6	2.7046	1306.87	1.4315
0.3000	794.9	2.8734	1310.25	1.4332
0.4000	804.9	3.0651	1313.98	1.4348
0.5000	814.5	3.2686	1318.04	1.4364
0.6000	823.8	3.4853	1322.34	1.4380
0.7000	832.8	3.7101	1326.87	1.4394
0.8000	841.5	3.9455	1331.48	1.4408
0.9000	849.9	4.1852	1336.08	1.4421
1.0000	858.0	4.4244	1340.81	1.4433
		313.15K		
0.0000	759.5	2.1994	1283.07	1.4254
0.1000	770.5	2.3138	1285.74	1.4276
0.2000	781.1	2.4433	1288.84	1.4294
0.3000	791.4	2.5887	1292.32	1.4311
0.4000	801.3	2.7547	1296.13	1.4327
0.5000	810.9	2.9277	1300.28	1.4343
0.6000	820.3	3.1132	1304.66	1.4359
0.7000	829.2	3.3056	1309.26	1.4373
0.8000	837.9	3.5080	1313.93	1.4387

0.9000	846.3	3.7149	1318.57	1.4400
1.0000	854.4	3.9185	1323.34	1.4414
		318.15K		
0.0000	756.1	1.9964	1264.98	1.4233
0.1000	767.0	2.1002	1267.78	1.4255
0.2000	777.6	2.2174	1270.98	1.4273
0.3000	787.9	2.3510	1274.56	1.4290
0.4000	797.8	2.5035	1278.47	1.4307
0.5000	807.4	2.6618	1282.69	1.4323
0.6000	816.7	2.8304	1287.14	1.4338
0.7000	825.6	3.0039	1291.79	1.4352
0.8000	834.3	3.1862	1296.51	1.4367
0.9000	842.7	3.3722	1301.21	1.4380
1.0000	850.8	3.5541	1306.04	1.4395
		323.15K		
0.0000	752.6	1.8226	1247.06	1.4211
0.1000	763.6	1.9169	1249.98	1.4234
0.2000	774.2	2.0231	1253.29	1.4252
0.3000	784.4	2.1435	1256.96	1.4269
0.4000	794.3	2.2796	1260.96	1.4286
0.5000	803.9	2.4207	1265.27	1.4302
0.6000	813.2	2.5708	1269.78	1.4318
0.7000	822.1	2.7231	1274.49	1.4332
0.8000	830.7	2.8871	1279.27	1.4346
0.9000	839.1	3.0527	1284.02	1.4360
1.0000	847.2	3.2140	1288.91	1.4375
		328.15K		
0.0000	749.2	1.6714	1229.32	1.4190
0.1000	760.1	1.7574	1232.35	1.4214
0.2000	770.7	1.8547	1235.77	1.4231
0.3000	780.9	1.9633	1239.54	1.4249
0.4000	790.8	2.0808	1243.62	1.4265
0.5000	800.4	2.2109	1247.99	1.4282
0.6000	809.6	2.3433	1252.57	1.4297
0.7000	818.5	2.4819	1257.36	1.4312
0.8000	827.1	2.6296	1262.21	1.4326
0.9000	835.5	2.7780	1267.05	1.4340
1.0000	843.6	2.9215	1271.94	1.4355
		333.15K		
0.0000	745.7	1.5370	1211.77	1.4169
0.1000	756.7	1.6155	1214.89	1.4193
0.2000	767.2	1.7044	1218.43	1.4210
0.3000	777.4	1.7991	1222.29	1.4228
0.4000	787.3	1.9027	1226.44	1.4245
0.5000	796.8	2.0142	1230.89	1.4261
0.6000	806.1	2.1330	1235.55	1.4277
0.7000	815.0	2.2541	1240.41	1.4292
0.8000	823.6	2.3849	1245.30	1.4306
0.9000	831.9	2.5159	1250.16	1.4320
1.0000	840.0	2.6432	1255.15	1.4335
		338.15K		
0.0000	742.3	1.4213	1194.43	1.4149
0.1000	753.2	1.4947	1197.66	1.4172
0.2000	763.8	1.5772	1201.27	1.4190
0.3000	774.0	1.6667	1205.22	1.4207
0.4000	783.8	1.7636	1209.44	1.4224
0.5000	793.3	1.8676	1213.96	1.4241
0.6000	802.5	1.9768	1218.72	1.4257

0.7000	811.4	2.0889	1223.65	1.4272
0.8000	820.0	2.2086	1228.56	1.4286
0.9000	828.3	2.3295	1233.50	1.4300
1.0000	836.4	2.4476	1238.56	1.4315
		343.15K		
0.0000	738.9	1.3164	1177.55	1.4129
0.1000	749.8	1.3855	1180.87	1.4151
0.2000	760.3	1.4617	1184.38	1.4170
0.3000	770.5	1.5435	1188.38	1.4187
0.4000	780.3	1.6320	1192.67	1.4204
0.5000	789.8	1.7267	1197.27	1.4221
0.6000	799.0	1.8255	1202.11	1.4238
0.7000	807.9	1.9287	1207.13	1.4254
0.8000	816.5	2.0349	1212.06	1.4267
0.9000	824.8	2.1434	1217.27	1.4281
1.0000	832.8	2.2541	1222.46	1.4296
		n-hexadecane (1) +1-butanol (2)		
		293.15K		
0.0000	809.80	2.8682	1256.59	1.3999
0.1000	798.54	2.8558	1275.37	1.4078
0.2000	791.49	2.8746	1290.74	1.4139
0.3000	786.53	2.8739	1303.11	1.4184
0.4000	782.88	2.8539	1313.43	1.4220
0.5000	780.07	2.9004	1322.05	1.4250
0.6000	777.91	2.9350	1329.74	1.4274
0.7000	776.24	2.9981	1336.82	1.4295
0.8000	774.92	3.1088	1343.35	1.4315
0.9000	773.90	3.2041	1349.59	1.4329
1.0000	773.35	3.4079	1357.37	1.4340
		298.15K		
0.0000	805.98	2.5306	1239.62	1.3979
0.1000	794.77	2.5196	1257.76	1.4057
0.2000	787.73	2.5412	1272.65	1.4118
0.3000	782.81	2.5429	1284.67	1.4162
0.4000	779.18	2.5354	1294.74	1.4199
0.5000	776.41	2.5779	1303.22	1.4228
0.6000	774.28	2.6156	1310.82	1.4252
0.7000	772.63	2.6752	1317.87	1.4274
0.8000	771.34	2.7699	1324.36	1.4293
0.9000	770.35	2.8524	1330.61	1.4307
1.0000	769.87	3.0355	1338.49	1.4318
		303.15K		
0.0000	802.13	2.2321	1222.76	1.3959
0.1000	790.97	2.2192	1240.25	1.4036
0.2000	783.97	2.2439	1254.67	1.4096
0.3000	779.07	2.2462	1266.36	1.4141
0.4000	775.47	2.2492	1276.20	1.4177
0.5000	772.74	2.2944	1284.57	1.4206
0.6000	770.64	2.3322	1292.10	1.4231
0.7000	769.03	2.3871	1299.09	1.4252
0.8000	767.77	2.471	1305.57	1.4271
0.9000	766.82	2.5441	1311.82	1.4286
1.0000	766.40	2.7084	1319.81	1.4296
		308.15K		
0.0000	798.25	1.9745	1206.02	1.3938
0.1000	787.14	1.9674	1222.84	1.4015
0.2000	780.17	1.9916	1236.79	1.4075
0.3000	775.31	2.0009	1248.17	1.4119

0.4000	771.75	2.0116	1257.82	1.4155
0.5000	769.05	2.0527	1266.07	1.4185
0.6000	766.99	2.0922	1273.53	1.4209
0.7000	765.42	2.1439	1280.51	1.4230
0.8000	764.19	2.2172	1286.97	1.4250
0.9000	763.28	2.2831	1293.24	1.4264
1.0000	762.95	2.4319	1301.34	1.4275
		313.15K		
0.0000	794.35	1.7579	1189.36	1.3918
0.1000	783.27	1.7548	1205.51	1.3994
0.2000	776.34	1.7811	1219.00	1.4053
0.3000	771.52	1.7939	1230.08	1.4097
0.4000	768.01	1.8107	1239.56	1.4134
0.5000	765.35	1.8509	1247.71	1.4163
0.6000	763.33	1.8903	1255.14	1.4187
0.7000	761.80	1.9388	1262.08	1.4208
0.8000	760.61	2.0041	1268.53	1.4228
0.9000	759.74	2.0641	1274.86	1.4242
1.0000	759.49	2.1994	1283.07	1.4254
		318.15K		
0.0000	790.41	1.5634	1172.77	1.3897
0.1000	779.38	1.5642	1188.23	1.3973
0.2000	772.49	1.5931	1201.29	1.4031
0.3000	767.71	1.6129	1212.09	1.4075
0.4000	764.24	1.6309	1221.41	1.4111
0.5000	761.63	1.6701	1229.48	1.4141
0.6000	759.66	1.7089	1236.88	1.4165
0.7000	758.17	1.7556	1243.81	1.4186
0.8000	757.02	1.8150	1250.26	1.4206
0.9000	756.20	1.8708	1256.65	1.4221
1.0000	756.05	1.9964	1264.98	1.4233
		323.15K		
0.0000	786.42	1.3990	1156.22	1.3876
0.1000	775.44	1.4039	1171.01	1.3951
0.2000	768.59	1.4347	1183.64	1.4009
0.3000	763.86	1.4519	1194.2	1.4053
0.4000	760.45	1.4790	1203.37	1.4089
0.5000	757.89	1.5171	1211.39	1.4119
0.6000	755.97	1.5562	1218.77	1.4143
0.7000	754.53	1.5997	1225.68	1.4164
0.8000	753.42	1.6539	1232.13	1.4184
0.9000	752.66	1.7067	1238.61	1.4199
1.0000	752.61	1.8226	1247.06	1.4211
		328.15K		
0.0000	782.39	1.2559	1139.68	1.3855
0.1000	771.46	1.2642	1153.81	1.3929
0.2000	764.66	1.2969	1166.03	1.3987
0.3000	759.99	1.3170	1176.38	1.4031
0.4000	756.63	1.3460	1185.43	1.4067
0.5000	754.13	1.3834	1193.42	1.4097
0.6000	752.26	1.4219	1200.79	1.4121
0.7000	750.87	1.4636	1207.69	1.4142
0.8000	749.82	1.5135	1214.16	1.4162
0.9000	749.13	1.5633	1220.75	1.4177
1.0000	749.18	1.6714	1229.32	1.4190
		333.15K		
0.0000	778.30	1.1311	1123.16	1.3833
0.1000	767.42	1.1429	1136.64	1.3907

0.2000	760.69	1.1767	1148.48	1.3965
0.3000	756.08	1.1991	1158.65	1.4009
0.4000	752.78	1.2296	1167.61	1.4045
0.5000	750.34	1.2658	1175.58	1.4074
0.6000	748.53	1.3032	1182.93	1.4099
0.7000	747.19	1.3430	1189.84	1.4121
0.8000	746.20	1.3891	1196.34	1.4141
0.9000	745.58	1.4369	1203.06	1.4156
1.0000	745.74	1.5370	1211.77	1.4169
		338.15K		
0.0000	774.15	1.0213	1106.63	1.3810
0.1000	763.33	1.0362	1119.49	1.3885
0.2000	756.66	1.0713	1130.98	1.3942
0.3000	752.13	1.0955	1141.02	1.3987
0.4000	748.90	1.1274	1149.88	1.4022
0.5000	746.53	1.1631	1157.86	1.4052
0.6000	744.78	1.1996	1165.22	1.4077
0.7000	743.51	1.2380	1172.14	1.4099
0.8000	742.57	1.2819	1178.69	1.4119
0.9000	742.04	1.3281	1185.54	1.4135
1.0000	742.31	1.4213	1194.43	1.4149
		343.15K		
0.0000	769.94	0.9250	1090.14	1.3788
0.1000	759.19	0.9425	1102.40	1.3862
0.2000	752.59	0.9782	1113.57	1.3920
0.3000	748.13	1.0041	1123.53	1.3964
0.4000	744.98	1.0366	1132.33	1.4000
0.5000	742.68	1.0713	1140.32	1.4030
0.6000	741.01	1.1067	1147.69	1.4056
0.7000	739.80	1.1437	1154.64	1.4076
0.8000	738.94	1.1854	1161.25	1.4097
0.9000	738.50	1.2303	1168.27	1.4114
1.0000	738.88	1.3164	1177.55	1.4129
		n-hexadecane (1) + 1-propanol (2)		
		293.15K		
0.0000	803.95	2.1470	1222.99	1.3852
0.1000	792.43	2.3881	1252.77	1.3993
0.2000	786.35	2.5413	1275.68	1.4084
0.3000	782.34	2.6710	1293.15	1.4148
0.4000	779.56	2.7755	1306.41	1.4196
0.5000	777.51	2.8447	1317.53	1.4233
0.6000	776.01	2.9165	1326.77	1.4266
0.7000	774.88	2.9901	1334.87	1.4288
0.8000	774.05	3.0929	1342.30	1.4310
0.9000	773.48	3.2135	1349.29	1.4327
1.0000	773.35	3.4079	1357.37	1.4340
		298.15K		
0.0000	799.93	1.9262	1205.74	1.3831
0.1000	788.52	2.1312	1234.91	1.3972
0.2000	782.50	2.2641	1257.38	1.4062
0.3000	778.55	2.3739	1274.50	1.4127
0.4000	775.81	2.4635	1287.54	1.4174
0.5000	773.81	2.5263	1298.53	1.4211
0.6000	772.34	2.5965	1307.70	1.4244
0.7000	771.25	2.6654	1315.79	1.4266
0.8000	770.46	2.7538	1323.21	1.4288
0.9000	769.92	2.8580	1330.26	1.4305
1.0000	769.87	3.0355	1338.49	1.4318

		303.15K		
0.0000	795.89	1.7164	1188.64	1.3810
0.1000	784.59	1.8902	1217.15	1.3951
0.2000	778.64	2.0121	1239.17	1.4041
0.3000	774.73	2.1079	1255.99	1.4105
0.4000	772.04	2.1869	1268.81	1.4152
0.5000	770.09	2.2444	1279.70	1.4189
0.6000	768.67	2.3136	1288.81	1.4222
0.7000	767.62	2.3760	1296.87	1.4244
0.8000	766.87	2.4502	1304.34	1.4266
0.9000	766.38	2.5496	1311.41	1.4284
1.0000	766.40	2.7084	1319.81	1.4296
		308.15K		
0.0000	791.82	1.5325	1171.64	1.3789
0.1000	780.63	1.6873	1199.52	1.3929
0.2000	774.74	1.7953	1221.09	1.4019
0.3000	770.89	1.8804	1237.59	1.4083
0.4000	768.26	1.9516	1250.21	1.4131
0.5000	766.36	2.0099	1261.01	1.4167
0.6000	764.98	2.0725	1270.08	1.4200
0.7000	763.98	2.1304	1278.15	1.4223
0.8000	763.27	2.2009	1285.63	1.4245
0.9000	762.83	2.2876	1292.78	1.4262
1.0000	762.95	2.4319	1301.34	1.4275
		313.15K		
0.0000	787.71	1.3786	1154.73	1.3768
0.1000	776.63	1.5155	1181.95	1.3908
0.2000	770.82	1.6140	1203.08	1.3998
0.3000	767.03	1.6911	1219.29	1.4061
0.4000	764.45	1.7561	1231.73	1.4109
0.5000	762.61	1.8116	1242.44	1.4145
0.6000	761.29	1.8707	1251.49	1.4179
0.7000	760.33	1.9252	1259.58	1.4201
0.8000	759.67	1.9888	1267.11	1.4223
0.9000	759.29	2.0674	1274.33	1.4241
1.0000	759.49	2.1994	1283.07	1.4254
		318.15K		
0.0000	783.56	1.2337	1137.89	1.3747
0.1000	772.59	1.3569	1164.43	1.3885
0.2000	766.85	1.4480	1185.14	1.3976
0.3000	763.14	1.5192	1201.07	1.4038
0.4000	760.62	1.5801	1213.34	1.4087
0.5000	758.84	1.6339	1223.98	1.4123
0.6000	757.58	1.6900	1233.04	1.4156
0.7000	756.67	1.7427	1241.16	1.4179
0.8000	756.07	1.7999	1248.73	1.4201
0.9000	755.74	1.8737	1256.05	1.4219
1.0000	756.05	1.9964	1264.98	1.4233
		323.15K		
0.0000	779.36	1.1118	1121.08	1.3726
0.1000	768.51	1.2230	1146.96	1.3863
0.2000	762.85	1.3084	1167.24	1.3952
0.3000	759.22	1.3747	1182.93	1.4016
0.4000	756.76	1.4316	1195.06	1.4064
0.5000	755.05	1.4835	1205.63	1.4100
0.6000	753.84	1.5368	1214.72	1.4134
0.7000	753.00	1.5871	1222.86	1.4157
0.8000	752.45	1.6391	1230.50	1.4179

0.9000	752.19	1.7083	1237.94	1.4197
1.0000	752.61	1.8226	1247.06	1.4211
		328.15K		
0.0000	775.10	1.0045	1104.30	1.3704
0.1000	764.37	1.1062	1129.51	1.3841
0.2000	758.80	1.1860	1149.39	1.3930
0.3000	755.25	1.2484	1164.84	1.3993
0.4000	752.86	1.3027	1176.85	1.4041
0.5000	751.23	1.3523	1187.39	1.4077
0.6000	750.09	1.4029	1196.53	1.4112
0.7000	749.32	1.4515	1204.70	1.4135
0.8000	748.83	1.4989	1212.42	1.4157
0.9000	748.64	1.5652	1220.00	1.4176
1.0000	749.18	1.6714	1229.32	1.4190
		333.15K		
0.0000	770.78	0.9109	1087.48	1.3682
0.1000	760.17	1.0041	1112.06	1.3818
0.2000	754.70	1.0792	1131.55	1.3907
0.3000	751.24	1.1384	1146.81	1.3970
0.4000	748.93	1.1898	1158.72	1.4018
0.5000	747.38	1.2366	1169.24	1.4054
0.6000	746.31	1.2840	1178.45	1.4089
0.7000	745.61	1.3310	1186.67	1.4113
0.8000	745.20	1.3746	1194.48	1.4135
0.9000	745.09	1.4381	1202.23	1.4154
1.0000	745.74	1.5370	1211.77	1.4169
		338.15K		
0.0000	766.40	0.8241	1070.64	1.3660
0.1000	755.91	0.9119	1094.56	1.3795
0.2000	750.55	0.9835	1113.72	1.3884
0.3000	747.19	1.0388	1128.81	1.3947
0.4000	744.97	1.0875	1140.65	1.3995
0.5000	743.50	1.1344	1151.20	1.4032
0.6000	742.52	1.1795	1160.49	1.4067
0.7000	741.89	1.2260	1168.78	1.4091
0.8000	741.55	1.2660	1176.70	1.4113
0.9000	741.53	1.3285	1184.62	1.4133
1.0000	742.31	1.4213	1194.43	1.4149
		343.15K		
0.0000	761.93	0.7468	1053.84	1.3635
0.1000	751.58	0.8305	1077.07	1.3771
0.2000	746.33	0.8985	1095.94	1.3860
0.3000	743.08	0.9461	1110.90	1.3924
0.4000	740.96	0.9894	1122.73	1.3972
0.5000	739.59	1.0423	1133.33	1.4010
0.6000	738.69	1.0850	1142.66	1.4044
0.7000	738.15	1.1308	1151.08	1.4069
0.8000	737.89	1.1679	1159.13	1.4092
0.9000	737.98	1.2298	1167.25	1.4111
1.0000	738.88	1.3164	1177.55	1.4129

[a]Standard uncertainties u for each variables are u(T) = 0.01 K; u_r(p) = 0.05; $u(x_1)$ = 0.0001,and the combined expanded uncertainties U_c are $U_c(\rho)$ = 0.8 kg·m^{-3}; $U_c(\eta)$ = 0.007 mPa·s, $U_c(u)$ = 0.2 m·s^{-1} and$U_c(n_D)$ = 2.8$\times$10^{-3}with 0.95 level of confidence (k ≈ 2).

Table A 9 Values of Calculated Excess Molar Volumes V^E ($m^3 \cdot mol^{-1}$), Viscosity Deviations $\Delta\eta$ (mPa·s), Deviations in Refractive Indices Δn_D, molar excess Gibbs free energies of activation of viscous flow ΔG^{*E} ($J \cdot mol^{-1}$) and Deviations in isentropic compressibility $\Delta\kappa_S$ (Pa^{-1}) of the ethyl laurate (1) + 1propanol, ethyl oleate (1) + 1-butanol (2), ethyl oleate (1) + 1-propanol (2), ethyl oleate (1) + *n*-hexadecane (2), *n*-hexadecane (1) + 1-butanol (2) and *n*-hexadecane (1) + 1-propanol (2), at T = 288.15−323.15 K and p = 0.1 MPa[a].

x_1	$10^6 V^E$ / ($m^3 \cdot mol^{-1}$)	$\Delta\eta$ / (mPa·s)	Δn_D /	ΔG^{*E}/ ($J \cdot mol^{-1}$)	$10^{10}\ \Delta\kappa_S$ / (Pa^{-1})
		ethyl laurate (1) + 1-propanol (2)			
		293.15K			
0.0000	-	-	-	-	-
0.1000	0.0615	-0.0983	0.0084	162.2	-0.0460
0.2000	0.0851	-0.1190	0.0124	304.2	-0.0510
0.3000	0.1201	-0.1206	0.0138	392.0	-0.0377
0.4000	0.1642	-0.1207	0.0137	423.6	-0.0204
0.5000	0.1976	-0.1196	0.0127	411.9	-0.0065
0.6000	0.2048	-0.1149	0.0111	365.9	0.0014
0.7000	0.1839	-0.1073	0.0089	294.1	0.0039
0.8000	0.1443	-0.0979	0.0063	198.4	0.0032
0.9000	0.0915	-0.0762	0.0033	87.5	0.0016
1.0000	-	-	-	-	-
		298.15K			
0.0000	-	-	-	-	-
0.1000	0.0697	-0.0762	0.0083	179.7	-0.0460
0.2000	0.0994	-0.0938	0.0123	324.3	-0.0504
0.3000	0.1383	-0.0955	0.0137	412.1	-0.0366
0.4000	0.1846	-0.0955	0.0136	443.4	-0.0188
0.5000	0.2192	-0.0952	0.0127	430.3	-0.0048
0.6000	0.2264	-0.0928	0.0109	381.4	0.0029
0.7000	0.2040	-0.0878	0.0088	306.1	0.0051
0.8000	0.1604	-0.0794	0.0063	208.1	0.0041
0.9000	0.1007	-0.0596	0.0033	96.1	0.0022
1.0000	-	-	-	-	-
		303.15K			
0.0000	-	-	-	-	-
0.1000	0.0788	-0.0609	0.0083	193.6	-0.0451
0.2000	0.1152	-0.0761	0.0123	341.7	-0.0490
0.3000	0.1587	-0.0772	0.0136	431.3	-0.0346
0.4000	0.2079	-0.0759	0.0135	464.2	-0.0164
0.5000	0.2435	-0.0747	0.0126	451.6	-0.0023
0.6000	0.2501	-0.0731	0.0109	400.7	0.0052
0.7000	0.2251	-0.0707	0.0088	321.2	0.0069
0.8000	0.1771	-0.0657	0.0062	218.2	0.0054
0.9000	0.1106	-0.0500	0.0032	101.7	0.0031
1.0000	-	-	-	-	-
		308.15K			
0.0000	-	-	-	-	-
0.1000	0.0890	-0.0466	0.0082	210.8	-0.0439
0.2000	0.1325	-0.0555	0.0122	368.6	-0.0471
0.3000	0.1809	-0.0559	0.0136	460.5	-0.0322
0.4000	0.2332	-0.0566	0.0135	491.0	-0.0135
0.5000	0.2702	-0.0576	0.0126	474.5	0.0007
0.6000	0.2762	-0.0574	0.0108	420.4	0.0078
0.7000	0.2485	-0.0556	0.0088	338.3	0.0089
0.8000	0.1952	-0.0519	0.0062	231.9	0.0067
0.9000	0.1207	-0.0404	0.0032	109.4	0.0038
1.0000	-	-	-	-	-
		313.15K			
0.0000	-	-	-	-	-

0.1000	0.1000	-0.0340	0.0082	230.0	-0.0423
0.2000	0.1512	-0.0400	0.0122	394.3	-0.0444
0.3000	0.2049	-0.0396	0.0136	488.3	-0.0286
0.4000	0.2604	-0.0399	0.0135	519.0	-0.0095
0.5000	0.2987	-0.0413	0.0125	500.9	0.0047
0.6000	0.3040	-0.0426	0.0109	443.1	0.0114
0.7000	0.2731	-0.0427	0.0087	356.3	0.0118
0.8000	0.2140	-0.0406	0.0062	245.5	0.0088
0.9000	0.1311	-0.0313	0.0032	118.6	0.0051
0.1000	-	-	-	-	-
			318.15K		
0.0000	-	-	-	-	-
0.1000	0.1122	-0.0241	0.0081	249.2	-0.0399
0.2000	0.1725	-0.0272	0.0121	421.6	-0.0408
0.3000	0.2318	-0.0267	0.0136	517.5	-0.0244
0.4000	0.2904	-0.0278	0.0134	547.1	-0.0052
0.5000	0.3298	-0.0300	0.0124	526.5	0.0089
0.6000	0.3344	-0.0320	0.0108	465.5	0.0152
0.7000	0.3007	-0.0329	0.0087	375.0	0.0149
0.8000	0.2356	-0.0319	0.0062	259.5	0.0111
0.9000	0.1431	-0.0252	0.0032	126.7	0.0064
1.0000	-	-	-	-	-
			323.15K		
0.0000	-	-	-	-	-
0.1000	0.1252	-0.0154	0.0079	270.1	-0.0372
0.2000	0.1947	-0.0160	0.0119	450.9	-0.0367
0.3000	0.2602	-0.0152	0.0134	548.8	-0.0194
0.4000	0.3224	-0.0166	0.0133	577.6	0.0002
0.5000	0.3631	-0.0194	0.0123	554.6	0.0142
0.6000	0.3664	-0.0220	0.0108	490.2	0.0199
0.7000	0.3287	-0.0238	0.0087	395.3	0.0187
0.8000	0.2567	-0.0241	0.0061	274.7	0.0140
0.9000	0.1548	-0.0197	0.0031	135.3	0.0082
1.0000	-	-	-	-	-
			328.15K		
0.0000	-	-	-	-	-
0.1000	0.1395	-0.0083	0.0079	291.6	-0.0334
0.2000	0.2189	-0.0067	0.0119	481.1	-0.0312
0.3000	0.2909	-0.0061	0.0134	580.7	-0.0131
0.4000	0.3568	-0.0080	0.0133	607.9	0.0068
0.5000	0.3989	-0.0112	0.0122	582.4	0.0205
0.6000	0.4011	-0.0140	0.0108	515.2	0.0254
0.7000	0.3592	-0.0160	0.0087	416.8	0.0231
0.8000	0.2795	-0.0173	0.0061	291.0	0.0172
0.9000	0.1667	-0.0153	0.0031	144.0	0.0102
1.0000	-	-	-	-	-
			333.15K		
0.0000	-	-	-	-	-
0.1000	0.1547	-0.0016	0.0079	315.3	-0.0298
0.2000	0.2451	0.0023	0.0119	515.0	-0.0255
0.3000	0.3240	0.0026	0.0134	615.3	-0.0062
0.4000	0.3935	-0.0007	0.0133	638.9	0.0142
0.5000	0.4364	-0.0049	0.0122	609.1	0.0276
0.6000	0.4370	-0.0079	0.0108	538.8	0.0317
0.7000	0.3908	-0.0099	0.0087	437.4	0.0283
0.8000	0.3035	-0.0118	0.0061	306.8	0.0211
0.9000	0.1797	-0.0119	0.0031	152.0	0.0127
1.0000	-	-	-	-	-

			338.15K		
0.0000	-	-	-	-	-
0.1000	0.1711	0.0043	0.0078	342.5	-0.0250
0.2000	0.2725	0.0101	0.0118	553.1	-0.0184
0.3000	0.3585	0.0101	0.0133	654.3	0.0020
0.4000	0.4321	0.0058	0.0133	674.4	0.0227
0.5000	0.4763	0.0008	0.0121	640.4	0.0359
0.6000	0.4752	-0.0025	0.0107	566.4	0.0391
0.7000	0.4240	-0.0045	0.0087	461.4	0.0344
0.8000	0.3283	-0.0069	0.0060	325.1	0.0257
0.9000	0.1929	-0.0087	0.0031	161.7	0.0154
1.0000	-	-	-	-	-
			343.15K		
0.0000	-	-	-	-	-
0.1000	0.1881	0.0109	0.0079	376.4	-0.0180
0.2000	0.3015	0.0183	0.0118	597.9	-0.0098
0.3000	0.3952	0.0169	0.0133	696.5	0.0109
0.4000	0.4729	0.0106	0.0133	709.5	0.0319
0.5000	0.5180	0.0046	0.0122	670.0	0.0450
0.6000	0.5146	0.0017	0.0108	593.6	0.0475
0.7000	0.4576	0.0004	0.0087	486.7	0.0412
0.8000	0.3526	-0.0023	0.0061	344.8	0.0306
0.9000	0.2052	-0.0064	0.0031	170.5	0.0183
1.0000	-	-	-	-	-
			ethyl oleate (1) + 1-butanol (2)		
			293.15K		
0.0000	-	-	-	-	-
0.1000	0.0549	-0.0353	0.0099	351.67	-0.0646
0.2000	0.0933	-0.0197	0.0145	586.58	-0.0630
0.3000	0.1363	0.0144	0.0163	722.58	-0.0485
0.4000	0.1500	0.0285	0.0162	763.67	-0.0345
0.5000	0.1555	0.0391	0.0150	740.66	-0.0231
0.6000	0.1497	0.0290	0.0129	658.19	-0.0140
0.7000	0.1387	0.0080	0.0105	531.80	-0.0091
0.8000	0.1186	-0.0229	0.0071	369.22	-0.0053
0.9000	0.0795	-0.0480	0.0041	182.34	-0.0038
1.0000	-	-	-	-	-
			298.15K		
0.0000	-	-	-	-	-
0.1000	0.0638	-0.0252	0.0099	362.63	-0.0659
0.2000	0.1050	-0.0121	0.0144	600.19	-0.0640
0.3000	0.1552	0.0137	0.0163	734.98	-0.0489
0.4000	0.1716	0.0278	0.0161	777.81	-0.0345
0.5000	0.1797	0.0386	0.0149	755.18	-0.0229
0.6000	0.1716	0.0323	0.0129	672.67	-0.0140
0.7000	0.1592	0.0158	0.0105	545.08	-0.0092
0.8000	0.1341	-0.0159	0.0070	377.35	-0.0051
0.9000	0.0887	-0.0313	0.0041	190.42	-0.0033
1.0000	-	-	-	-	-
			303.15K		
0.0000	-	-	-	-	-
0.1000	0.0735	-0.0168	0.0099	374.08	-0.0671
0.2000	0.1253	-0.0005	0.0144	619.36	-0.0646
0.3000	0.1758	0.0216	0.0162	754.86	-0.0492
0.4000	0.1946	0.0372	0.0161	800.10	-0.0345
0.5000	0.2039	0.0402	0.0149	771.86	-0.0229
0.6000	0.1959	0.0335	0.0128	686.99	-0.0140
0.7000	0.1806	0.0156	0.0104	555.08	-0.0090

0.8000	0.1518	-0.0159	0.0069	382.51	-0.0050
0.9000	0.0988	-0.0328	0.0041	190.77	-0.0033
1.0000	-	-	-	-	-
		308.15K			
0.0000	-	-	-	-	-
0.1000	0.0841	-0.0026	0.0099	395.16	-0.0678
0.2000	0.1431	0.0157	0.0145	647.40	-0.0649
0.3000	0.1987	0.0360	0.0162	784.49	-0.0491
0.4000	0.2195	0.0470	0.0160	826.74	-0.0339
0.5000	0.2304	0.0503	0.0148	797.58	-0.0225
0.6000	0.2212	0.0420	0.0128	708.54	-0.0134
0.7000	0.2178	0.0237	0.0104	572.14	-0.0083
0.8000	0.1700	-0.0034	0.0069	396.54	-0.0047
0.9000	0.1095	-0.0193	0.0041	200.35	-0.0030
1.0000	-	-	-	-	-
		313.15K			
0.0000	-	-	-	-	-
0.1000	0.0955	0.0088	0.0098	414.78	-0.0684
0.2000	0.1623	0.0327	0.0144	677.56	-0.0651
0.3000	0.2226	0.0536	0.0161	817.40	-0.0489
0.4000	0.2466	0.0605	0.0159	855.45	-0.0336
0.5000	0.2585	0.0592	0.0147	820.80	-0.0218
0.6000	0.2480	0.0488	0.0126	727.31	-0.0130
0.7000	0.2424	0.0296	0.0103	586.18	-0.0079
0.8000	0.1888	0.0036	0.0068	406.49	-0.0045
0.9000	0.1195	-0.0116	0.0040	206.69	-0.0025
0.1000	-	-	-	-	-
		318.15K			
0.0000	-	-	-	-	-
0.1000	0.1088	0.0136	0.0097	435.05	-0.0689
0.2000	0.1834	0.0365	0.0144	706.03	-0.0648
0.3000	0.2490	0.0534	0.0160	846.40	-0.0484
0.4000	0.2758	0.0616	0.0158	887.14	-0.0328
0.5000	0.2888	0.0616	0.0146	851.93	-0.0209
0.6000	0.2780	0.0519	0.0125	754.98	-0.0120
0.7000	0.2687	0.0339	0.0102	609.01	-0.0072
0.8000	0.2093	0.0089	0.0067	422.82	-0.0036
0.9000	0.1311	-0.0055	0.0039	216.65	-0.0018
1.0000	-	-	-	-	-
		323.15K			
0.0000	-	-	-	-	-
0.1000	0.1220	0.0196	0.0096	457.04	-0.0692
0.2000	0.2052	0.0436	0.0143	737.68	-0.0645
0.3000	0.2763	0.0589	0.0159	879.53	-0.0475
0.4000	0.3067	0.0669	0.0157	920.55	-0.0316
0.5000	0.3204	0.0649	0.0145	881.25	-0.0198
0.6000	0.3087	0.0553	0.0124	780.51	-0.0111
0.7000	0.2957	0.0378	0.0101	629.54	-0.0061
0.8000	0.2301	0.0139	0.0066	437.66	-0.0025
0.9000	0.1419	-0.0005	0.0039	225.49	-0.0010
1.0000	-	-	-	-	-
		328.15K			
0.0000	-	-	-	-	
0.1000	0.1363	0.0244	0.0095	480.34	-0.0694
0.2000	0.2290	0.0493	0.0143	771.11	-0.0640
0.3000	0.3054	0.0638	0.0159	915.48	-0.0467
0.4000	0.3396	0.0701	0.0156	954.58	-0.0303
0.5000	0.3543	0.0681	0.0145	913.13	-0.0186

0.6000	0.3411	0.0577	0.0124	807.30	-0.0096
0.7000	0.3246	0.0410	0.0101	651.37	-0.0047
0.8000	0.2517	0.0181	0.0066	453.53	-0.0014
0.9000	0.1530	-0.0022	0.0039	228.96	-0.0002
1.0000	-	-	-	-	-
			333.15K		
0.0000	-	-	-	-	-
0.1000	0.1511	0.0300	0.0096	505.62	-0.0695
0.2000	0.2523	0.0567	0.0143	807.42	-0.0632
0.3000	0.3361	0.0727	0.0159	956.82	-0.0456
0.4000	0.3735	0.0760	0.0157	990.79	-0.0286
0.5000	0.3903	0.0713	0.0145	943.11	-0.0168
0.6000	0.3756	0.0594	0.0124	831.11	-0.0077
0.7000	0.3537	0.0425	0.0102	669.66	-0.0031
0.8000	0.2731	0.0212	0.0066	467.22	0.0001
0.9000	0.1640	0.0060	0.0039	241.95	0.0011
1.0000	-	-	-	-	-
			338.15K		
0.0000	-	-	-	-	-
0.1000	0.1664	0.0313	0.0096	530.16	-0.0699
0.2000	0.2789	0.0567	0.0142	841.81	-0.0620
0.3000	0.3679	0.0698	0.0158	991.34	-0.0443
0.4000	0.4091	0.0746	0.0156	1028.53	-0.0269
0.5000	0.4270	0.0717	0.0144	980.67	-0.0147
0.6000	0.4102	0.0610	0.0124	865.09	-0.0056
0.7000	0.3838	0.0452	0.0102	697.92	-0.0010
0.8000	0.2958	0.0248	0.0067	488.05	0.0021
0.9000	0.1760	0.0090	0.0040	253.59	0.0025
1.0000	-	-	-	-	-
			343.15K		
0.0000	-	-	-	-	-
0.1000	0.1830	0.0331	0.0096	555.19	-0.0695
0.2000	0.3059	0.0586	0.0142	877.85	-0.0588
0.3000	0.4001	0.0713	0.0159	1030.69	-0.0411
0.4000	0.4460	0.0755	0.0157	1067.10	-0.0231
0.5000	0.4644	0.0720	0.0145	1015.45	-0.0101
0.6000	0.4462	0.0616	0.0124	895.18	-0.0003
0.7000	0.4139	0.0464	0.0101	722.33	0.0040
0.8000	0.3175	0.0267	0.0069	505.64	0.0072
0.9000	0.1865	0.0108	0.0040	263.19	0.0068
1.0000	-	-	-	-	-
			ethyl oleate (1) + 1-propanol (2)		
			293.15K		
0.0000	-	-	-	-	-
0.1000	0.0545	0.1749	0.0164	736.85	-0.0976
0.2000	0.0927	0.2985	0.0225	1124.95	-0.0896
0.3000	0.1214	0.3727	0.0243	1296.73	-0.0691
0.4000	0.1268	0.3848	0.0238	1312.35	-0.0512
0.5000	0.1350	0.3628	0.0215	1228.06	-0.0334
0.6000	0.1303	0.3086	0.0185	1067.48	-0.0222
0.7000	0.1145	0.2344	0.0146	851.41	-0.0135
0.8000	0.0896	0.1350	0.0103	587.74	-0.0078
0.9000	0.0522	0.0409	0.0054	296.46	-0.0054
1.0000	-	-	-	-	-
			298.15K		
0.0000	-	-	-	-	-
0.1000	0.0633	0.1561	0.0163	742.58	-0.1013
0.2000	0.1083	0.2583	0.0224	1127.51	-0.0924

0.3000	0.1416	0.3131	0.0243	1293.89	-0.0710
0.4000	0.1501	0.3251	0.0237	1312.15	-0.0522
0.5000	0.1591	0.3123	0.0215	1232.44	-0.0336
0.6000	0.1533	0.2648	0.0185	1071.36	-0.0225
0.7000	0.1369	0.2006	0.0146	854.73	-0.0135
0.8000	0.1068	0.1199	0.0103	592.65	-0.0076
0.9000	0.0626	0.0371	0.0054	299.15	-0.0051
1.0000	-	-	-	-	-
		303.15K			
0.0000	-	-	-	-	-
0.1000	0.0737	0.1426	0.0162	755.38	-0.1047
0.2000	0.1258	0.2325	0.0224	1143.49	-0.0950
0.3000	0.1639	0.2824	0.0242	1312.63	-0.0722
0.4000	0.1738	0.2876	0.0237	1326.79	-0.0530
0.5000	0.1850	0.2778	0.0215	1247.43	-0.0338
0.6000	0.1784	0.2374	0.0184	1085.62	-0.0225
0.7000	0.1597	0.1778	0.0145	864.70	-0.0134
0.8000	0.1248	0.1034	0.0102	597.85	-0.0074
0.9000	0.0731	0.0343	0.0054	303.29	-0.0050
1.0000	-	-	-	-	-
		308.15K			
0.0000	-	-	-	-	-
0.1000	0.0844	0.1333	0.0162	773.43	-0.1080
0.2000	0.1443	0.2135	0.0224	1165.56	-0.0974
0.3000	0.1876	0.2572	0.0242	1335.56	-0.0736
0.4000	0.2011	0.2664	0.0237	1353.40	-0.0533
0.5000	0.2132	0.2520	0.0215	1267.77	-0.0336
0.6000	0.2061	0.2145	0.0184	1102.41	-0.0221
0.7000	0.1853	0.1625	0.0146	879.17	-0.0130
0.8000	0.1447	0.0942	0.0102	607.17	-0.0069
0.9000	0.0852	0.0319	0.0054	308.07	-0.0047
1.0000	-	-	-	-	-
		313.15K			
0.0000	-	-	-	-	-
0.1000	0.0962	0.1279	0.0162	792.40	-0.1114
0.2000	0.1646	0.2029	0.0224	1190.27	-0.0997
0.3000	0.2132	0.2435	0.0242	1361.94	-0.0749
0.4000	0.2300	0.2505	0.0236	1377.53	-0.0535
0.5000	0.2436	0.2331	0.0214	1286.21	-0.0335
0.6000	0.2352	0.1976	0.0183	1117.25	-0.0216
0.7000	0.2109	0.1487	0.0145	889.75	-0.0124
0.8000	0.1645	0.0865	0.0101	614.15	-0.0065
0.9000	0.0963	0.0329	0.0053	313.68	-0.0042
0.1000	-	-	-	-	-
		318.15K			
0.0000	-	-	-	-	-
0.1000	0.1092	0.1180	0.0162	814.92	-0.1147
0.2000	0.1872	0.1843	0.0223	1218.87	-0.1015
0.3000	0.2416	0.2176	0.0241	1389.60	-0.0756
0.4000	0.2621	0.2262	0.0235	1408.12	-0.0533
0.5000	0.2766	0.2121	0.0213	1316.28	-0.0326
0.6000	0.2670	0.1824	0.0182	1145.57	-0.0208
0.7000	0.2395	0.1380	0.0144	912.67	-0.0116
0.8000	0.1865	0.0815	0.0100	630.59	-0.0054
0.9000	0.1092	0.0319	0.0052	322.47	-0.0034
1.0000	-	-	-	-	-
		323.15K			
0.0000	-	-	-	-	-

0.1000	0.1226	0.1113	0.0161	837.81	-0.1179
0.2000	0.2106	0.1722	0.0222	1248.64	-0.1034
0.3000	0.2721	0.2020	0.0240	1420.86	-0.0758
0.4000	0.2958	0.2108	0.0234	1440.05	-0.0528
0.5000	0.3117	0.1970	0.0212	1344.75	-0.0315
0.6000	0.3001	0.1689	0.0181	1169.36	-0.0195
0.7000	0.2693	0.1284	0.0143	931.79	-0.0103
0.8000	0.2085	0.0771	0.0099	644.60	-0.0042
0.9000	0.1215	0.0324	0.0052	331.12	-0.0027
1.0000	-	-	-	-	-
			328.15K		
0.0000	-	-	-	-	-
0.1000	0.1378	0.1050	0.0161	861.76	-0.1208
0.2000	0.2357	0.1619	0.0223	1281.46	-0.1050
0.3000	0.3043	0.1885	0.0240	1454.59	-0.0760
0.4000	0.3320	0.1974	0.0234	1474.46	-0.0519
0.5000	0.3477	0.1830	0.0212	1374.28	-0.0302
0.6000	0.3348	0.1574	0.0181	1195.22	-0.0180
0.7000	0.2999	0.1204	0.0143	952.82	-0.0086
0.8000	0.2321	0.0737	0.0100	660.05	-0.0028
0.9000	0.1358	0.0323	0.0051	339.95	-0.0017
1.0000	-	-	-	-	-
			333.15K		
0.0000	-	-	-	-	-
0.1000	0.1534	0.1007	0.0160	886.46	-0.1241
0.2000	0.2627	0.1558	0.0223	1316.76	-0.1067
0.3000	0.3386	0.1808	0.0240	1491.80	-0.0759
0.4000	0.3697	0.1884	0.0234	1509.48	-0.0507
0.5000	0.3871	0.1715	0.0212	1401.23	-0.0285
0.6000	0.3707	0.1477	0.0181	1218.42	-0.0159
0.7000	0.3323	0.1123	0.0143	969.91	-0.0064
0.8000	0.2548	0.0693	0.0100	672.01	-0.0011
0.9000	0.1474	0.0320	0.0052	347.65	-0.0003
1.0000	-	-	-	-	-
			338.15K		
0.0000	-	-	-	-	-
0.1000	0.1708	0.0936	0.0159	913.92	-0.1274
0.2000	0.2916	0.1451	0.0222	1356.26	-0.1078
0.3000	0.3753	0.1656	0.0240	1529.86	-0.0753
0.4000	0.4094	0.1751	0.0234	1551.71	-0.0490
0.5000	0.4278	0.1596	0.0212	1440.28	-0.0264
0.6000	0.4097	0.1398	0.0181	1255.22	-0.0132
0.7000	0.3658	0.1080	0.0143	1001.10	-0.0037
0.8000	0.2782	0.0681	0.0100	694.85	0.0012
0.9000	0.1617	0.0321	0.0052	359.86	0.0016
1.0000	-	-	-	-	-
			343.15K		
0.0000	-	-	-	-	-
0.1000	0.1889	0.0897	0.0161	946.75	-0.1288
0.2000	0.3216	0.1371	0.0224	1397.29	-0.1064
0.3000	0.4134	0.1551	0.0241	1571.15	-0.0718
0.4000	0.4510	0.1657	0.0235	1595.84	-0.0446
0.5000	0.4696	0.1494	0.0213	1477.33	-0.0213
0.6000	0.4487	0.1327	0.0182	1289.95	-0.0072
0.7000	0.3993	0.1032	0.0143	1029.12	0.0025
0.8000	0.3025	0.0657	0.0100	714.60	0.0068
0.9000	0.1755	0.0319	0.0051	371.02	0.0069
1.0000	-	-	-	-	-

ethyl oleate (1) + *n*-hexadecane (2)

293.15K					
0.0000	-	-	-	-	-
0.1000	0.1364	-0.1135	0.0006	-18.14	0.0109
0.2000	0.2185	-0.2045	0.0007	-30.12	0.0176
0.3000	0.2659	-0.2533	0.0008	-25.33	0.0209
0.4000	0.2884	-0.2737	0.0009	-15.75	0.0217
0.5000	0.2868	-0.2682	0.0009	-2.83	0.0200
0.6000	0.2459	-0.2469	0.0010	5.47	0.0165
0.7000	0.2106	-0.2033	0.0008	13.13	0.0121
0.8000	0.1526	-0.1413	0.0006	16.90	0.0077
0.9000	0.0835	-0.0806	0.0003	9.47	0.0040
1.0000	-	-	-	-	-
298.15K					
0.0000	-	-	-	-	-
0.1000	0.1326	-0.1027	0.0006	-21.77	0.0106
0.2000	0.2164	-0.1772	0.0008	-30.54	0.0172
0.3000	0.2622	-0.2223	0.0009	-28.01	0.0205
0.4000	0.2847	-0.2338	0.0009	-18.14	0.0211
0.5000	0.2834	-0.2247	0.0009	0.73	0.0193
0.6000	0.2433	-0.2008	0.0010	6.73	0.0159
0.7000	0.2082	-0.1636	0.0008	13.44	0.0117
0.8000	0.1522	-0.1108	0.0006	21.89	0.0075
0.9000	0.0838	-0.0563	0.0003	15.38	0.0040
1.0000	-	-	-	-	-
303.15K					
0.0000	-	-	-	-	-
0.1000	0.1322	-0.0843	0.0006	-17.87	0.0104
0.2000	0.2147	-0.1545	0.0008	-31.99	0.0167
0.3000	0.2598	-0.1922	0.0009	-28.65	0.0197
0.4000	0.2820	-0.1970	0.0009	-16.34	0.0204
0.5000	0.2819	-0.1903	0.0010	2.30	0.0187
0.6000	0.2416	-0.1689	0.0010	9.45	0.0153
0.7000	0.2066	-0.1402	0.0008	11.40	0.0111
0.8000	0.1512	-0.0969	0.0006	20.40	0.0070
0.9000	0.0831	-0.0497	0.0003	14.31	0.0037
1.0000	-	-	-	-	-
308.15K					
0.0000	-	-	-	-	-
0.1000	0.1307	-0.0710	0.0007	-15.72	0.0101
0.2000	0.2122	-0.1258	0.0008	-24.22	0.0163
0.3000	0.2579	-0.1563	0.0009	-19.64	0.0193
0.4000	0.2806	-0.1638	0.0010	-7.69	0.0199
0.5000	0.2797	-0.1596	0.0010	5.68	0.0182
0.6000	0.2388	-0.1421	0.0010	11.82	0.0147
0.7000	0.2049	-0.1166	0.0008	16.29	0.0106
0.8000	0.1513	-0.0804	0.0006	22.01	0.0066
0.9000	0.0832	-0.0400	0.0003	15.83	0.0036
1.0000	-	-	-	-	-
313.15K					
0.0000	-	-	-	-	-
0.1000	0.1288	-0.0575	0.0007	-12.40	0.0100
0.2000	0.2105	-0.0999	0.0008	-16.67	0.0160
0.3000	0.2562	-0.1264	0.0009	-13.69	0.0189
0.4000	0.2782	-0.1323	0.0009	-2.74	0.0195
0.5000	0.2785	-0.1313	0.0009	7.82	0.0177
0.6000	0.2369	-0.1177	0.0008	12.36	0.0141
0.7000	0.2037	-0.0972	0.0007	15.66	0.0099

0.8000	0.1502	-0.0667	0.0004	21.57	0.0060
0.9000	0.0826	-0.0317	0.0002	16.40	0.0033
0.1000	-	-	-	-	-
			318.15K		
0.0000	-	-	-	-	-
0.1000	0.1275	-0.0520	0.0006	-12.48	0.0097
0.2000	0.2098	-0.0905	0.0008	-17.04	0.0158
0.3000	0.2556	-0.1127	0.0009	-11.96	0.0186
0.4000	0.2780	-0.1160	0.0009	0.99	0.0191
0.5000	0.2758	-0.1135	0.0009	13.19	0.0172
0.6000	0.2363	-0.1006	0.0008	17.94	0.0136
0.7000	0.2022	-0.0829	0.0006	19.81	0.0095
0.8000	0.1504	-0.0564	0.0004	25.16	0.0058
0.9000	0.0823	-0.0261	0.0002	18.62	0.0032
1.0000	-	-	-	-	-
			323.15K		
0.0000	-	-	-	-	-
0.1000	0.1267	-0.0448	0.0007	-10.80	0.0096
0.2000	0.2080	-0.0778	0.0008	-13.92	0.0155
0.3000	0.2544	-0.0965	0.0009	-8.09	0.0183
0.4000	0.2777	-0.0996	0.0009	4.86	0.0186
0.5000	0.2768	-0.0976	0.0009	15.74	0.0166
0.6000	0.2359	-0.0866	0.0008	21.10	0.0130
0.7000	0.2016	-0.0735	0.0006	21.73	0.0091
0.8000	0.1505	-0.0486	0.0004	25.81	0.0054
0.9000	0.0816	-0.0222	0.0001	19.15	0.0030
1.0000	-	-	-	-	-
			328.15K		
0.0000	-	-	-	-	-
0.1000	0.1256	-0.0390	0.0007	-9.33	0.0095
0.2000	0.2073	-0.0667	0.0008	-10.20	0.0152
0.3000	0.2540	-0.0831	0.0009	-4.35	0.0179
0.4000	0.2768	-0.0906	0.0009	8.21	0.0182
0.5000	0.2765	-0.0856	0.0009	16.89	0.0163
0.6000	0.2356	-0.0782	0.0008	23.43	0.0127
0.7000	0.2005	-0.0646	0.0006	24.05	0.0085
0.8000	0.1498	-0.0419	0.0004	26.82	0.0048
0.9000	0.0820	-0.0185	0.0001	20.09	0.0022
1.0000	-	-	-	-	-
			333.15K		
0.0000	-	-	-	-	-
0.1000	0.1254	-0.0321	0.0007	-5.99	0.0097
0.2000	0.2071	-0.0538	0.0008	-3.26	0.0150
0.3000	0.2525	-0.0698	0.0009	-0.68	0.0176
0.4000	0.2756	-0.0768	0.0009	10.53	0.0179
0.5000	0.2765	-0.0759	0.0009	13.75	0.0160
0.6000	0.2347	-0.0677	0.0008	22.27	0.0122
0.7000	0.1993	-0.0572	0.0006	22.50	0.0079
0.8000	0.1498	-0.0371	0.0004	24.91	0.0045
0.9000	0.0823	-0.0167	0.0002	18.66	0.0026
1.0000	-	-	-	-	-
			338.15K		
0.0000	-	-	-	-	-
0.1000	0.1249	-0.0292	0.0006	-4.98	0.0096
0.2000	0.2065	-0.0494	0.0008	-2.17	0.0152
0.3000	0.2533	-0.0625	0.0008	3.22	0.0176
0.4000	0.2753	-0.0682	0.0008	16.36	0.0182
0.5000	0.2762	-0.0669	0.0009	19.53	0.0160

0.6000	0.2355	-0.0603	0.0008	28.95	0.0119
0.7000	0.1996	-0.0508	0.0007	28.46	0.0075
0.8000	0.1508	-0.0337	0.0004	26.27	0.0047
0.9000	0.0824	-0.0155	0.0002	19.04	0.0033
1.0000	-	-	-	-	-
		343.15K			
0.0000	-	-	-	-	-
0.1000	0.1249	-0.0247	0.0005	-1.15	0.0097
0.2000	0.2056	-0.0422	0.0007	2.76	0.0184
0.3000	0.2527	-0.0542	0.0008	7.73	0.0213
0.4000	0.2749	-0.0595	0.0008	20.61	0.0217
0.5000	0.2764	-0.0586	0.0008	22.82	0.0195
0.6000	0.2346	-0.0535	0.0008	32.17	0.0150
0.7000	0.2013	-0.0441	0.0008	30.49	0.0102
0.8000	0.1502	-0.0317	0.0004	24.65	0.0081
0.9000	0.0820	-0.0169	0.0001	15.10	0.0033
1.0000	-	-	-	-	-
		n-hexadecane (1) + 1-butanol (2)			
		293.15K			
0.0000	-	-	-	-	-
0.1000	0.238	-0.0664	0.0045	153.65	0.0888
0.2000	0.353	-0.1015	0.0072	249.49	0.1197
0.3000	0.4235	-0.1562	0.0082	270.14	0.1306
0.4000	0.4628	-0.2302	0.0085	230.69	0.1301
0.5000	0.4827	-0.2377	0.0081	213.87	0.1252
0.6000	0.471	-0.257	0.0071	159.4	0.1135
0.7000	0.4258	-0.2479	0.0058	105.63	0.0958
0.8000	0.3507	-0.1912	0.0043	69.9	0.0746
0.9000	0.2387	-0.1498	0.0023	3.7	0.0492
1.0000	-	-	-	-	-
		298.15K			
0.0000	-	-	-	-	-
0.1000	0.246	-0.0615	0.0044	153.92	0.0954
0.2000	0.3698	-0.0904	0.0071	254.01	0.1298
0.3000	0.4462	-0.1392	0.0082	274.96	0.1425
0.4000	0.4909	-0.1972	0.0084	242.5	0.1426
0.5000	0.5122	-0.2052	0.008	224.17	0.1371
0.6000	0.5007	-0.218	0.007	172.96	0.1241
0.7000	0.454	-0.2088	0.0057	119.06	0.1045
0.8000	0.3768	-0.1646	0.0043	76.71	0.0817
0.9000	0.2589	-0.1326	0.0023	4.89	0.0539
1.0000	-	-	-	-	-
		303.15K			
0.0000	-	-	-	-	-
0.1000	0.2562	-0.0605	0.0044	150.07	0.1031
0.2000	0.3891	-0.0835	0.007	255.4	0.1413
0.3000	0.4737	-0.1288	0.0081	274.75	0.1558
0.4000	0.5237	-0.1734	0.0084	249.69	0.1563
0.5000	0.5467	-0.1759	0.0079	236.39	0.1499
0.6000	0.535	-0.1857	0.007	186.02	0.1355
0.7000	0.4872	-0.1784	0.0057	130.14	0.1143
0.8000	0.4072	-0.1421	0.0043	83.56	0.0892
0.9000	0.283	-0.1167	0.0023	7.11	0.059
1.0000	-	-	-	-	-
		308.15K			
0.0000	-	-	-	-	-
0.1000	0.2684	-0.0528	0.0044	154.45	0.1119
0.2000	0.4118	-0.0744	0.0069	260.74	0.1545

0.3000	0.5043	-0.1108	0.008	285.94	0.1709
0.4000	0.5588	-0.1459	0.0083	266.88	0.1714
0.5000	0.5855	-0.1505	0.0078	250.39	0.1643
0.6000	0.574	-0.1568	0.0069	202.3	0.1484
0.7000	0.5241	-0.1508	0.0056	144.6	0.1248
0.8000	0.4416	-0.1232	0.0042	91.04	0.0976
0.9000	0.3093	-0.1031	0.0023	9.81	0.0645
1.0000	-	-	-	-	-
			313.15K		
0.0000	-	-	-	-	-
0.1000	0.2822	-0.0473	0.0043	157.78	0.1218
0.2000	0.437	-0.0651	0.0069	268.69	0.1693
0.3000	0.538	-0.0964	0.0079	296.77	0.1877
0.4000	0.5987	-0.1238	0.0082	283.72	0.1883
0.5000	0.6277	-0.1278	0.0078	267.38	0.1802
0.6000	0.6167	-0.1325	0.0068	219.7	0.1622
0.7000	0.5653	-0.1282	0.0056	159.28	0.1366
0.8000	0.4789	-0.107	0.0041	99.47	0.107
0.9000	0.3386	-0.0911	0.0022	13.34	0.0704
0.1000	-	-	-	-	-
			318.15K		
0.0000	-	-	-	-	-
0.1000	0.2983	-0.0425	0.0042	161.07	0.1334
0.2000	0.4661	-0.0569	0.0067	277.52	0.186
0.3000	0.5771	-0.0804	0.0078	314.43	0.2066
0.4000	0.6431	-0.1057	0.008	300.48	0.2071
0.5000	0.6752	-0.1098	0.0076	283.21	0.1977
0.6000	0.6645	-0.1143	0.0067	234.39	0.1777
0.7000	0.6115	-0.1109	0.0055	171.91	0.1495
0.8000	0.5219	-0.0948	0.004	106.12	0.1173
0.9000	0.3704	-0.0823	0.0022	15.22	0.0769
1.0000	-	-	-	-	-
			323.15K		
0.0000	-	-	-	-	-
0.1000	0.3159	-0.0375	0.0042	166.41	0.146
0.2000	0.4976	-0.049	0.0066	288.52	0.2045
0.3000	0.6187	-0.0742	0.0077	319.5	0.2271
0.4000	0.6914	-0.0894	0.0079	319.83	0.2277
0.5000	0.7267	-0.0937	0.0075	301.43	0.2166
0.6000	0.7167	-0.097	0.0066	253.08	0.1943
0.7000	0.6613	-0.0958	0.0054	185.89	0.1637
0.8000	0.5679	-0.084	0.0039	113.81	0.1286
0.9000	0.404	-0.0735	0.0021	19.12	0.0838
1.0000	-	-	-	-	-
			328.15K		
0.0000	-	-	-	-	-
0.1000	0.3355	-0.0333	0.0041	171.77	0.1603
0.2000	0.5326	-0.0421	0.0065	300.52	0.2254
0.3000	0.6645	-0.0636	0.0076	335.66	0.2499
0.4000	0.7449	-0.0761	0.0078	339.18	0.2503
0.5000	0.7829	-0.0802	0.0074	320.05	0.2373
0.6000	0.7736	-0.0833	0.0065	270.51	0.2125
0.7000	0.7169	-0.0832	0.0053	200.2	0.1793
0.8000	0.6174	-0.0748	0.0039	121.74	0.141
0.9000	0.4395	-0.0666	0.0021	22.28	0.0912
1.0000	-	-	-	-	-
			333.15K		
0.0000	-	-	-	-	-

0.1000	0.3574	-0.0288	0.0041	179.32	0.1763
0.2000	0.5717	-0.0356	0.0065	314.36	0.2485
0.3000	0.7147	-0.0538	0.0075	353.92	0.275
0.4000	0.8018	-0.0639	0.0078	360.96	0.275
0.5000	0.8446	-0.0682	0.0073	340.24	0.26
0.6000	0.8359	-0.0715	0.0065	288.8	0.2329
0.7000	0.777	-0.0722	0.0052	214.9	0.1966
0.8000	0.671	-0.0667	0.0038	130.07	0.1548
0.9000	0.4766	-0.0595	0.002	27.28	0.0992
1.0000	-	-	-	-	-
		338.15K			
0.0000	-	-	-	-	-
0.1000	0.3818	-0.0251	0.0041	187.05	0.1942
0.2000	0.6135	-0.03	0.0064	329.21	0.2742
0.3000	0.769	-0.0458	0.0075	372.49	0.3024
0.4000	0.8643	-0.0539	0.0077	383.02	0.3024
0.5000	0.9105	-0.0582	0.0072	361.33	0.2851
0.6000	0.9028	-0.0617	0.0064	307.52	0.2552
0.7000	0.8414	-0.0633	0.0051	229.72	0.2158
0.8000	0.7286	-0.0594	0.0037	139.98	0.17
0.9000	0.515	-0.0532	0.0019	33.28	0.1084
1.0000	-	-	-	-	-
		343.15K			
0.0000	-	-	-	-	-
0.1000	0.4081	-0.0217	0.0041	195.62	0.215
0.2000	0.6587	-0.0251	0.0064	344.77	0.3042
0.3000	0.8273	-0.0383	0.0074	393.13	0.3343
0.4000	0.9312	-0.045	0.0076	406.45	0.3344
0.5000	0.9821	-0.0494	0.0072	383.07	0.3151
0.6000	0.9752	-0.0532	0.0064	326.65	0.2826
0.7000	0.9112	-0.0553	0.005	245.29	0.2399
0.8000	0.789	-0.0527	0.0036	150.58	0.1901
0.9000	0.5533	-0.047	0.0018	40.86	0.1214
1.0000	-	-	-	-	-
		n-hexadecane (1) + 1-propanol (2)			
		293.15K			
0.0000	-	-	-	-	-
0.1000	0.2730	0.1150	0.0093	444.78	0.1182
0.2000	0.3704	0.1421	0.0134	647.97	0.1405
0.3000	0.4365	0.1457	0.0150	736.01	0.1410
0.4000	0.4707	0.1241	0.0149	736.06	0.1385
0.5000	0.4873	0.0673	0.0137	657.91	0.1270
0.6000	0.4759	0.0130	0.0121	545.73	0.1136
0.7000	0.4384	-0.0395	0.0095	405.84	0.0963
0.8000	0.3681	-0.0628	0.0068	264.92	0.0742
0.9000	0.2529	-0.0683	0.0036	115.89	0.0474
1.0000	-	-	-	-	-
		298.15K			
0.0000	-	-	-	-	-
0.1000	0.2821	0.0941	0.0092	440.99	0.1260
0.2000	0.3886	0.1160	0.0134	645.27	0.1514
0.3000	0.4612	0.1149	0.0149	730.57	0.1536
0.4000	0.5010	0.0936	0.0149	729.19	0.1516
0.5000	0.5203	0.0455	0.0136	652.86	0.1395
0.6000	0.5093	0.0047	0.0121	546.72	0.1249
0.7000	0.4700	-0.0373	0.0094	409.39	0.1058
0.8000	0.3955	-0.0598	0.0068	264.95	0.0818
0.9000	0.2756	-0.0666	0.0036	112.42	0.0523

1.0000	-	-	-	-	-
		303.15K			
0.0000	-	-	-	-	-
0.1000	0.2934	0.0746	0.0092	436.22	0.1353
0.2000	0.4104	0.0973	0.0133	648.70	0.1643
0.3000	0.4908	0.0939	0.0149	733.01	0.1678
0.4000	0.5361	0.0737	0.0148	730.64	0.1665
0.5000	0.5575	0.0320	0.0135	654.67	0.1533
0.6000	0.5477	0.0020	0.0120	553.91	0.1374
0.7000	0.5072	-0.0348	0.0094	415.03	0.1166
0.8000	0.4288	-0.0598	0.0067	263.12	0.0899
0.9000	0.3009	-0.0596	0.0036	114.34	0.0578
1.0000	-	-	-	-	-
		308.15K			
0.0000	-	-	-	-	-
0.1000	0.3064	0.0649	0.0091	441.38	0.1454
0.2000	0.4349	0.0829	0.0133	654.79	0.1786
0.3000	0.5238	0.0781	0.0148	738.53	0.1840
0.4000	0.5754	0.0593	0.0147	735.68	0.1832
0.5000	0.5993	0.0277	0.0135	665.94	0.1689
0.6000	0.5902	0.0004	0.0120	562.86	0.1513
0.7000	0.5485	-0.0317	0.0093	422.68	0.1283
0.8000	0.4653	-0.0511	0.0067	271.47	0.0991
0.9000	0.3287	-0.0544	0.0036	115.88	0.0637
1.0000	-	-	-	-	-
		313.15K			
0.0000	-	-	-	-	-
0.1000	0.3212	0.0548	0.0091	443.11	0.1572
0.2000	0.4615	0.0712	0.0133	661.02	0.1949
0.3000	0.5602	0.0663	0.0148	745.72	0.2022
0.4000	0.6195	0.0492	0.0147	742.86	0.2019
0.5000	0.6455	0.0226	0.0134	674.97	0.1865
0.6000	0.6372	-0.0004	0.0119	572.58	0.167
0.7000	0.5931	-0.0280	0.0093	431.78	0.1414
0.8000	0.5062	-0.0464	0.0066	276.6	0.1092
0.9000	0.3591	-0.0499	0.0035	117.42	0.0702
0.1000	-	-	-	-	-
		318.15K			
0.0000	-	-	-	-	-
0.1000	0.3384	0.0469	0.0090	447.79	0.1708
0.2000	0.4929	0.0618	0.0132	670.77	0.2136
0.3000	0.6011	0.0567	0.0146	756.67	0.2228
0.4000	0.6689	0.0413	0.0146	754.19	0.2231
0.5000	0.6987	0.0188	0.0133	687.74	0.2063
0.6000	0.6906	-0.0013	0.0118	584.34	0.1843
0.7000	0.6448	-0.0249	0.0092	442.82	0.1559
0.8000	0.5523	-0.0440	0.0066	280.88	0.1206
0.9000	0.3940	-0.0464	0.0035	119.16	0.0774
1.0000	-	-	-	-	-
		323.15K			
0.0000	-	-	-	-	-
0.1000	0.3577	0.0401	0.0088	451.75	0.1858
0.2000	0.5275	0.0544	0.0129	681.56	0.2346
0.3000	0.6466	0.0497	0.0144	769.10	0.2457
0.4000	0.7230	0.0355	0.0143	766.58	0.2464
0.5000	0.7562	0.0163	0.0131	701.33	0.2281
0.6000	0.7489	-0.0015	0.0117	596.99	0.2033
0.7000	0.7003	-0.0223	0.0091	453.81	0.1721

0.8000	0.6019	-0.0413	0.0065	285.72	0.1331
0.9000	0.4304	-0.0432	0.0034	121.10	0.0851
1.0000	-	-	-	-	-
			328.15K		
0.0000	-	-	-	-	-
0.1000	0.3791	0.0350	0.0088	457.75	0.2030
0.2000	0.5655	0.0481	0.0128	692.97	0.2583
0.3000	0.6970	0.0439	0.0143	782.93	0.2717
0.4000	0.7821	0.0314	0.0142	781.78	0.2725
0.5000	0.8191	0.0144	0.0130	716.26	0.2523
0.6000	0.8131	-0.0017	0.0116	610.19	0.2242
0.7000	0.7605	-0.0198	0.0090	465.80	0.1899
0.8000	0.6550	-0.0391	0.0064	290.78	0.1468
0.9000	0.4692	-0.0395	0.0034	124.81	0.0935
1.0000	-	-	-	-	-
			333.15K		
0.0000	-	-	-	-	-
0.1000	0.4034	0.0306	0.0087	463.68	0.2221
0.2000	0.6080	0.0431	0.0127	705.48	0.2849
0.3000	0.7530	0.0397	0.0142	798.80	0.3005
0.4000	0.8473	0.0285	0.0141	798.20	0.3016
0.5000	0.8883	0.0127	0.0129	731.17	0.2793
0.6000	0.8833	-0.0025	0.0115	622.06	0.2476
0.7000	0.8269	-0.0182	0.0089	476.86	0.2098
0.8000	0.7130	-0.0372	0.0063	295.59	0.1623
0.9000	0.5098	-0.0363	0.0033	128.39	0.1027
1.0000	-	-	-	-	-
			338.15K		
0.0000	-	-	-	-	-
0.1000	0.4304	0.0281	0.0086	475.17	0.2446
0.2000	0.6554	0.0399	0.0126	724.21	0.3153
0.3000	0.8138	0.0355	0.0140	816.42	0.3332
0.4000	0.9185	0.0245	0.0139	814.35	0.3345
0.5000	0.9636	0.0117	0.0127	750.44	0.3095
0.6000	0.9584	-0.0029	0.0113	637.44	0.2738
0.7000	0.8988	-0.0161	0.0088	491.60	0.2321
0.8000	0.7752	-0.0359	0.0062	301.14	0.1795
0.9000	0.5509	-0.0331	0.0032	133.77	0.1132
1.0000	-	-	-	-	-
			343.15K		
0.0000	-	-	-	-	-
0.1000	0.4601	0.0267	0.0087	490.07	0.2720
0.2000	0.7067	0.0378	0.0127	745.63	0.3516
0.3000	0.8811	0.0284	0.0141	824.15	0.3724
0.4000	0.9952	0.0147	0.0140	812.77	0.3733
0.5000	1.0451	0.0107	0.0128	769.92	0.3453
0.6000	1.0407	-0.0036	0.0113	652.38	0.3066
0.7000	0.9760	-0.0147	0.0088	505.84	0.2598
0.8000	0.8421	-0.0346	0.0061	306.88	0.2018
0.9000	0.5935	-0.0296	0.0032	140.61	0.1280
1.0000	-	-	-	-	-

[a]Standard uncertainties u for each variables are u(T) = ± 0.001 K for densimeter, u(T) = ±0.01 K for viscometer, u(T) = ±0.03 K for refractometer; u(p) = 5%; u(x_1) = 0.0001, and the combined expanded uncertainties U_c are $U_c(\rho)$ = ± 0.8kg·m^{-3}; $U_c(V^E)$= ±2×10^{-7} m^3·mol^{-1};$U_c(\eta)$ = ±0.007 mPa.s; $U_c(\Delta\eta)$ = ±0.009 mPa.s; $U_c(u)$= ±0.2 m.s^{-1}; Uc(n_D) = ±2.8×10^{-3} and Uc(Δn_D) = ±3.4×10^{-3} with 0.95 level of confidence (k ≈ 2)

Table A 10 Redlich−Kister Parameters for Excess Molar Volumes V^E, Viscosity Deviations $\Delta\eta$, Deviations in Refractive Indices Δn_D, Excess Molar Gibbs Energy Of Activation Of Viscous Flow $\Delta G^{*E}$and Deviations in Isentropic Compressibility $\Delta\kappa_s$ at temperature *T* for Binary Mixtures ethyl laurae (1) + 1-propanol (2), ethyl oleate (1) + 1-butanol (2), ethyl oleate (1) + 1-propanol (2), ethyl oleate (1) + *n*-hexadecane (2), *n*-hexadecane (1) + 1-butanol (2) and *n*-hexadecane (1) + 1-propanol (2) along with the corresponding values of rmsd.

Function	*T*/(K)	A_0	A_1	A_2	A_3	A_4	σ
			ethyl laurate (1) + 1-propanol (2)				
10^6V^E	293.15	0.790333	0.436986	-0.585755	-0.357448	1.060947	0.00001
($m^3\cdot mol^{-1}$)	298.15	0.87676	0.449957	-0.551376	-0.366988	1.032486	0.00002
	303.15	0.974053	0.453845	-0.542793	-0.36454	1.038918	0.00002
	308.15	1.080844	0.463505	-0.530891	-0.380658	1.035099	0.00002
	313.15	1.194847	0.469632	-0.518614	-0.396998	1.027331	0.00003
	318.15	1.319171	0.475501	-0.478381	-0.407937	0.989368	0.00002
	323.15	1.452274	0.475529	-0.470183	-0.423196	0.985209	0.00002
	328.15	1.595477	0.4791	-0.45032	-0.453455	0.957906	0.00009
	333.15	1.745467	0.472288	-0.420064	-0.466683	0.927016	0.00008
	338.15	1.905034	0.469378	-0.408671	-0.496857	0.921081	0.00009
	343.15	2.071858	0.455655	-0.401898	-0.526415	0.900751	0.00008
$\Delta\eta$	293.15	-0.478476	0.054399	-0.278249	0.1548	-0.764058	0.00001
(mPa·s)	298.15	-0.380877	0.022687	-0.267807	0.144673	-0.493744	0.00001
	303.15	-0.298818	0.026357	-0.278966	0.077088	-0.338823	0.00000
	308.15	-0.230419	-0.011969	-0.160267	0.085975	-0.367109	0.00000
	313.15	-0.165219	-0.030852	-0.153066	0.077501	-0.243208	0.00000
	318.15	-0.12002	-0.046659	-0.102087	0.060967	-0.216193	0.00000
	323.15	-0.07722	-0.058299	-0.06882	0.044432	-0.180064	0.00000
	328.15	-0.04482	-0.062928	-0.018208	0.021284	-0.180912	0.00000
	333.15	-0.01962	-0.075362	0.047648	0.00599	-0.209703	0.00000
	338.15	0.00318	-0.085779	0.099145	-0.007031	-0.222404	0.00000
	343.15	0.01838	-0.090905	0.18678	-0.04568	-0.275741	0.00000
	293.15	0.050682	-0.027081	0.021993	-0.01302	-	0.00003
Δn_D	298.15	0.050231	-0.027282	0.021873	-0.01165	-	0.00003
	303.15	0.050072	-0.026312	0.021444	-0.014205	-	0.00004
	308.15	0.049881	-0.027282	0.020784	-0.01165	-	0.00002
	313.15	0.04998	-0.027098	0.020596	-0.011801	-	0.00001
	318.15	0.049581	-0.02672	0.020585	-0.011443	-	0.00000
	323.15	0.049361	-0.02618	0.01887	-0.011184	-	0.00007
	328.15	0.049361	-0.02618	0.01887	-0.011184	-	0.00007
	333.15	0.049361	-0.02618	0.01887	-0.011184	-	0.00007
	338.15	0.049335	-0.026427	0.017536	-0.009701	-	0.0001
	343.15	0.049403	-0.025403	0.018376	-0.012386	-	0.00007
ΔG^{*E}	293.15	1643.8823	-607.1698	47.782461	155.35228	-698.7025	0.32660
($J\cdot mol^{-1}$)	298.15	1718.023	-651.2366	26.468969	127.90142	-491.4536	0.21920
	303.15	1803.1385	-664.1175	-15.59418	58.082275	-369.3464	0.23720
	308.15	1894.9231	-738.0958	113.84262	71.539952	-457.4851	0.23310
	313.15	2000.0909	-792.6599	119.74856	48.058335	-338.1427	0.24922
	318.15	2102.4876	-850.9305	190.73441	19.077792	-328.5413	0.25513
	323.15	2214.826	-909.9398	253.26662	-21.65842	-298.6958	0.26367
	328.15	2326.0417	-962.2461	355.502	-77.53077	-319.8307	0.2666
	333.15	2433.2762	-1037.156	521.94177	-131.628	-410.7404	0.26085
	338.15	2558.2491	-1116.746	688.0461	-196.638	-473.941	0.25818
	343.15	2676.8654	-1192.825	974.76361	-348.531	-631.6818	0.24067

$10^{10}\Delta\kappa_S$ (Pa^{-1})	293.15	-0.026003	0.219974	-0.338927	0.172784	-0.009219	0.00000
	298.15	-0.01922	0.219611	-0.348265	0.178774	-0.001696	0.00000
	303.15	-0.00922	0.218024	-0.355623	0.181254	0.007087	0.00000
	308.15	0.00278	0.214981	-0.365875	0.181667	0.020935	0.00000
	313.15	0.01878	0.210914	-0.372283	0.184768	0.031217	0.00000
	318.15	0.03558	0.20473	-0.369397	0.182494	0.035878	0.00000
	323.15	0.05678	0.19729	-0.37344	0.184354	0.051472	0.00000
	328.15	0.081994	0.186376	-0.374916	0.181878	0.070872	0.00000
	333.15	0.110397	0.17543	-0.374403	0.187045	0.083182	0.00001
	338.15	0.14358	0.163626	-0.371588	0.182701	0.099793	0.00000
	343.15	0.179981	0.15645	-0.373101	0.149425	0.147565	0.00000
ethyl oleate (1) + 1-butanol (2)							
10^6V^E ($m^3\cdot mol^{-1}$)	293.15	0.6197	-0.0242	0.1838	0.3212	-	0.0029
	298.15	0.7123	-0.0102	0.1860	0.3126	-	0.0038
	303.15	0.8048	-0.0010	0.2268	0.2855	-	0.0028
	308.15	0.9209	0.0706	0.2401	0.1645	-	0.0041
	313.15	1.0336	0.0742	0.2523	0.1483	-	0.0045
	318.15	1.1554	0.0815	0.2781	0.1163	-	0.0045
	323.15	1.2816	0.1377	0.2872	-	-	0.0045
	328.15	1.4199	0.1071	0.2825	-	-	0.0050
	333.15	1.5622	0.0909	0.2915	-	-	0.0045
	338.15	1.7080	0.0731	0.3100	-	-	0.0043
	343.15	1.8681	0.0506	0.2770	-	-	0.0042
$\Delta\eta$ (mPa·s)	293.15	0.1492	0.0014	-0.5304	-0.1145	-0.6712	0.0019
	298.15	0.1517	0.0351	-0.5114	-0.1324	-0.3529	0.0015
	303.15	0.1646	-0.0218	-0.4382	-0.1449	-0.4013	0.0009
	308.15	0.2013	-0.0579	-0.3533	-0.0992	-0.2435	0.0007
	313.15	0.2384	-0.1386	-0.2395	-0.0160	-0.2558	0.0009
	318.15	0.2468	-0.1128	-0.2385	-0.0488	-0.1252	0.0009
	323.15	0.2616	-0.1272	-0.1904	-0.0370	-0.0862	0.0009
	328.15	0.2711	-0.1232	-0.0972	-0.0998	-0.2063	0.0003
	333.15	0.2857	-0.1837	-0.0714	0.0166	-0.1035	0.0006
	338.15	0.2861	-0.1474	-0.0732	-0.0244	-0.0377	0.0006
	343.15	0.2878	-0.1495	-0.0441	-0.0203	-0.0386	0.0006
Δn_D	293.15	0.0600	-0.0366	0.0240	-	-	0.0002
	298.15	0.0598	-0.0363	0.0233	-	-	0.0003
	303.15	0.0594	-0.0365	0.0234	-	-	0.0003
	308.15	0.0592	-0.0371	0.0251	-	-	0.0003
	313.15	0.0588	-0.0378	0.0241	-	-	0.0003
	318.15	0.0583	-0.0381	0.0242	-	-	0.0002
	323.15	0.0579	-0.0379	0.0245	-	-	0.0003
	328.15	0.0577	-0.0378	0.0246	-	-	0.0002
	333.15	0.0578	-0.0378	0.0247	-	-	0.0003
	338.15	0.0577	-0.0369	0.0246	-	-	0.0002
	343.15	0.0579	-0.0366	0.0246	-	-	0.0002
ΔG^{*E} ($J\cdot mol^{-1}$)	293.15	2964.4	-1130.5	60.4	-	-	2.7
	298.15	3020.4	-1157.2	100.4	-	-	2.5
	303.15	3090.2	-1230.4	118.6	-	-	2.9
	308.15	3190.4	-1300.5	210.1	-	-	2.9
	313.15	3283.6	-1407.6	301.3	-	-	2.8
	318.15	3406.9	-1463.9	353.8	-	-	3.5
	323.15	3524.5	-1548.7	433.4	-	-	3.9
	328.15	3652.2	-1639.7	475.7	-	-	5.2

	333.15	3771.5	-1764.3	600.6	-	-	3.9
	338.15	3922.7	-1829.5	669.0	-	-	5.5
	343.15	4061.9	-1924.0	784.9	-	-	5.9
$10^{10}\Delta\kappa_S$ (Pa^{-1})	293.15	-0.0928	0.1769	-0.2045	0.3689	-0.3793	0.0008
	298.15	-0.0921	0.1757	-0.2170	0.3902	-0.3727	0.0008
	303.15	-0.0922	0.1756	-0.2140	0.4024	-0.3923	0.0008
	308.15	-0.0900	0.1767	-0.2161	0.4112	-0.3993	0.0008
	313.15	-0.0878	0.1762	-0.2227	0.4220	-0.3972	0.0009
	318.15	-0.0841	0.1756	-0.2234	0.4343	-0.3997	0.0010
	323.15	-0.0798	0.1739	-0.2204	0.4493	-0.4099	0.0009
	328.15	-0.0745	0.1753	-0.2181	0.4572	-0.4185	0.0010
	333.15	-0.0672	0.1757	-0.2215	0.4699	-0.4132	0.0011
	338.15	-0.0596	0.1772	-0.2098	0.4836	-0.4352	0.0012
	343.15	-0.0416	0.1838	-0.1901	0.5082	-0.4434	0.0016
			ethyl oleate (1) + 1-propanol (2)				
10^6V^E ($m^3\cdot mol^{-1}$)	293.15	0.5398	-0.0161	0.0832	-	-	0.0022
	298.15	0.6362	-0.0069	0.1017	-	-	0.0021
	303.15	0.7398	-0.0052	0.1197	-	-	0.0025
	308.15	0.8526	0.0045	0.1418	-	-	0.0024
	313.15	0.9740	0.0008	0.1482	-	-	0.0025
	318.15	1.1060	-0.0033	0.1722	-	-	0.0024
	323.15	1.2464	-0.0107	0.1755	-	-	0.0027
	328.15	1.3905	-0.0147	0.2038	-	-	0.0025
	333.15	1.5480	-0.0423	0.1926	-	-	0.0030
	338.15	1.7109	-0.0617	0.2106	-	-	0.0033
	343.15	1.8783	-0.0897	0.2242	-	-	0.0035
$\Delta\eta$ (mPa·s)	293.15	1.4691	-0.8519	-0.3198	-	-	0.0054
	298.15	1.2494	-0.7175	-0.1937	-	-	0.0053
	303.15	1.1103	-0.6685	-0.1761	-	-	0.0050
	308.15	1.0077	-0.6212	-0.1288	-	-	0.0042
	313.15	0.9344	-0.6046	-0.0795	-	-	0.0030
	318.15	0.8482	-0.5334	-0.0496	-	-	0.0038
	323.15	0.7879	-0.4936	-0.0263	-	-	0.0034
	328.15	0.7327	-0.4608	0.0129	-	-	0.0031
	333.15	0.6934	-0.4480	0.0335	-	-	0.0024
	338.15	0.6479	-0.3983	0.0459	-	-	0.0029
	343.15	0.6125	-0.3685	0.0620	-	-	0.0033
Δn_D	293.15	0.0861	-0.0540	0.0473	-0.0291	-	0.0003
	298.15	0.0857	-0.0533	0.0464	-0.0274	-	0.0003
	303.15	0.0858	-0.0532	0.0466	-0.0302	-	0.0002
	308.15	0.0856	-0.0532	0.0456	-0.0267	-	0.0003
	313.15	0.0851	-0.0532	0.0466	-0.0286	-	0.0003
	318.15	0.0850	-0.0538	0.0453	-0.0276	-	0.0003
	323.15	0.0846	-0.0536	0.0444	-0.0274	-	0.0003
	328.15	0.0844	-0.0525	0.0460	-0.0315	-	0.0002
	333.15	0.0846	-0.0533	0.0470	-0.0323	-	0.0002
	338.15	0.0845	-0.0534	0.0463	-0.0313	-	0.0002
	343.15	0.0847	-0.0534	0.0463	-0.0309	-	0.0002
ΔG^{*E} ($J\cdot mol^{-1}$)	293.15	4908.1	-2508.3	1271.0	-842.7	-	1.6
	298.15	4911.8	-2461.8	1311.0	-938.1	-	2.5
	303.15	4974.9	-2482.6	1338.1	-1066.4	-	3.2

	308.15	5064.1	-2580.8	1328.7	-899.7	-	4.8
	313.15	5141.7	-2671.7	1385.4	-910.1	-	5.5
	318.15	5259.7	-2682.7	1443.6	-1058.7	-	6.2
	323.15	5372.2	-2762.7	1510.5	-1058.3	-	7.3
	328.15	5491.0	-2834.3	1603.0	-1115.0	-	7.5
	333.15	5605.6	-2958.6	1692.4	-1100.6	-	7.9
	338.15	5758.6	-2984.5	1823.7	-1269.8	-	7.6
	343.15	5909.8	-3081.0	1962.3	-1250.9	-	9.3
$10^{10}\Delta\kappa_s$ (Pa^{-1})	293.15	-0.1400	0.2346	-0.2220	0.5984	-0.6989	0.0019
	298.15	-0.1417	0.2398	-0.2338	0.6319	-0.7211	0.0020
	303.15	-0.1429	0.2436	-0.2390	0.6629	-0.7553	0.0021
	308.15	-0.1422	0.2491	-0.2509	0.6921	-0.7778	0.0021
	313.15	-0.1415	0.2541	-0.2604	0.7239	-0.8041	0.0022
	318.15	-0.1388	0.2567	-0.2668	0.7623	-0.8326	0.0024
	323.15	-0.1346	0.2608	-0.2709	0.7971	-0.8703	0.0024
	328.15	-0.1294	0.2658	-0.2764	0.8302	-0.9003	0.0025
	333.15	-0.1223	0.2713	-0.2828	0.8697	-0.9343	0.0026
	338.15	-0.1134	0.2759	-0.2814	0.9147	-0.9773	0.0027
	343.15	-0.0924	0.2827	-0.2699	0.9700	-0.9957	0.0030
ethyl oleate (1) + *n*-hexadecane (2)							
$10^6 V^E$ ($m^3 \cdot mol^{-1}$)	293.15	1.1255	-0.3507	0.1100	-	-	0.0038
	298.15	1.1042	-0.3359	0.1351	-	-	0.0036
	303.15	1.0940	-0.3304	0.1376	-	-	0.0038
	308.15	1.0792	-0.3239	0.1629	-	-	0.0042
	313.15	1.0723	-0.3200	0.1585	-	-	0.0044
	318.15	1.0720	-0.3117	0.1449	-	-	0.0039
	323.15	1.0684	-0.3120	0.1369	-	-	0.0044
	328.15	1.0695	-0.3002	0.1295	-	-	0.0044
	333.15	1.0669	-0.2995	0.1360	-	-	0.0047
	338.15	1.0688	-0.2944	0.1286	-	-	0.0045
	343.15	1.0668	-0.2927	0.1226	-	-	0.0046
$\Delta\eta$ (mPa·s)	293.15	-1.0789	0.2932	0.0665	-	-	0.0038
	298.15	-0.9061	0.3429	0.0127	-	-	0.0020
	303.15	-0.7612	0.2998	0.0679	-	-	0.0040
	308.15	-0.6385	0.2352	0.0127	-	-	0.0018
	313.15	-0.5253	0.1729	0.0129	-	-	0.0015
	318.15	-0.4540	0.1772	0.0126	-	-	0.0017
	323.15	-0.3909	0.1514	0.0122	-	-	0.0019
	328.15	-0.3530	0.1292	0.0376	-	-	0.0015
	333.15	-0.3039	0.0903	0.0496	-	-	0.0011
	338.15	-0.2687	0.0822	0.0247	-	-	0.0009
	343.15	-0.2345	0.0560	0.0076	-	-	0.0003
Δn_D	293.15	0.0037	0.0006	0.0017	-0.0040	-	0.00002
	298.15	0.0038	0.0007	0.0019	-0.0045	-	0.00002
	303.15	0.0038	0.0004	0.0019	-0.0044	-	0.00002
	308.15	0.0039	0.0002	0.0020	-0.0044	-	0.00004
	313.15	0.0036	-0.0005	0.0010	-0.0037	-	0.00003
	318.15	0.0035	-0.0006	0.0008	-0.0038	-	0.00004
	323.15	0.0035	-0.0010	0.0008	-0.0034	-	0.00004
	328.15	0.0035	-0.0008	0.0009	-0.0043	-	0.00003
	333.15	0.0035	-0.0007	0.0013	-0.0038	-	0.00003

	338.15	0.0034	-0.0006	0.0008	-0.0034	-	0.00003
	343.15	0.0033	0.0004	0.0006	-0.0049	-	0.00004
ΔG^{*E} ($J \cdot mol^{-1}$)	293.15	-14.8	244.5	-106.4	-55.3	86.5	1.3
	298.15	-11.3	254.4	-140.1	18.7	181.9	1.9
	303.15	-0.4	264.2	-275.8	-38.6	404.5	2.0
	308.15	17.1	216.1	-169.9	25.2	236.4	1.3
	313.15	26.0	166.5	-128.0	65.2	206.8	1.2
	318.15	47.4	183.8	-183.0	66.0	269.8	1.3
	323.15	60.3	171.9	-177.6	69.0	257.0	1.1
	328.15	68.3	159.3	-131.1	77.5	193.0	0.8
	333.15	61.9	122.9	-25.6	73.2	69.6	1.4
	338.15	88.6	137.0	-69.1	42.9	81.8	1.4
	343.15	103.1	132.4	-56.7	-35.3	23.6	1.6
$10^{10}\Delta\kappa_s$ (Pa^{-1})	293.15	0.0801	-0.0538	-0.0131	0.0078	0.0269	0.00005
	298.15	0.0773	-0.0552	-0.0087	0.0143	0.0235	0.00005
	303.15	0.0746	-0.0537	-0.0112	0.0109	0.0268	0.00006
	308.15	0.0727	-0.0548	-0.0146	0.0140	0.0297	0.00006
	313.15	0.0708	-0.0568	-0.0190	0.0150	0.0361	0.00006
	318.15	0.0686	-0.0578	-0.0145	0.0180	0.0303	0.00007
	323.15	0.0664	-0.0589	-0.0125	0.0200	0.0282	0.00006
	328.15	0.0650	-0.0580	-0.0173	0.0111	0.0277	0.00004
	333.15	0.0637	-0.0609	-0.0279	0.0181	0.0557	0.00004
	338.15	0.0636	-0.0639	-0.0268	0.0245	0.0529	0.00015
	343.15	0.0762	-0.0715	0.0155	0.0443	-0.0256	0.00060
n-hexadecane (1) + 1-butanol (2)							
$10^6 V^E$ ($m^3 \cdot mol^{-1}$)	293.15	1.9040	0.0302	0.8903	-	-	0.0087
	298.15	2.0275	0.0871	0.9327	-	-	0.0093
	303.15	2.1617	0.1384	1.0128	-	-	0.0100
	308.15	2.3269	0.1311	1.0246	-	-	0.0121
	313.15	2.4721	0.2388	1.2454	-	-	0.0121
	318.15	2.6797	0.2779	1.2608	-	-	0.0142
	323.15	2.8536	0.3343	1.4124	-	-	0.0159
	328.15	3.0878	0.4032	1.5041	-	-	0.0172
	333.15	3.3378	0.4945	1.5176	-	-	0.0193
	338.15	3.6088	0.5720	1.7628	-	-	0.0188
	343.15	3.9112	0.6290	1.7998	-	-	0.0199
$\Delta\eta$ ($mPa \cdot s$)	293.15	-1.0085	-0.4194	0.6395	-0.2336	-1.3837	0.0094
	298.15	-0.8643	-0.3097	0.5605	-0.2787	-1.3289	0.0071
	303.15	-0.7448	-0.2062	0.4144	-0.2948	-1.1582	0.0067
	308.15	-0.6301	-0.1593	0.3201	-0.2937	-1.0197	0.0047
	313.15	-0.5336	-0.1208	0.2395	-0.2878	-0.9018	0.0039
	318.15	-0.4578	-0.1197	0.2241	-0.2413	-0.8924	0.0031
	323.15	-0.3887	-0.0821	0.1094	-0.2693	-0.6859	0.0029
	328.15	-0.3324	-0.0759	0.0841	-0.2498	-0.6396	0.0025
	333.15	-0.2819	-0.0764	0.0509	-0.2218	-0.5591	0.0021
	338.15	-0.2404	-0.0769	0.0264	-0.1930	-0.4892	0.0019
	343.15	-0.2037	-0.0805	0.0073	-0.1567	-0.4222	0.0016
Δn_D	293.15	0.0321	0.0150	0.0093	-	-	0.00005
	298.15	0.0318	0.0148	0.0089	-	-	0.00005

	303.15	0.0315	0.0146	0.0087	-	-	0.00005
	308.15	0.0312	0.0143	0.0092	-	-	0.00004
	313.15	0.0308	0.0143	0.0088	-	-	0.00004
	318.15	0.0303	0.0141	0.0084	-	-	0.00003
	323.15	0.0299	0.0140	0.0079	-	-	0.00003
	328.15	0.0295	0.0139	0.0078	-	-	0.00003
	333.15	0.0293	0.0138	0.0080	-	-	0.00004
	338.15	0.0288	0.0140	0.0080	-	-	0.00004
	343.15	0.0287	0.0144	0.0070	-	-	0.00006
ΔG^{*E} ($J\cdot mol^{-1}$)	293.15	807.0	-862.2	812.9	-273.8	-1040.1	7.3
	298.15	854.8	-817.1	815.2	-340.6	-1142.1	6.3
	303.15	900.0	-753.4	733.3	-393.6	-1131.1	6.8
	308.15	966.4	-734.7	679.5	-429.9	-1128.0	5.4
	313.15	1037.6	-715.7	619.1	-461.3	-1115.2	5.0
	318.15	1103.5	-744.6	638.7	-426.9	-1248.9	4.5
	323.15	1180.9	-708.7	481.7	-516.1	-1048.6	4.9
	328.15	1257.2	-724.8	465.2	-519.1	-1097.7	4.7
	333.15	1340.9	-753.9	418.6	-505.0	-1063.1	4.5
	338.15	1426.3	-784.8	381.5	-479.7	-1026.5	4.6
	343.15	1515.2	-827.6	350.1	-425.9	-979.9	4.4
$10^{10}\Delta\kappa_s$ (Pa^{-1})	293.15	0.5011	-0.1784	0.1601	0.1542	0.3937	0.0005
	298.15	0.5489	-0.1987	0.1649	-0.1427	0.4236	0.0004
	303.15	0.6004	-0.2219	0.1810	-0.1348	0.4449	0.0005
	308.15	0.6579	-0.2484	0.1996	-0.1303	0.4694	0.0005
	313.15	0.7210	-0.2791	0.2278	-0.1247	0.4863	0.0005
	318.15	0.7912	-0.3142	0.2574	-0.1234	0.5140	0.0005
	323.15	0.8668	-0.3524	0.3005	-0.1240	0.5269	0.0004
	328.15	0.9500	-0.3938	0.3499	-0.1339	0.5441	0.0004
	333.15	1.0409	-0.4356	0.4178	-0.1552	0.5417	0.0004
	338.15	1.1404	-0.4863	0.4953	-0.1682	0.5437	0.0003
	343.15	1.2612	-0.5307	0.5719	-0.1845	0.5919	0.0002
				n-hexadecane (1) + 1-propanol (2)			
10^6V^E ($m^3\cdot mol^{-1}$)	293.15	1.906079	-0.01759	1.297603	-	-	0.01149
	298.15	2.043785	0.102335	1.284853	-	-	0.01321
	303.15	2.193375	0.06569	1.337796	-	-	0.01247
	308.15	2.366469	0.206575	1.318789	-	-	0.01463
	313.15	2.544631	0.253978	1.486058	-	-	0.01401
	318.15	2.775354	0.247587	1.515809	-	-	0.01625
	323.15	2.974041	0.384627	1.750288	-	-	0.01592
	328.15	3.241599	0.393838	1.664787	-	-	0.02002
	333.15	3.528968	0.505387	1.88936	-	-	0.01932
	338.15	3.802167	0.583993	2.045113	-	-	0.01975
	343.15	4.145507	0.622111	1.987892	-	-	0.02259
$\Delta\eta$ ($mPa\cdot s$)	293.15	0.281966	-1.049	-0.18273	-0.25001	0.230766	0.00514
	298.15	0.195713	-0.83841	-0.03536	-0.36017	-0.05326	0.00395
	303.15	0.146287	-0.71338	-0.0085	-0.32426	-0.15451	0.00239
	308.15	0.118552	-0.58876	-0.00744	-0.35172	-0.13525	0.00152
	313.15	0.096472	-0.49933	0.013799	-0.34391	-0.19059	0.00106

	318.15	0.080076	-0.43042	0.009187	-0.33855	-0.20589	0.00059
	323.15	0.068695	-0.37829	0.011591	-0.32035	-0.23183	0.00055
	328.15	0.060992	-0.3386	-0.00468	-0.29248	-0.21015	0.00086
	333.15	0.054051	-0.31415	-0.00968	-0.25102	-0.20405	0.00112
	338.15	0.047575	-0.28249	-0.01735	-0.24939	-0.1688	0.00165
	343.15	0.032927	-0.21919	-0.0254	-0.32339	-0.08417	0.00302
Δn_D	293.15	0.054783	-0.02973	0.023917	-0.01466	-	0.00011
	298.15	0.054475	-0.03094	0.024225	-0.01091	-	0.00012
	303.15	0.054116	-0.02976	0.024699	-0.01359	-	0.00011
	308.15	0.053861	-0.02942	0.024847	-0.0142	-	0.00011
	313.15	0.053552	-0.03014	0.024302	-0.01212	-	0.00013
	318.15	0.05319	-0.03043	0.024048	-0.01159	-	0.00011
	323.15	0.052288	-0.02978	0.02359	-0.0113	-	0.00013
	328.15	0.051824	-0.02949	0.023626	-0.01207	-	0.00013
	333.15	0.051457	-0.02837	0.023086	-0.01376	-	0.00011
	338.15	0.050959	-0.02915	0.022218	-0.01212	-	0.00011
	343.15	0.051051	-0.02981	0.022221	-0.01309	-	0.0001
ΔG^{*E} (J·mol^{-1})	293.15	2628.576	-1866.55	677.8163	-549.832	-	5.72886
	298.15	2611.573	-1777.6	694.2564	-750.894	-	4.70082
	303.15	2630.339	-1784.37	647.5953	-680.994	-	3.01859
	308.15	2668.74	-1717.95	670.2913	-845.25	-	2.77057
	313.15	2709.478	-1713.81	638.5518	-845.391	-	1.92772
	318.15	2758.644	-1730.44	609.5372	-855.878	-	1.03294
	323.15	2819.03	-1738.45	568.507	-879.751	-	1.22552
	328.15	2874.177	-1766.62	570.8863	-863.727	-	1.63549
	333.15	2934.212	-1810.25	566.8978	-824.604	-	2.37099
	338.15	3001.569	-1829.91	614.8224	-871.147	-	3.77657
	343.15	3047.105	-1733.97	694.4032	-1229.09	-	7.61749
$10^{10}\Delta\kappa_s$ (Pa^{-1})	293.15	0.5130	-0.2033	0.2115	-0.4294	0.6565	0.0013
	298.15	0.5632	-0.2209	0.2206	-0.4318	0.6913	0.0014
	303.15	0.6193	-0.2419	0.2332	-0.4407	0.7345	0.0015
	308.15	0.6821	-0.2686	0.2505	-0.4429	0.7707	0.0016
	313.15	0.7529	-0.2973	0.2646	-0.4546	0.8234	0.0016
	318.15	0.8321	-0.3327	0.2832	-0.4662	0.8836	0.0018
	323.15	0.9190	-0.3718	0.3152	-0.4823	0.9299	0.0019
	328.15	1.0156	-0.4188	0.3539	-0.5011	0.9806	0.0020
	333.15	1.1231	-0.4696	0.4016	-0.5258	1.0287	0.0022
	338.15	1.2440	-0.5283	0.4531	-0.5600	1.1006	0.0025
	343.15	1.3891	-0.5890	0.5230	-0.5996	1.2075	0.0026

Table A 11 Densities ρ (kg·m^{-3}), Dynamic Viscosities η (mPa·s), speeds of sound u (m·s^{-1}) and Refractive Indices n_D for the Ternary Mixtures Ethyl Oleate (1) + *n*-hexadecane (2) + 1-butanol (3) as a Function of Ethyl Oleate Mole Fraction x_1 and *n*- hexadecane Mole Fraction x_2 at T = 293.15−343.15 K and p = 0.1 MPa[a].

x_1	x_2	ρ/ (kg·m^{-3})	η / (mPa·s)	u / (m·s^{-1})	n_D /
			293.15K		
0.0902	0.1001	814.4	3.1349	1304.15	1.4186
0.0800	0.2000	805.1	3.1006	1311.12	1.4212
0.0722	0.2785	799.1	3.0802	1316.15	1.4233
0.0600	0.3999	791.8	3.0642	1323.56	1.4258
0.0501	0.4999	787.1	3.0715	1329.36	1.4277
0.0400	0.6000	783.2	3.0903	1334.78	1.4293
0.0300	0.6996	780.0	3.1279	1340.08	1.4307
0.0201	0.7999	777.3	3.1778	1345.30	1.4321
0.0100	0.8999	775.0	3.2577	1350.72	1.4332
0.1800	0.1000	825.6	3.4613	1323.84	1.4256
0.1600	0.2000	815.2	3.3842	1326.22	1.4269
0.1400	0.3000	806.6	3.3214	1329.20	1.4281
0.1200	0.4000	799.4	3.2747	1332.51	1.4291
0.1000	0.5000	793.3	3.2511	1335.92	1.4301
0.0800	0.6000	788.0	3.2393	1339.59	1.4311
0.0600	0.7000	783.5	3.2441	1343.38	1.4319
0.0400	0.8000	779.5	3.2655	1347.35	1.4327
0.0200	0.9000	776.1	3.3038	1351.61	1.4335
0.3600	0.0999	840.1	4.1120	1349.99	1.4362
0.3200	0.2001	829.7	3.9490	1348.20	1.4352
0.2801	0.3000	820.2	3.7980	1345.30	1.4352
0.2400	0.3999	811.6	3.6787	1346.99	1.4345
0.2000	0.5000	803.7	3.5792	1347.25	1.4343
0.1600	0.6001	796.5	3.5143	1346.28	1.4346
0.1201	0.6998	789.8	3.4507	1347.67	1.4344
0.0800	0.8000	783.8	3.3948	1349.48	1.4343
0.0400	0.9000	778.3	3.3576	1353.42	1.4342
0.5400	0.1000	849.4	4.7377	1367.40	1.4413
0.4800	0.2000	839.5	4.4958	1363.89	1.4404
0.4200	0.3000	830.0	4.2697	1360.99	1.4394
0.3600	0.4000	820.9	4.0502	1358.64	1.4384
0.3000	0.5000	812.1	3.9158	1356.88	1.4376
0.2400	0.6000	803.7	3.7667	1355.66	1.4368
0.1800	0.7000	795.6	3.6360	1354.95	1.4361
0.1200	0.8000	787.8	3.5296	1354.88	1.4354
0.0600	0.9000	780.3	3.4409	1355.38	1.4348
0.7201	0.0999	855.8	5.3645	1380.16	1.4453
0.6400	0.2000	846.7	5.0518	1375.94	1.4442
0.5601	0.2999	837.5	4.7722	1372.03	1.4429
0.4800	0.4000	828.3	4.4982	1368.50	1.4416
0.3999	0.5001	819.1	4.2684	1365.33	1.4402
0.3200	0.6000	810.0	4.0487	1362.63	1.4391
0.2400	0.7000	800.7	3.8439	1360.27	1.4378
0.1600	0.8000	791.6	3.6635	1358.52	1.4366
0.0800	0.9000	782.4	3.5143	1357.49	1.4355
0.8101	0.0999	858.4	5.6931	1385.38	1.4470
0.7201	0.1999	849.6	5.3388	1380.97	1.4457
0.6300	0.3000	840.7	5.0267	1376.85	1.4444
0.5400	0.4000	831.5	4.7193	1372.88	1.4430
0.4500	0.5000	822.2	4.4471	1369.22	1.4416
0.3602	0.5998	812.8	4.1899	1365.95	1.4401
0.2700	0.7000	803.1	3.9522	1362.93	1.4387

0.1800	0.8000	793.3	3.7422	1360.42	1.4372
0.0900	0.9000	783.4	3.5539	1358.52	1.4358
			298.15K		
0.0902	0.1001	810.7	2.7729	1286.35	1.4165
0.0800	0.2000	801.3	2.7463	1292.99	1.4191
0.0722	0.2785	795.4	2.7312	1297.82	1.4211
0.0600	0.3999	788.1	2.7205	1305.00	1.4237
0.0501	0.4999	783.5	2.7302	1310.64	1.4256
0.0400	0.6000	779.6	2.7493	1315.97	1.4271
0.0300	0.6996	776.4	2.7848	1321.20	1.4285
0.0201	0.7999	773.7	2.8310	1326.38	1.4299
0.0100	0.8999	771.5	2.8981	1331.77	1.4310
0.1800	0.1000	821.8	3.0637	1305.97	1.4235
0.1600	0.2000	811.4	2.9990	1308.11	1.4248
0.1400	0.3000	802.9	2.9470	1310.88	1.4259
0.1200	0.4000	795.8	2.9087	1314.02	1.4269
0.1000	0.5000	789.7	2.8900	1317.30	1.4280
0.0800	0.6000	784.4	2.8813	1320.87	1.4290
0.0600	0.7000	779.9	2.8866	1324.57	1.4297
0.0400	0.8000	776.0	2.9056	1328.47	1.4306
0.0200	0.9000	772.6	2.9392	1332.70	1.4313
0.3600	0.0999	836.4	3.6351	1332.06	1.4341
0.3200	0.2001	826.0	3.4936	1330.22	1.4331
0.2801	0.3000	816.5	3.3654	1329.00	1.4331
0.2400	0.3999	807.9	3.2624	1328.65	1.4324
0.2000	0.5000	800.1	3.1765	1328.79	1.4322
0.1600	0.6001	792.9	3.1199	1327.94	1.4325
0.1201	0.6998	786.3	3.0671	1329.19	1.4323
0.0800	0.8000	780.2	3.0201	1330.88	1.4321
0.0400	0.9000	774.7	2.9871	1334.56	1.4321
0.5400	0.1000	845.7	4.1892	1349.44	1.4392
0.4800	0.2000	835.8	3.9747	1345.84	1.4383
0.4200	0.3000	826.4	3.7798	1342.82	1.4373
0.3600	0.4000	817.3	3.5841	1340.38	1.4363
0.3000	0.5000	808.5	3.4681	1338.51	1.4355
0.2400	0.6000	800.1	3.3388	1337.18	1.4347
0.1800	0.7000	792.0	3.2262	1336.36	1.4339
0.1200	0.8000	784.3	3.1366	1336.18	1.4332
0.0600	0.9000	776.8	3.0609	1336.60	1.4327
0.7201	0.0999	852.2	4.7415	1362.18	1.4432
0.6400	0.2000	843.0	4.4705	1357.90	1.4421
0.5601	0.2999	833.9	4.2245	1353.92	1.4408
0.4800	0.4000	824.7	3.9855	1350.29	1.4395
0.3999	0.5001	815.5	3.7824	1347.02	1.4381
0.3200	0.6000	806.4	3.5880	1344.23	1.4370
0.2400	0.7000	797.2	3.4108	1341.77	1.4357
0.1600	0.8000	788.0	3.2557	1339.92	1.4345
0.0800	0.9000	778.9	3.1270	1338.75	1.4334
0.8101	0.0999	854.8	5.0318	1367.36	1.4449
0.7201	0.1999	846.0	4.7248	1362.90	1.4437
0.6300	0.3000	837.0	4.4520	1358.71	1.4423
0.5400	0.4000	828.0	4.1818	1354.67	1.4409
0.4500	0.5000	818.7	3.9408	1350.93	1.4395
0.3602	0.5998	809.3	3.7134	1347.55	1.4380
0.2700	0.7000	799.6	3.5050	1344.43	1.4366
0.1800	0.8000	789.8	3.3245	1341.81	1.4350
0.0900	0.9000	779.9	3.1614	1339.79	1.4337
			303.15K		

0.0902	0.1001	806.9	2.4535	1268.68	1.4144
0.0800	0.2000	797.6	2.4306	1274.99	1.4170
0.0722	0.2785	791.6	2.4229	1279.64	1.4190
0.0600	0.3999	784.4	2.4143	1286.57	1.4215
0.0501	0.4999	779.8	2.4298	1292.09	1.4234
0.0400	0.6000	776.0	2.4453	1297.33	1.4249
0.0300	0.6996	772.8	2.4800	1302.51	1.4264
0.0201	0.7999	770.1	2.5238	1307.80	1.4278
0.0100	0.8999	767.9	2.5803	1313.01	1.4289
0.1800	0.1000	818.0	2.7141	1288.21	1.4214
0.1600	0.2000	807.7	2.6604	1290.12	1.4227
0.1400	0.3000	799.3	2.6171	1292.70	1.4238
0.1200	0.4000	792.1	2.5854	1295.68	1.4248
0.1000	0.5000	786.0	2.5708	1298.84	1.4258
0.0800	0.6000	780.8	2.5653	1302.31	1.4268
0.0600	0.7000	776.3	2.5707	1305.95	1.4276
0.0400	0.8000	772.4	2.5882	1309.78	1.4284
0.0200	0.9000	769.0	2.6186	1313.98	1.4292
0.3600	0.0999	832.6	3.2200	1314.26	1.4320
0.3200	0.2001	822.2	3.0972	1312.28	1.4312
0.2801	0.3000	812.8	2.9874	1311.28	1.4310
0.2400	0.3999	804.3	2.8991	1310.46	1.4303
0.2000	0.5000	796.4	2.8231	1310.48	1.4301
0.1600	0.6001	789.3	2.7745	1310.16	1.4304
0.1201	0.6998	782.7	2.7293	1311.28	1.4302
0.0800	0.8000	777.2	2.6893	1312.82	1.4300
0.0400	0.9000	771.2	2.6594	1315.91	1.4299
0.5400	0.1000	842.0	3.7037	1331.64	1.4371
0.4800	0.2000	832.1	3.5192	1327.95	1.4362
0.4200	0.3000	822.7	3.3504	1324.84	1.4352
0.3600	0.4000	813.6	3.2462	1322.28	1.4342
0.3000	0.5000	804.9	3.0784	1320.30	1.4334
0.2400	0.6000	796.5	2.9682	1318.88	1.4326
0.1800	0.7000	788.5	2.8703	1317.95	1.4318
0.1200	0.8000	780.7	2.7931	1317.69	1.4311
0.0600	0.9000	773.3	2.7281	1318.03	1.4305
0.7201	0.0999	848.5	4.1874	1344.35	1.4412
0.6400	0.2000	839.4	3.9535	1340.02	1.4400
0.5601	0.2999	830.3	3.7401	1335.96	1.4387
0.4800	0.4000	821.1	3.5349	1332.25	1.4374
0.3999	0.5001	812.0	3.3580	1328.90	1.4360
0.3200	0.6000	802.9	3.1890	1326.01	1.4349
0.2400	0.7000	793.6	3.0344	1323.45	1.4336
0.1600	0.8000	784.5	2.8996	1321.49	1.4324
0.0800	0.9000	775.4	2.7878	1320.22	1.4313
0.8101	0.0999	851.1	4.4400	1349.50	1.4429
0.7201	0.1999	842.4	4.1761	1344.97	1.4416
0.6300	0.3000	833.4	3.9402	1340.74	1.4402
0.5400	0.4000	824.4	3.7063	1336.63	1.4388
0.4500	0.5000	815.1	3.5011	1332.81	1.4374
0.3602	0.5998	805.7	3.3038	1329.35	1.4359
0.2700	0.7000	796.1	3.1188	1326.12	1.4345
0.1800	0.8000	786.3	2.9588	1323.39	1.4329
0.0900	0.9000	776.4	2.8175	1321.24	1.4316
		308.15K			
0.0902	0.1001	803.0	2.1859	1251.11	1.4123
0.0800	0.2000	793.8	2.1686	1257.12	1.4149
0.0722	0.2785	787.9	2.1585	1261.58	1.4169

0.0600	0.3999	780.7	2.1574	1268.30	1.4193
0.0501	0.4999	776.1	2.1744	1273.70	1.4212
0.0400	0.6000	772.3	2.1902	1278.88	1.4228
0.0300	0.6996	769.2	2.2249	1283.99	1.4242
0.0201	0.7999	766.5	2.2628	1289.17	1.4257
0.0100	0.8999	764.4	2.3165	1294.46	1.4267
0.1800	0.1000	814.2	2.4187	1270.58	1.4193
0.1600	0.2000	803.9	2.3746	1272.27	1.4205
0.1400	0.3000	795.5	2.3384	1274.67	1.4216
0.1200	0.4000	788.4	2.3136	1277.52	1.4226
0.1000	0.5000	782.3	2.3016	1280.56	1.4236
0.0800	0.6000	777.2	2.2984	1283.94	1.4247
0.0600	0.7000	772.7	2.3044	1287.49	1.4254
0.0400	0.8000	768.8	2.3207	1291.28	1.4262
0.0200	0.9000	765.5	2.3487	1295.46	1.4270
0.3600	0.0999	828.9	2.8714	1296.59	1.4299
0.3200	0.2001	818.5	2.7644	1294.48	1.4289
0.2801	0.3000	809.1	2.6741	1293.03	1.4289
0.2400	0.3999	800.6	2.5923	1292.43	1.4281
0.2000	0.5000	792.8	2.5277	1292.33	1.4279
0.1600	0.6001	785.6	2.4838	1291.72	1.4282
0.1201	0.6998	779.1	2.4443	1292.79	1.4280
0.0800	0.8000	773.1	2.4110	1294.38	1.4279
0.0400	0.9000	767.7	2.3883	1297.46	1.4278
0.5400	0.1000	838.2	3.3015	1314.00	1.4350
0.4800	0.2000	828.4	3.1405	1310.21	1.4341
0.4200	0.3000	819.0	2.9938	1307.00	1.4331
0.3600	0.4000	810.0	2.8937	1304.35	1.4321
0.3000	0.5000	801.3	2.7548	1302.27	1.4312
0.2400	0.6000	792.9	2.6589	1300.74	1.4304
0.1800	0.7000	784.9	2.5732	1299.72	1.4296
0.1200	0.8000	777.2	2.5041	1299.37	1.4289
0.0600	0.9000	769.8	2.4481	1299.65	1.4284
0.7201	0.0999	844.8	3.7262	1326.69	1.4391
0.6400	0.2000	835.7	3.5229	1322.27	1.4379
0.5601	0.2999	826.6	3.3367	1318.15	1.4366
0.4800	0.4000	817.5	3.1584	1314.37	1.4353
0.3999	0.5001	808.4	3.0023	1310.94	1.4339
0.3200	0.6000	799.3	2.8550	1307.97	1.4328
0.2400	0.7000	790.1	2.7191	1305.31	1.4314
0.1600	0.8000	781.0	2.6017	1303.25	1.4303
0.0800	0.9000	771.9	2.5030	1301.87	1.4291
0.8101	0.0999	847.5	3.9489	1331.82	1.4408
0.7201	0.1999	838.7	3.7212	1327.23	1.4395
0.6300	0.3000	829.8	3.5158	1322.92	1.4381
0.5400	0.4000	820.8	3.2124	1318.68	1.4367
0.4500	0.5000	811.5	3.1302	1314.85	1.4353
0.3602	0.5998	802.2	2.9575	1311.31	1.4338
0.2700	0.7000	792.6	2.7970	1308.00	1.4324
0.1800	0.8000	782.8	2.6561	1305.16	1.4308
0.0900	0.9000	772.9	2.5319	1302.91	1.4294
			313.15K		
0.0902	0.1001	799.2	1.9587	1233.64	1.4102
0.0800	0.2000	790.0	1.9458	1239.35	1.4127
0.0722	0.2785	784.1	1.9424	1243.64	1.4147
0.0600	0.3999	777.0	1.9450	1250.15	1.4172
0.0501	0.4999	772.4	1.9602	1255.47	1.4190
0.0400	0.6000	768.7	1.9794	1260.58	1.4206

0.0300	0.6996	765.6	2.0090	1265.66	1.4220
0.0201	0.7999	763.0	2.0454	1270.73	1.4235
0.0100	0.8999	760.9	2.0934	1276.10	1.4245
0.1800	0.1000	810.4	2.1693	1253.06	1.4172
0.1600	0.2000	800.1	2.1333	1254.54	1.4184
0.1400	0.3000	791.7	2.1035	1256.78	1.4195
0.1200	0.4000	784.7	2.0836	1259.49	1.4205
0.1000	0.5000	778.7	2.0748	1262.43	1.4215
0.0800	0.6000	773.5	2.0735	1265.73	1.4225
0.0600	0.7000	769.1	2.0800	1269.22	1.4232
0.0400	0.8000	765.3	2.0955	1272.94	1.4241
0.0200	0.9000	762.0	2.1220	1277.15	1.4248
0.3600	0.0999	825.1	2.5733	1279.07	1.4278
0.3200	0.2001	814.8	2.4821	1276.83	1.4268
0.2801	0.3000	805.4	2.4001	1275.26	1.4269
0.2400	0.3999	796.9	2.3333	1274.54	1.4260
0.2000	0.5000	789.1	2.2771	1274.35	1.4258
0.1600	0.6001	782.0	2.2396	1273.84	1.4262
0.1201	0.6998	775.5	2.2052	1274.83	1.4260
0.0800	0.8000	769.6	2.1763	1276.32	1.4258
0.0400	0.9000	764.2	2.1584	1279.23	1.4256
0.5400	0.1000	834.5	2.9460	1296.47	1.4330
0.4800	0.2000	824.7	2.8084	1292.61	1.4320
0.4200	0.3000	815.4	2.6846	1289.32	1.4310
0.3600	0.4000	806.3	2.5978	1286.58	1.4300
0.3000	0.5000	797.7	2.4793	1284.40	1.4291
0.2400	0.6000	789.3	2.3957	1282.78	1.4283
0.1800	0.7000	781.3	2.3208	1281.68	1.4275
0.1200	0.8000	773.6	2.2611	1281.25	1.4268
0.0600	0.9000	766.3	2.2129	1281.48	1.4262
0.7201	0.0999	841.2	3.3146	1309.17	1.4371
0.6400	0.2000	832.1	3.1404	1304.69	1.4358
0.5601	0.2999	823.0	2.9808	1300.50	1.4345
0.4800	0.4000	813.9	2.8292	1296.63	1.4332
0.3999	0.5001	804.8	2.6954	1293.13	1.4318
0.3200	0.6000	795.7	2.5699	1290.08	1.4307
0.2400	0.7000	786.5	2.4523	1287.35	1.4293
0.1600	0.8000	777.5	2.3495	1285.19	1.4281
0.0800	0.9000	768.4	2.2626	1283.71	1.4270
0.8101	0.0999	843.8	3.5082	1314.29	1.4388
0.7201	0.1999	835.1	3.3138	1309.64	1.4374
0.6300	0.3000	826.2	3.1379	1305.27	1.4361
0.5400	0.4000	817.2	2.9639	1301.01	1.4346
0.4500	0.5000	808.0	2.8077	1297.04	1.4332
0.3602	0.5998	798.6	2.6599	1293.44	1.4317
0.2700	0.7000	789.0	2.5226	1290.04	1.4303
0.1800	0.8000	779.3	2.3984	1287.11	1.4287
0.0900	0.9000	769.5	2.2886	1284.74	1.4273
			318.15K		
0.0902	0.1001	795.3	1.7573	1216.26	1.4080
0.0800	0.2000	786.1	1.7488	1221.67	1.4105
0.0722	0.2785	780.3	1.7477	1225.79	1.4125
0.0600	0.3999	773.2	1.7540	1232.13	1.4150
0.0501	0.4999	768.7	1.7700	1237.37	1.4168
0.0400	0.6000	765.0	1.7896	1242.43	1.4184
0.0300	0.6996	761.9	1.8183	1247.45	1.4198
0.0201	0.7999	759.4	1.8529	1252.54	1.4214
0.0100	0.8999	757.3	1.8968	1257.94	1.4224

0.1800	0.1000	806.5	1.9508	1235.63	1.4150
0.1600	0.2000	796.3	1.9217	1236.91	1.4162
0.1400	0.3000	787.9	1.8970	1238.99	1.4173
0.1200	0.4000	780.9	1.8809	1241.58	1.4183
0.1000	0.5000	775.0	1.8750	1244.42	1.4193
0.0800	0.6000	769.9	1.8752	1247.64	1.4203
0.0600	0.7000	765.5	1.8823	1251.08	1.4211
0.0400	0.8000	761.7	1.8976	1254.78	1.4219
0.0200	0.9000	758.4	1.9231	1259.01	1.4227
0.3600	0.0999	821.3	2.3221	1261.67	1.4257
0.3200	0.2001	811.0	2.2395	1259.30	1.4246
0.2801	0.3000	801.9	2.1679	1257.44	1.4249
0.2400	0.3999	793.2	2.1088	1256.79	1.4238
0.2000	0.5000	785.5	2.0593	1256.50	1.4236
0.1600	0.6001	778.3	2.0257	1256.08	1.4241
0.1201	0.6998	771.9	1.9964	1257.01	1.4239
0.0800	0.8000	766.0	1.9718	1258.49	1.4237
0.0400	0.9000	760.6	1.9576	1261.17	1.4234
0.5400	0.1000	830.8	2.6679	1279.09	1.4309
0.4800	0.2000	821.0	2.5431	1275.13	1.4299
0.4200	0.3000	811.7	2.4307	1271.75	1.4289
0.3600	0.4000	802.7	2.3486	1268.94	1.4278
0.3000	0.5000	794.0	2.2426	1266.67	1.4270
0.2400	0.6000	785.7	2.1688	1264.98	1.4261
0.1800	0.7000	777.7	2.1023	1263.80	1.4254
0.1200	0.8000	770.1	2.0495	1263.30	1.4247
0.0600	0.9000	762.8	2.0077	1263.48	1.4241
0.7201	0.0999	837.5	3.0073	1291.78	1.4350
0.6400	0.2000	828.4	2.8502	1287.25	1.4337
0.5601	0.2999	819.4	2.7053	1282.98	1.4324
0.4800	0.4000	810.3	2.5677	1279.05	1.4311
0.3999	0.5001	801.2	2.4449	1275.46	1.4297
0.3200	0.6000	792.1	2.3298	1272.33	1.4285
0.2400	0.7000	783.0	2.2226	1269.53	1.4272
0.1600	0.8000	774.0	2.1313	1267.29	1.4260
0.0800	0.9000	764.9	2.0537	1265.72	1.4249
0.8101	0.0999	840.2	3.1844	1296.88	1.4367
0.7201	0.1999	831.5	3.0100	1292.19	1.4354
0.6300	0.3000	822.6	2.8508	1287.77	1.4340
0.5400	0.4000	813.6	2.6927	1283.43	1.4326
0.4500	0.5000	804.4	2.5501	1279.41	1.4312
0.3602	0.5998	795.1	2.4145	1275.71	1.4296
0.2700	0.7000	785.5	2.2885	1272.23	1.4281
0.1800	0.8000	775.8	2.1756	1269.22	1.4266
0.0900	0.9000	766.0	2.0775	1266.76	1.4252
323.15K					
0.0902	0.1001	791.4	1.5859	1198.95	1.4059
0.0800	0.2000	782.2	1.5811	1204.08	1.4083
0.0722	0.2785	776.4	1.5829	1208.05	1.4103
0.0600	0.3999	769.5	1.5920	1214.22	1.4128
0.0501	0.4999	765.0	1.6089	1219.39	1.4146
0.0400	0.6000	761.3	1.6282	1224.40	1.4162
0.0300	0.6996	758.3	1.6557	1229.39	1.4176
0.0201	0.7999	755.8	1.6882	1234.49	1.4193
0.0100	0.8999	753.8	1.7301	1239.94	1.4202
0.1800	0.1000	802.6	1.7640	1218.31	1.4129
0.1600	0.2000	792.5	1.7410	1219.40	1.4141
0.1400	0.3000	784.1	1.7207	1221.32	1.4151

0.1200	0.4000	777.2	1.7080	1223.79	1.4161
0.1000	0.5000	771.2	1.7044	1226.54	1.4171
0.0800	0.6000	766.2	1.7060	1229.70	1.4181
0.0600	0.7000	761.8	1.7139	1233.09	1.4189
0.0400	0.8000	758.1	1.7289	1236.78	1.4197
0.0200	0.9000	754.9	1.7538	1241.05	1.4205
0.3600	0.0999	817.5	2.1041	1244.38	1.4236
0.3200	0.2001	807.2	2.0311	1241.89	1.4225
0.2801	0.3000	798.0	1.9678	1240.05	1.4229
0.2400	0.3999	789.5	1.9163	1239.17	1.4217
0.2000	0.5000	781.8	1.8728	1238.79	1.4215
0.1600	0.6001	774.7	1.8416	1238.45	1.4220
0.1201	0.6998	768.2	1.8167	1239.30	1.4218
0.0800	0.8000	762.4	1.7974	1240.71	1.4216
0.0400	0.9000	757.1	1.7860	1243.28	1.4213
0.5400	0.1000	827.0	2.4180	1261.84	1.4288
0.4800	0.2000	817.3	2.3069	1257.80	1.4278
0.4200	0.3000	808.0	2.2076	1254.33	1.4268
0.3600	0.4000	799.0	2.1325	1251.42	1.4257
0.3000	0.5000	790.4	2.0393	1249.07	1.4248
0.2400	0.6000	782.1	1.9740	1247.31	1.4240
0.1800	0.7000	774.2	1.9153	1246.07	1.4232
0.1200	0.8000	766.5	1.8687	1245.50	1.4225
0.0600	0.9000	759.3	1.8325	1245.64	1.4220
0.7201	0.0999	833.8	2.7251	1274.53	1.4329
0.6400	0.2000	824.8	2.5854	1269.94	1.4317
0.5601	0.2999	815.7	2.4563	1265.62	1.4303
0.4800	0.4000	806.7	2.3341	1261.61	1.4290
0.3999	0.5001	797.6	2.2244	1257.95	1.4276
0.3200	0.6000	788.6	2.1218	1254.74	1.4264
0.2400	0.7000	779.5	2.0256	1251.85	1.4251
0.1600	0.8000	770.4	1.9443	1249.53	1.4239
0.0800	0.9000	761.4	1.8747	1247.87	1.4227
0.8101	0.0999	836.5	2.8847	1279.63	1.4347
0.7201	0.1999	827.9	2.7302	1274.89	1.4333
0.6300	0.3000	819.0	2.5887	1270.42	1.4319
0.5400	0.4000	810.0	2.4483	1266.02	1.4305
0.4500	0.5000	800.8	2.3207	1261.93	1.4291
0.3602	0.5998	791.5	2.1995	1258.16	1.4275
0.2700	0.7000	782.0	2.0866	1254.59	1.4260
0.1800	0.8000	772.3	1.9850	1251.48	1.4245
0.0900	0.9000	762.5	1.8966	1248.94	1.4231
			328.15K		
0.0902	0.1001	787.4	1.4368	1181.70	1.4037
0.0800	0.2000	778.3	1.4359	1186.57	1.4061
0.0722	0.2785	772.6	1.4394	1190.40	1.4081
0.0600	0.3999	765.7	1.4506	1196.43	1.4106
0.0501	0.4999	761.2	1.4683	1201.54	1.4124
0.0400	0.6000	757.6	1.4872	1206.51	1.4140
0.0300	0.6996	754.6	1.5138	1211.47	1.4154
0.0201	0.7999	752.2	1.5448	1216.59	1.4172
0.0100	0.8999	750.2	1.5849	1222.11	1.4180
0.1800	0.1000	798.7	1.6015	1201.06	1.4107
0.1600	0.2000	788.6	1.5839	1201.97	1.4119
0.1400	0.3000	780.3	1.5673	1203.76	1.4130
0.1200	0.4000	773.4	1.5575	1206.12	1.4139
0.1000	0.5000	767.5	1.5559	1208.79	1.4149
0.0800	0.6000	762.5	1.5585	1211.88	1.4160

0.0600	0.7000	758.2	1.5671	1215.25	1.4167
0.0400	0.8000	754.5	1.5801	1218.93	1.4176
0.0200	0.9000	751.3	1.6067	1223.25	1.4184
0.3600	0.0999	813.6	1.9150	1227.19	1.4214
0.3200	0.2001	803.4	1.8501	1224.58	1.4203
0.2801	0.3000	794.2	1.7952	1222.69	1.4208
0.2400	0.3999	785.8	1.7488	1221.68	1.4195
0.2000	0.5000	778.1	1.7105	1221.21	1.4193
0.1600	0.6001	771.0	1.6815	1220.93	1.4200
0.1201	0.6998	764.6	1.6606	1221.73	1.4197
0.0800	0.8000	758.8	1.6459	1223.13	1.4195
0.0400	0.9000	753.6	1.6371	1225.55	1.4192
0.5400	0.1000	823.3	2.2019	1244.71	1.4267
0.4800	0.2000	813.6	2.1028	1240.59	1.4257
0.4200	0.3000	804.3	2.0143	1237.03	1.4247
0.3600	0.4000	795.3	1.9453	1234.04	1.4236
0.3000	0.5000	786.7	1.8634	1231.62	1.4227
0.2400	0.6000	778.5	1.8051	1229.79	1.4219
0.1800	0.7000	770.6	1.7528	1228.47	1.4211
0.1200	0.8000	763.0	1.7116	1227.86	1.4204
0.0600	0.9000	755.8	1.6803	1227.94	1.4198
0.7201	0.0999	830.1	2.4815	1257.42	1.4309
0.6400	0.2000	821.1	2.3567	1252.77	1.4296
0.5601	0.2999	812.1	2.2411	1248.38	1.4282
0.4800	0.4000	803.0	2.1320	1244.31	1.4269
0.3999	0.5001	794.0	2.0333	1240.58	1.4255
0.3200	0.6000	785.0	1.9413	1237.30	1.4244
0.2400	0.7000	775.9	1.8547	1234.34	1.4230
0.1600	0.8000	766.9	1.7817	1231.93	1.4218
0.0800	0.9000	757.9	1.7192	1230.20	1.4206
0.8101	0.0999	832.9	2.6265	1262.55	1.4327
0.7201	0.1999	824.2	2.4886	1257.75	1.4312
0.6300	0.3000	815.4	2.3621	1253.22	1.4299
0.5400	0.4000	806.4	2.2362	1248.75	1.4284
0.4500	0.5000	797.2	2.1215	1244.60	1.4270
0.3602	0.5998	788.0	2.0127	1240.76	1.4254
0.2700	0.7000	778.4	1.9112	1237.11	1.4240
0.1800	0.8000	768.8	1.8190	1233.91	1.4224
0.0900	0.9000	759.0	1.7392	1231.29	1.4210
			333.15K		
0.0902	0.1001	783.4	1.3054	1164.50	1.4014
0.0800	0.2000	774.4	1.3076	1169.14	1.4039
0.0722	0.2785	768.7	1.3127	1172.84	1.4059
0.0600	0.3999	761.8	1.3260	1178.75	1.4083
0.0501	0.4999	757.4	1.3440	1183.81	1.4102
0.0400	0.6000	753.8	1.3628	1188.75	1.4118
0.0300	0.6996	750.9	1.3882	1193.71	1.4133
0.0201	0.7999	748.6	1.4180	1198.82	1.4151
0.0100	0.8999	746.7	1.4566	1204.47	1.4159
0.1800	0.1000	794.7	1.4576	1183.89	1.4085
0.1600	0.2000	784.7	1.4448	1184.64	1.4097
0.1400	0.3000	776.5	1.4314	1186.31	1.4108
0.1200	0.4000	769.6	1.4241	1188.57	1.4117
0.1000	0.5000	763.7	1.4242	1191.16	1.4128
0.0800	0.6000	758.8	1.4278	1194.21	1.4138
0.0600	0.7000	754.5	1.4370	1197.56	1.4145
0.0400	0.8000	750.9	1.4499	1201.25	1.4154
0.0200	0.9000	747.8	1.4764	1205.63	1.4163

0.3600	0.0999	809.8	1.7457	1210.10	1.4192
0.3200	0.2001	799.6	1.6897	1207.39	1.4181
0.2801	0.3000	790.4	1.6424	1205.44	1.4187
0.2400	0.3999	782.0	1.6002	1204.31	1.4174
0.2000	0.5000	774.4	1.5668	1203.77	1.4171
0.1600	0.6001	767.4	1.5390	1203.55	1.4179
0.1201	0.6998	761.0	1.5220	1204.29	1.4176
0.0800	0.8000	755.2	1.5128	1205.63	1.4174
0.0400	0.9000	750.0	1.5052	1208.00	1.4171
0.5400	0.1000	819.5	2.0011	1227.69	1.4246
0.4800	0.2000	809.8	1.9148	1223.50	1.4236
0.4200	0.3000	800.6	1.8385	1219.87	1.4226
0.3600	0.4000	791.6	1.7769	1216.81	1.4215
0.3000	0.5000	783.1	1.7064	1214.30	1.4206
0.2400	0.6000	774.9	1.6553	1212.41	1.4198
0.1800	0.7000	767.0	1.6088	1211.04	1.4190
0.1200	0.8000	759.4	1.5723	1210.37	1.4183
0.0600	0.9000	752.3	1.5453	1210.42	1.4177
0.7201	0.0999	826.4	2.2513	1240.45	1.4288
0.6400	0.2000	817.4	2.1417	1235.74	1.4275
0.5601	0.2999	808.4	2.0402	1231.30	1.4262
0.4800	0.4000	799.4	1.9449	1227.16	1.4248
0.3999	0.5001	790.4	1.8584	1223.37	1.4234
0.3200	0.6000	781.4	1.7783	1220.01	1.4223
0.2400	0.7000	772.3	1.7030	1216.98	1.4209
0.1600	0.8000	763.4	1.6375	1214.50	1.4197
0.0800	0.9000	754.4	1.5808	1212.71	1.4185
0.8101	0.0999	829.2	2.3811	1245.62	1.4306
0.7201	0.1999	820.6	2.2596	1240.77	1.4292
0.6300	0.3000	811.8	2.1482	1236.18	1.4278
0.5400	0.4000	802.8	2.0379	1231.64	1.4264
0.4500	0.5000	793.7	1.9374	1227.43	1.4250
0.3602	0.5998	784.4	1.8419	1223.53	1.4234
0.2700	0.7000	774.9	1.7532	1219.81	1.4219
0.1800	0.8000	765.3	1.6716	1216.52	1.4203
0.0900	0.9000	755.5	1.5993	1213.81	1.4189
			338.15K		
0.0902	0.1001	779.3	1.1912	1147.37	1.3992
0.0800	0.2000	770.4	1.1960	1151.80	1.4017
0.0722	0.2785	764.7	1.2030	1155.40	1.4037
0.0600	0.3999	757.9	1.2177	1161.18	1.4061
0.0501	0.4999	753.6	1.2357	1166.20	1.4080
0.0400	0.6000	750.1	1.2548	1171.13	1.4096
0.0300	0.6996	747.2	1.2796	1176.11	1.4111
0.0201	0.7999	744.9	1.3090	1181.32	1.4131
0.0100	0.8999	743.1	1.3462	1187.01	1.4138
0.1800	0.1000	790.8	1.3335	1166.81	1.4064
0.1600	0.2000	780.8	1.3251	1167.42	1.4075
0.1400	0.3000	772.6	1.3142	1168.97	1.4087
0.1200	0.4000	765.8	1.3088	1171.14	1.4096
0.1000	0.5000	760.0	1.3105	1173.68	1.4106
0.0800	0.6000	755.0	1.3150	1176.68	1.4116
0.0600	0.7000	750.8	1.3247	1180.03	1.4124
0.0400	0.8000	747.2	1.3379	1183.73	1.4133
0.0200	0.9000	744.2	1.3648	1188.20	1.4142
0.3600	0.0999	805.9	1.6050	1193.12	1.4169
0.3200	0.2001	795.8	1.5531	1190.31	1.4160
0.2801	0.3000	786.6	1.5129	1188.22	1.4167

0.2400	0.3999	778.3	1.4733	1187.08	1.4152
0.2000	0.5000	770.7	1.4436	1186.46	1.4150
0.1600	0.6001	763.7	1.4176	1186.27	1.4158
0.1201	0.6998	757.3	1.4037	1187.01	1.4156
0.0800	0.8000	751.6	1.3979	1188.42	1.4154
0.0400	0.9000	746.5	1.3922	1190.63	1.4150
0.5400	0.1000	815.7	1.8490	1210.82	1.4225
0.4800	0.2000	806.1	1.7690	1206.56	1.4215
0.4200	0.3000	796.8	1.6978	1202.86	1.4205
0.3600	0.4000	787.9	1.6396	1199.73	1.4194
0.3000	0.5000	779.4	1.5743	1197.15	1.4185
0.2400	0.6000	771.2	1.5276	1195.21	1.4177
0.1800	0.7000	763.4	1.4859	1193.78	1.4169
0.1200	0.8000	755.9	1.4535	1193.06	1.4162
0.0600	0.9000	748.8	1.4298	1193.07	1.4157
0.7201	0.0999	822.7	2.0851	1223.64	1.4268
0.6400	0.2000	813.8	1.9840	1218.89	1.4255
0.5601	0.2999	804.8	1.8898	1214.37	1.4241
0.4800	0.4000	795.8	1.8011	1210.17	1.4228
0.3999	0.5001	786.8	1.7203	1206.33	1.4213
0.3200	0.6000	777.8	1.6453	1202.89	1.4202
0.2400	0.7000	768.8	1.5746	1199.81	1.4189
0.1600	0.8000	759.9	1.5143	1197.26	1.4176
0.0800	0.9000	751.0	1.4626	1195.42	1.4165
0.8101	0.0999	825.6	2.2065	1228.86	1.4286
0.7201	0.1999	817.0	2.0948	1223.96	1.4272
0.6300	0.3000	808.2	1.9917	1219.33	1.4258
0.5400	0.4000	799.2	1.8895	1214.70	1.4244
0.4500	0.5000	790.1	1.7956	1210.45	1.4229
0.3602	0.5998	780.8	1.7063	1206.49	1.4213
0.2700	0.7000	771.4	1.6228	1202.69	1.4198
0.1800	0.8000	761.8	1.5460	1199.34	1.4182
0.0900	0.9000	752.0	1.4794	1196.53	1.4168
			343.15K		
0.0902	0.1001	775.2	1.0893	1130.36	1.3970
0.0800	0.2000	766.3	1.0970	1134.61	1.3995
0.0722	0.2785	760.7	1.1049	1138.11	1.4016
0.0600	0.3999	754.0	1.1207	1143.77	1.4040
0.0501	0.4999	749.8	1.1393	1148.75	1.4059
0.0400	0.6000	746.3	1.1581	1153.69	1.4074
0.0300	0.6996	743.5	1.1823	1158.72	1.4090
0.0201	0.7999	741.3	1.2111	1163.89	1.4111
0.0100	0.8999	739.5	1.2472	1169.79	1.4118
0.1800	0.1000	786.7	1.2221	1149.86	1.4042
0.1600	0.2000	776.8	1.2179	1150.36	1.4054
0.1400	0.3000	768.7	1.2089	1151.81	1.4065
0.1200	0.4000	761.9	1.2055	1153.91	1.4074
0.1000	0.5000	756.1	1.2085	1156.37	1.4085
0.0800	0.6000	751.3	1.2136	1159.34	1.4095
0.0600	0.7000	747.1	1.2242	1162.71	1.4103
0.0400	0.8000	743.6	1.2373	1166.45	1.4112
0.0200	0.9000	740.7	1.2646	1170.99	1.4122
0.3600	0.0999	802.0	1.4770	1176.29	1.4147
0.3200	0.2001	791.9	1.4304	1173.41	1.4139
0.2801	0.3000	782.8	1.3953	1171.33	1.4147
0.2400	0.3999	774.5	1.3591	1170.05	1.4131
0.2000	0.5000	766.9	1.3329	1169.33	1.4129
0.1600	0.6001	759.9	1.3085	1169.22	1.4138

0.1201	0.6998	753.6	1.2974	1169.91	1.4136
0.0800	0.8000	748.0	1.2949	1171.32	1.4134
0.0400	0.9000	743.0	1.2907	1173.51	1.4129
0.5400	0.1000	811.9	1.7037	1194.14	1.4205
0.4800	0.2000	802.3	1.6312	1189.79	1.4195
0.4200	0.3000	793.1	1.5670	1186.04	1.4184
0.3600	0.4000	784.2	1.5134	1182.85	1.4174
0.3000	0.5000	775.7	1.4545	1180.21	1.4165
0.2400	0.6000	767.6	1.4130	1178.24	1.4156
0.1800	0.7000	759.8	1.3756	1176.75	1.4148
0.1200	0.8000	752.3	1.3465	1175.95	1.4141
0.0600	0.9000	745.2	1.3257	1175.95	1.4136
0.7201	0.0999	819.0	1.9225	1207.03	1.4249
0.6400	0.2000	810.1	1.8308	1202.26	1.4236
0.5601	0.2999	801.1	1.7451	1197.70	1.4222
0.4800	0.4000	792.1	1.6647	1193.42	1.4208
0.3999	0.5001	783.2	1.5910	1189.52	1.4193
0.3200	0.6000	774.2	1.5228	1185.99	1.4182
0.2400	0.7000	765.2	1.4584	1182.89	1.4169
0.1600	0.8000	756.3	1.4033	1180.26	1.4156
0.0800	0.9000	747.5	1.3560	1178.38	1.4145
0.8101	0.0999	821.9	2.0341	1212.31	1.4268
0.7201	0.1999	813.3	1.9330	1207.40	1.4253
0.6300	0.3000	804.6	1.8395	1202.71	1.4239
0.5400	0.4000	795.6	1.7465	1197.99	1.4224
0.4500	0.5000	786.5	1.6608	1193.70	1.4209
0.3602	0.5998	777.3	1.5794	1189.69	1.4194
0.2700	0.7000	767.8	1.5033	1185.83	1.4178
0.1800	0.8000	758.3	1.4327	1182.40	1.4163
0.0900	0.9000	748.6	1.3714	1179.50	1.4148

[a] Standard uncertainties u for each variables are $u(T) = 0.01$ K; $u_r(p) = 0.05$; $u(x_1) = 0.0001$, and the combined expanded uncertainties U_c are $U_c(\rho) = 0.8$ kg·m^{-3}; $U_c(\eta) = 0.007$ mPa·s, $U_c(u) = 0.2$ m·s^{-1} and $U_c(n_D) = 2.8\times10^{-3}$ with 0.95 level of confidence ($k \approx 2$).

Table A 12 Values of Calculated Excess Molar Volumes V^E ($m^3 \cdot mol^{-1}$) Viscosity Deviations $\Delta\eta$ (mPa·s), Deviations in Refractive Indices Δn_D and Deviations in isentropic compressibility $\Delta\kappa_S$ (Pa^{-1}) of the Ethyl oleate (1) + *n*-hexadecane (2) + butanol (3) Ternary System, as a Function of Ethyl oleate Mole Fraction x_1 and *n*-hexadecane Mole Fraction x_2, at T = 293.15−343.15 K and p = 0.1 MPa[a]

x_1	x_2	$10^{-6}V^E$ / ($m^3 \cdot mol^{-1}$)	$\Delta\eta$ / (mPa·s)	Δn_D /	10^{10} $\Delta\kappa_S$ / (Pa^{-1})
			293.15K		
0.0902	0.1001	0.2539	-0.1071	0.0108	0.0234
0.0800	0.2000	0.3487	-0.1592	0.0106	0.0672
0.0722	0.2785	0.4283	-0.1943	0.0103	0.0901
0.0600	0.3999	0.4795	-0.2325	0.0093	0.1052
0.0501	0.4999	0.4937	-0.2441	0.0083	0.1059
0.0400	0.6000	0.4770	-0.2435	0.0069	0.1002
0.0300	0.6996	0.4263	-0.2242	0.0055	0.0874
0.0201	0.7999	0.3461	-0.1934	0.0037	0.0695
0.0100	0.8999	0.2381	-0.1316	0.0021	0.0443
0.1800	0.1000	0.2668	-0.0990	0.0134	0.0045
0.1600	0.2000	0.3798	-0.1592	0.0123	0.0468
0.1400	0.3000	0.4451	-0.2051	0.0110	0.0718
0.1200	0.4000	0.4762	-0.2348	0.0096	0.0847
0.1000	0.5000	0.4880	-0.2415	0.0082	0.0901
0.0800	0.6000	0.4719	-0.2363	0.0068	0.0871
0.0600	0.7000	0.4216	-0.2146	0.0052	0.0780
0.0400	0.8000	0.3491	-0.1763	0.0036	0.0632
0.0200	0.9000	0.2385	-0.1210	0.0019	0.0419
0.3600	0.0999	0.2991	-0.0864	0.0150	0.0028
0.3200	0.2001	0.3782	-0.1617	0.0127	0.0291
0.2801	0.3000	0.4398	-0.2251	0.0112	0.0491
0.2400	0.3999	0.4719	-0.2562	0.0091	0.0600
0.2000	0.5000	0.4820	-0.2679	0.0075	0.0669
0.1600	0.6001	0.4582	-0.2450	0.0063	0.0671
0.1201	0.6998	0.4493	-0.2210	0.0047	0.0626
0.0800	0.8000	0.6266	-0.1888	0.0032	0.0531
0.0400	0.9000	0.2274	-0.1381	0.0017	0.0364
0.5400	0.1000	0.2802	-0.0989	0.0113	0.0047
0.4800	0.2000	0.3596	-0.1821	0.0099	0.0206
0.4200	0.3000	0.4080	-0.2494	0.0085	0.0331
0.3600	0.4000	0.4471	-0.3102	0.0071	0.0428
0.3000	0.5000	0.4517	-0.2858	0.0058	0.0484
0.2400	0.6000	0.4331	-0.2762	0.0046	0.0504
0.1800	0.7000	0.3949	-0.2481	0.0034	0.0487
0.1200	0.8000	0.3203	-0.1958	0.0023	0.0414
0.0600	0.9000	0.2190	-0.1257	0.0013	0.0291
0.7201	0.0999	0.2210	-0.1106	0.0064	0.0041
0.6400	0.2000	0.2928	-0.1933	0.0058	0.0128
0.5601	0.2999	0.3450	-0.2436	0.0050	0.0206
0.4800	0.4000	0.3826	-0.2876	0.0043	0.0269
0.3999	0.5001	0.3950	-0.2875	0.0035	0.0316
0.3200	0.6000	0.3718	-0.2778	0.0029	0.0333
0.2400	0.7000	0.3585	-0.2530	0.0022	0.0341
0.1600	0.8000	0.2798	-0.2037	0.0016	0.0296
0.0800	0.9000	0.1873	-0.1233	0.0010	0.0196
0.8101	0.0999	0.1756	-0.1011	0.0036	0.0030
0.7201	0.1999	0.2459	-0.1903	0.0034	0.0093
0.6300	0.3000	0.2990	-0.2369	0.0031	0.0143
0.5400	0.4000	0.3307	-0.2792	0.0027	0.0194
0.4500	0.5000	0.3561	-0.2863	0.0024	0.0233
0.3602	0.5998	0.3471	-0.2790	0.0020	0.0249

0.2700	0.7000	0.3230	-0.2510	0.0016	0.0256
0.1800	0.8000	0.2644	-0.1959	0.0011	0.0227
0.0900	0.9000	0.1617	-0.1191	0.0008	0.0148
			298.15K		
0.0902	0.1001	0.2669	-0.0899	0.0107	0.0271
0.0800	0.2000	0.3669	-0.1351	0.0105	0.0739
0.0722	0.2785	0.4494	-0.1655	0.0102	0.0983
0.0600	0.3999	0.5040	-0.1994	0.0092	0.1143
0.0501	0.4999	0.5185	-0.2093	0.0082	0.1151
0.0400	0.6000	0.5020	-0.2092	0.0069	0.1087
0.0300	0.6996	0.4501	-0.1927	0.0054	0.0948
0.0201	0.7999	0.3795	-0.1662	0.0037	0.0757
0.0100	0.8999	0.2555	-0.1181	0.0021	0.0483
0.1800	0.1000	0.2834	-0.0795	0.0133	0.0068
0.1600	0.2000	0.3993	-0.1322	0.0122	0.0514
0.1400	0.3000	0.4671	-0.1723	0.0109	0.0779
0.1200	0.4000	0.4995	-0.1986	0.0095	0.0916
0.1000	0.5000	0.5117	-0.2053	0.0082	0.0972
0.0800	0.6000	0.4953	-0.2021	0.0068	0.0938
0.0600	0.7000	0.4430	-0.1848	0.0051	0.0841
0.0400	0.8000	0.3691	-0.1538	0.0036	0.0684
0.0200	0.9000	0.2531	-0.1083	0.0019	0.0454
0.3600	0.0999	0.3192	-0.0701	0.0150	0.0039
0.3200	0.2001	0.3983	-0.1373	0.0126	0.0303
0.2801	0.3000	0.4664	-0.1914	0.0112	0.0516
0.2400	0.3999	0.4922	-0.2196	0.0091	0.0636
0.2000	0.5000	0.5016	-0.2311	0.0075	0.0708
0.1600	0.6001	0.4775	-0.2133	0.0063	0.0711
0.1201	0.6998	0.4419	-0.1919	0.0047	0.0665
0.0800	0.8000	0.3793	-0.1642	0.0031	0.0567
0.0400	0.9000	0.2391	-0.1228	0.0017	0.0390
0.5400	0.1000	0.2989	-0.0782	0.0112	0.0053
0.4800	0.2000	0.3769	-0.1558	0.0098	0.0215
0.4200	0.3000	0.4247	-0.2138	0.0084	0.0345
0.3600	0.4000	0.4633	-0.2727	0.0070	0.0444
0.3000	0.5000	0.4662	-0.2518	0.0058	0.0504
0.2400	0.6000	0.4471	-0.2442	0.0046	0.0525
0.1800	0.7000	0.4073	-0.2199	0.0034	0.0508
0.1200	0.8000	0.3310	-0.1727	0.0023	0.0434
0.0600	0.9000	0.2254	-0.1115	0.0013	0.0304
0.7201	0.0999	0.2327	-0.0883	0.0063	0.0041
0.6400	0.2000	0.3030	-0.1597	0.0057	0.0127
0.5601	0.2999	0.3549	-0.2066	0.0050	0.0206
0.4800	0.4000	0.3904	-0.2460	0.0043	0.0271
0.3999	0.5001	0.4028	-0.2495	0.0035	0.0320
0.3200	0.6000	0.3782	-0.2448	0.0029	0.0337
0.2400	0.7000	0.3634	-0.2227	0.0022	0.0346
0.1600	0.8000	0.2832	-0.1785	0.0016	0.0299
0.0800	0.9000	0.1886	-0.1078	0.0010	0.0199
0.8101	0.0999	0.1812	-0.0790	0.0035	0.0030
0.7201	0.1999	0.2499	-0.1555	0.0033	0.0091
0.6300	0.3000	0.3015	-0.1974	0.0031	0.0140
0.5400	0.4000	0.3327	-0.2371	0.0027	0.0191
0.4500	0.5000	0.3567	-0.2475	0.0024	0.0230
0.3602	0.5998	0.3465	-0.2449	0.0020	0.0248
0.2700	0.7000	0.3220	-0.2222	0.0016	0.0256
0.1800	0.8000	0.2625	-0.1721	0.0011	0.0227
0.0900	0.9000	0.1574	-0.1047	0.0008	0.0147

			303.15K		
0.0902	0.1001	0.2835	-0.0747	0.0107	0.0314
0.0800	0.2000	0.3895	-0.1171	0.0104	0.0815
0.0722	0.2785	0.4758	-0.1407	0.0102	0.1074
0.0600	0.3999	0.5346	-0.1735	0.0092	0.1247
0.0501	0.4999	0.5502	-0.1784	0.0082	0.1253
0.0400	0.6000	0.5332	-0.1827	0.0068	0.1181
0.0300	0.6996	0.4806	-0.1679	0.0054	0.1029
0.0201	0.7999	0.4185	-0.1446	0.0036	0.0808
0.0100	0.8999	0.2771	-0.1080	0.0021	0.0528
0.1800	0.1000	0.3042	-0.0613	0.0133	0.0098
0.1600	0.2000	0.4254	-0.1076	0.0121	0.0569
0.1400	0.3000	0.4649	-0.1434	0.0109	0.0837
0.1200	0.4000	0.5285	-0.1677	0.0095	0.0994
0.1000	0.5000	0.5420	-0.1748	0.0081	0.1052
0.0800	0.6000	0.5248	-0.1729	0.0067	0.1015
0.0600	0.7000	0.4714	-0.1600	0.0051	0.0908
0.0400	0.8000	0.3950	-0.1351	0.0035	0.0740
0.0200	0.9000	0.2729	-0.0972	0.0019	0.0492
0.3600	0.0999	0.3435	-0.0511	0.0149	0.0055
0.3200	0.2001	0.4238	-0.1114	0.0127	0.0331
0.2801	0.3000	0.4955	-0.1589	0.0111	0.0553
0.2400	0.3999	0.5185	-0.1844	0.0090	0.0678
0.2000	0.5000	0.5274	-0.1979	0.0074	0.0754
0.1600	0.6001	0.5011	-0.1840	0.0063	0.0759
0.1201	0.6998	0.4730	-0.1668	0.0048	0.0713
0.0800	0.8000	0.2043	-0.1441	0.0032	0.0602
0.0400	0.9000	0.2561	-0.1115	0.0017	0.0417
0.5400	0.1000	0.3220	-0.0631	0.0111	0.0059
0.4800	0.2000	0.3994	-0.1300	0.0098	0.0225
0.4200	0.3000	0.4471	-0.1812	0.0084	0.0359
0.3600	0.4000	0.4852	-0.1678	0.0070	0.0464
0.3000	0.5000	0.4881	-0.2180	0.0057	0.0527
0.2400	0.6000	0.4678	-0.2106	0.0045	0.0549
0.1800	0.7000	0.4178	-0.1909	0.0034	0.0531
0.1200	0.8000	0.3467	-0.1505	0.0023	0.0454
0.0600	0.9000	0.2364	-0.0979	0.0013	0.0317
0.7201	0.0999	0.2483	-0.0753	0.0063	0.0042
0.6400	0.2000	0.3171	-0.1363	0.0057	0.0127
0.5601	0.2999	0.3686	-0.1772	0.0049	0.0207
0.4800	0.4000	0.4035	-0.2095	0.0042	0.0273
0.3999	0.5001	0.4150	-0.2135	0.0034	0.0323
0.3200	0.6000	0.3893	-0.2101	0.0029	0.0342
0.2400	0.7000	0.3730	-0.1920	0.0022	0.0352
0.1600	0.8000	0.2909	-0.1541	0.0016	0.0305
0.0800	0.9000	0.1937	-0.0933	0.0010	0.0202
0.8101	0.0999	0.1891	-0.0705	0.0035	0.0030
0.7201	0.1999	0.2573	-0.1342	0.0033	0.0091
0.6300	0.3000	0.3082	-0.1697	0.0030	0.0138
0.5400	0.4000	0.3381	-0.2034	0.0027	0.0188
0.4500	0.5000	0.3618	-0.2084	0.0024	0.0228
0.3602	0.5998	0.3506	-0.2059	0.0020	0.0245
0.2700	0.7000	0.3246	-0.1902	0.0016	0.0256
0.1800	0.8000	0.2641	-0.1500	0.0011	0.0228
0.0900	0.9000	0.1587	-0.0911	0.0008	0.0149
			308.15K		
0.0902	0.1001	0.3026	-0.0554	0.0107	0.0368
0.0800	0.2000	0.4155	-0.0934	0.0104	0.0903

0.0722	0.2785	0.5057	-0.1203	0.0101	0.1179
0.0600	0.3999	0.5695	-0.1470	0.0091	0.1362
0.0501	0.4999	0.5868	-0.1515	0.0081	0.1367
0.0400	0.6000	0.5696	-0.1567	0.0068	0.1284
0.0300	0.6996	0.5162	-0.1431	0.0053	0.1120
0.0201	0.7999	0.4597	-0.1268	0.0036	0.0894
0.0100	0.8999	0.3031	-0.0941	0.0021	0.0577
0.1800	0.1000	0.3276	-0.0425	0.0132	0.0135
0.1600	0.2000	0.4516	-0.0834	0.0121	0.0632
0.1400	0.3000	0.5255	-0.1163	0.0108	0.0928
0.1200	0.4000	0.5619	-0.1378	0.0094	0.1079
0.1000	0.5000	0.5763	-0.1466	0.0080	0.1139
0.0800	0.6000	0.5596	-0.1465	0.0067	0.1098
0.0600	0.7000	0.5049	-0.1373	0.0051	0.0985
0.0400	0.8000	0.4253	-0.1177	0.0035	0.0803
0.0200	0.9000	0.2965	-0.0865	0.0019	0.0535
0.3600	0.0999	0.3710	-0.0308	0.0149	0.0077
0.3200	0.2001	0.4528	-0.0856	0.0125	0.0364
0.2801	0.3000	0.5255	-0.1238	0.0111	0.0595
0.2400	0.3999	0.5495	-0.1531	0.0089	0.0727
0.2000	0.5000	0.5581	-0.1655	0.0073	0.0808
0.1600	0.6001	0.5595	-0.1572	0.0063	0.0809
0.1201	0.6998	0.5065	-0.1445	0.0047	0.0754
0.0800	0.8000	0.4234	-0.1254	0.0032	0.0643
0.0400	0.9000	0.2757	-0.0959	0.0016	0.0447
0.5400	0.1000	0.3485	-0.0417	0.0111	0.0068
0.4800	0.2000	0.4259	-0.1014	0.0098	0.0240
0.4200	0.3000	0.4739	-0.1469	0.0084	0.0379
0.3600	0.4000	0.5112	-0.1457	0.0070	0.0488
0.3000	0.5000	0.5126	-0.1834	0.0057	0.0554
0.2400	0.6000	0.4912	-0.1780	0.0045	0.0579
0.1800	0.7000	0.4475	-0.1625	0.0033	0.0563
0.1200	0.8000	0.3657	-0.1303	0.0022	0.0480
0.0600	0.9000	0.2494	-0.0851	0.0013	0.0333
0.7201	0.0999	0.2676	-0.0582	0.0063	0.0046
0.6400	0.2000	0.3347	-0.1110	0.0057	0.0133
0.5601	0.2999	0.3859	-0.1472	0.0049	0.0213
0.4800	0.4000	0.4195	-0.1750	0.0042	0.0280
0.3999	0.5001	0.4305	-0.1807	0.0034	0.0331
0.3200	0.6000	0.4026	-0.1779	0.0029	0.0349
0.2400	0.7000	0.3855	-0.1636	0.0022	0.0361
0.1600	0.8000	0.3005	-0.1307	0.0016	0.0314
0.0800	0.9000	0.1992	-0.0792	0.0010	0.0208
0.8101	0.0999	0.2007	-0.0560	0.0035	0.0032
0.7201	0.1999	0.2672	-0.1089	0.0033	0.0092
0.6300	0.3000	0.3166	-0.1394	0.0030	0.0140
0.5400	0.4000	0.3462	-0.2680	0.0027	0.0190
0.4500	0.5000	0.3689	-0.1755	0.0024	0.0230
0.3602	0.5998	0.3570	-0.1738	0.0020	0.0247
0.2700	0.7000	0.3296	-0.1592	0.0016	0.0257
0.1800	0.8000	0.2673	-0.1253	0.0011	0.0230
0.0900	0.9000	0.1602	-0.0748	0.0009	0.0150
			313.15K		
0.0902	0.1001	0.3249	-0.0383	0.0106	0.0430
0.0800	0.2000	0.4462	-0.0732	0.0103	0.1003
0.0722	0.2785	0.5405	-0.0945	0.0100	0.1296
0.0600	0.3999	0.6095	-0.1191	0.0090	0.1493
0.0501	0.4999	0.6283	-0.1267	0.0080	0.1491

0.0400	0.6000	0.6118	-0.1298	0.0066	0.1399
0.0300	0.6996	0.5574	-0.1226	0.0052	0.1219
0.0201	0.7999	0.4654	-0.1091	0.0035	0.0974
0.0100	0.8999	0.3333	-0.0834	0.0020	0.0630
0.1800	0.1000	0.3546	-0.0217	0.0131	0.0178
0.1600	0.2000	0.4837	-0.0586	0.0120	0.0703
0.1400	0.3000	0.5616	-0.0893	0.0107	0.1015
0.1200	0.4000	0.6004	-0.1102	0.0093	0.1175
0.1000	0.5000	0.6165	-0.1199	0.0080	0.1237
0.0800	0.6000	0.5994	-0.1221	0.0066	0.1191
0.0600	0.7000	0.5434	-0.1166	0.0050	0.1068
0.0400	0.8000	0.4614	-0.1020	0.0034	0.0876
0.0200	0.9000	0.3243	-0.0765	0.0018	0.0580
0.3600	0.0999	0.4022	-0.0065	0.0148	0.0100
0.3200	0.2001	0.4860	-0.0555	0.0124	0.0401
0.2801	0.3000	0.5560	-0.0954	0.0111	0.0642
0.2400	0.3999	0.5848	-0.1197	0.0089	0.0782
0.2000	0.5000	0.5936	-0.1337	0.0073	0.0867
0.1600	0.6001	0.5835	-0.1289	0.0063	0.0867
0.1201	0.6998	0.5420	-0.1211	0.0047	0.0808
0.0800	0.8000	0.4309	-0.1076	0.0032	0.0689
0.0400	0.9000	0.2985	-0.0833	0.0016	0.0477
0.5400	0.1000	0.3789	-0.0228	0.0110	0.0082
0.4800	0.2000	0.4560	-0.0749	0.0096	0.0258
0.4200	0.3000	0.5039	-0.1132	0.0083	0.0402
0.3600	0.4000	0.5409	-0.1145	0.0069	0.0515
0.3000	0.5000	0.5415	-0.1475	0.0056	0.0585
0.2400	0.6000	0.5196	-0.1456	0.0044	0.0611
0.1800	0.7000	0.4735	-0.1351	0.0033	0.0594
0.1200	0.8000	0.3883	-0.1093	0.0022	0.0507
0.0600	0.9000	0.2647	-0.0720	0.0012	0.0349
0.7201	0.0999	0.2888	-0.0433	0.0062	0.0051
0.6400	0.2000	0.3557	-0.0886	0.0056	0.0139
0.5601	0.2999	0.4057	-0.1197	0.0048	0.0220
0.4800	0.4000	0.5194	-0.1424	0.0041	0.0291
0.3999	0.5001	0.5251	-0.1473	0.0033	0.0342
0.3200	0.6000	0.4914	-0.1443	0.0028	0.0360
0.2400	0.7000	0.4003	-0.1332	0.0021	0.0371
0.1600	0.8000	0.3127	-0.1073	0.0015	0.0324
0.0800	0.9000	0.2066	-0.0655	0.0010	0.0215
0.8101	0.0999	0.2137	-0.0441	0.0034	0.0035
0.7201	0.1999	0.2801	-0.0882	0.0032	0.0095
0.6300	0.3000	0.3280	-0.1136	0.0029	0.0141
0.5400	0.4000	0.3571	-0.1373	0.0026	0.0194
0.4500	0.5000	0.3796	-0.1432	0.0023	0.0235
0.3602	0.5998	0.3652	-0.1411	0.0019	0.0250
0.2700	0.7000	0.3371	-0.1277	0.0015	0.0261
0.1800	0.8000	0.2727	-0.1016	0.0011	0.0234
0.0900	0.9000	0.1638	-0.0611	0.0008	0.0155
			318.15K		
0.0902	0.1001	0.3509	-0.0290	0.0105	0.0501
0.0800	0.2000	0.4812	-0.0605	0.0101	0.1118
0.0722	0.2785	0.5815	-0.0800	0.0099	0.1431
0.0600	0.3999	0.6565	-0.1020	0.0089	0.1638
0.0501	0.4999	0.6777	-0.1096	0.0079	0.1630
0.0400	0.6000	0.6614	-0.1132	0.0065	0.1527
0.0300	0.6996	0.6065	-0.1077	0.0052	0.1333
0.0201	0.7999	0.5154	-0.0969	0.0034	0.1063

0.0100	0.8999	0.3687	-0.0762	0.0020	0.0686
0.1800	0.1000	0.3857	-0.0142	0.0130	0.0230
0.1600	0.2000	0.5204	-0.0468	0.0118	0.0786
0.1400	0.3000	0.6038	-0.0750	0.0106	0.1116
0.1200	0.4000	0.6456	-0.0946	0.0092	0.1285
0.1000	0.5000	0.6642	-0.1040	0.0078	0.1348
0.0800	0.6000	0.6475	-0.1073	0.0065	0.1298
0.0600	0.7000	0.5897	-0.1036	0.0049	0.1164
0.0400	0.8000	0.5036	-0.0918	0.0034	0.0954
0.0200	0.9000	0.3577	-0.0698	0.0018	0.0630
0.3600	0.0999	0.4381	-0.0012	0.0147	0.0128
0.3200	0.2001	0.5241	-0.0476	0.0123	0.0445
0.2801	0.3000	0.5296	-0.0830	0.0112	0.0697
0.2400	0.3999	0.6265	-0.1055	0.0087	0.0846
0.2000	0.5000	0.6357	-0.1187	0.0072	0.0935
0.1600	0.6001	0.6501	-0.1161	0.0063	0.0936
0.1201	0.6998	0.5807	-0.1091	0.0047	0.0871
0.0800	0.8000	0.4744	-0.0973	0.0032	0.0742
0.0400	0.9000	0.3259	-0.0751	0.0015	0.0511
0.5400	0.1000	0.4143	-0.0138	0.0109	0.0099
0.4800	0.2000	0.4911	-0.0624	0.0095	0.0282
0.4200	0.3000	0.5391	-0.0987	0.0082	0.0432
0.3600	0.4000	0.5761	-0.1047	0.0068	0.0548
0.3000	0.5000	0.5777	-0.1345	0.0055	0.0623
0.2400	0.6000	0.5539	-0.1322	0.0043	0.0648
0.1800	0.7000	0.5055	-0.1225	0.0032	0.0630
0.1200	0.8000	0.4166	-0.0992	0.0021	0.0538
0.0600	0.9000	0.2847	-0.0648	0.0012	0.0367
0.7201	0.0999	0.3145	-0.0329	0.0061	0.0061
0.6400	0.2000	0.3807	-0.0738	0.0055	0.0148
0.5601	0.2999	0.4303	-0.1029	0.0047	0.0233
0.4800	0.4000	0.8030	-0.1244	0.0040	0.0303
0.3999	0.5001	0.7940	-0.1311	0.0033	0.0357
0.3200	0.6000	0.7850	-0.1304	0.0028	0.0377
0.2400	0.7000	0.4202	-0.1217	0.0021	0.0387
0.1600	0.8000	0.3291	-0.0970	0.0015	0.0337
0.0800	0.9000	0.2180	-0.0587	0.0010	0.0224
0.8101	0.0999	0.2312	-0.0349	0.0033	0.0043
0.7201	0.1999	0.2964	-0.0735	0.0031	0.0101
0.6300	0.3000	0.3433	-0.0966	0.0028	0.0146
0.5400	0.4000	0.3724	-0.1189	0.0026	0.0200
0.4500	0.5000	0.3931	-0.1256	0.0023	0.0239
0.3602	0.5998	0.3775	-0.1257	0.0018	0.0258
0.2700	0.7000	0.3485	-0.1155	0.0015	0.0269
0.1800	0.8000	0.2832	-0.0925	0.0011	0.0242
0.0900	0.9000	0.1719	-0.0548	0.0008	0.0159
			323.15K		
0.0902	0.1001	0.3797	-0.0192	0.0104	0.0582
0.0800	0.2000	0.5204	-0.0478	0.0100	0.1245
0.0722	0.2785	0.6260	-0.0651	0.0098	0.1578
0.0600	0.3999	0.7085	-0.0853	0.0088	0.1798
0.0501	0.4999	0.7323	-0.0928	0.0078	0.1784
0.0400	0.6000	0.7175	-0.0976	0.0064	0.1669
0.0300	0.6996	0.6602	-0.0941	0.0051	0.1458
0.0201	0.7999	0.5629	-0.0861	0.0033	0.1161
0.0100	0.8999	0.4080	-0.0682	0.0019	0.0748
0.1800	0.1000	0.4199	-0.0041	0.0129	0.0286
0.1600	0.2000	0.5612	-0.0331	0.0118	0.0876

0.1400	0.3000	0.6498	-0.0595	0.0105	0.1227
0.1200	0.4000	0.6952	-0.0782	0.0091	0.1405
0.1000	0.5000	0.7164	-0.0879	0.0078	0.1471
0.0800	0.6000	0.7006	-0.0924	0.0064	0.1415
0.0600	0.7000	0.6417	-0.0905	0.0048	0.1270
0.0400	0.8000	0.5510	-0.0816	0.0033	0.1040
0.0200	0.9000	0.3943	-0.0627	0.0017	0.0683
0.3600	0.0999	0.4768	0.0094	0.0146	0.0162
0.3200	0.2001	0.5661	-0.0335	0.0122	0.0494
0.2801	0.3000	0.6152	-0.0667	0.0112	0.0757
0.2400	0.3999	0.6729	-0.0877	0.0087	0.0917
0.2000	0.5000	0.6827	-0.1010	0.0071	0.1011
0.1600	0.6001	0.6804	-0.1020	0.0063	0.1013
0.1201	0.6998	0.6556	-0.0967	0.0047	0.0942
0.0800	0.8000	0.5266	-0.0857	0.0032	0.0802
0.0400	0.9000	0.3562	-0.0668	0.0015	0.0547
0.5400	0.1000	0.4517	-0.0035	0.0108	0.0119
0.4800	0.2000	0.5303	-0.0480	0.0095	0.0309
0.4200	0.3000	0.5782	-0.0808	0.0081	0.0465
0.3600	0.4000	0.6150	-0.0893	0.0067	0.0589
0.3000	0.5000	0.6160	-0.1160	0.0055	0.0666
0.2400	0.6000	0.5910	-0.1148	0.0043	0.0692
0.1800	0.7000	0.5404	-0.1069	0.0032	0.0671
0.1200	0.8000	0.4461	-0.0870	0.0021	0.0573
0.0600	0.9000	0.3048	-0.0566	0.0012	0.0387
0.7201	0.0999	0.3425	-0.0232	0.0060	0.0074
0.6400	0.2000	0.4083	-0.0599	0.0054	0.0162
0.5601	0.2999	0.4577	-0.0863	0.0047	0.0247
0.4800	0.4000	0.5513	-0.1055	0.0040	0.0320
0.3999	0.5001	0.5554	-0.1123	0.0032	0.0375
0.3200	0.6000	0.5203	-0.1122	0.0027	0.0396
0.2400	0.7000	0.4415	-0.1055	0.0020	0.0408
0.1600	0.8000	0.3473	-0.0840	0.0015	0.0356
0.0800	0.9000	0.2315	-0.0507	0.0010	0.0238
0.8101	0.0999	0.2500	-0.0269	0.0033	0.0053
0.7201	0.1999	0.3147	-0.0605	0.0030	0.0110
0.6300	0.3000	0.3598	-0.0808	0.0028	0.0152
0.5400	0.4000	0.3889	-0.1002	0.0025	0.0207
0.4500	0.5000	0.4090	-0.1069	0.0022	0.0246
0.3602	0.5998	0.3929	-0.1073	0.0018	0.0264
0.2700	0.7000	0.3624	-0.0990	0.0015	0.0278
0.1800	0.8000	0.2950	-0.0796	0.0011	0.0252
0.0900	0.9000	0.1816	-0.0470	0.0008	0.0166
			328.15K		
0.0902	0.1001	0.4121	-0.0109	0.0103	0.0672
0.0800	0.2000	0.5638	-0.0363	0.0099	0.1386
0.0722	0.2785	0.6764	-0.0525	0.0097	0.1742
0.0600	0.3999	0.7654	-0.0714	0.0087	0.1972
0.0501	0.4999	0.7928	-0.0788	0.0077	0.1953
0.0400	0.6000	0.7788	-0.0846	0.0063	0.1825
0.0300	0.6996	0.7212	-0.0828	0.0050	0.1596
0.0201	0.7999	0.6115	-0.0769	0.0033	0.1269
0.0100	0.8999	0.4501	-0.0616	0.0019	0.0815
0.1800	0.1000	0.4576	0.0042	0.0128	0.0351
0.1600	0.2000	0.6068	-0.0216	0.0117	0.0977
0.1400	0.3000	0.7014	-0.0464	0.0104	0.1350
0.1200	0.4000	0.7512	-0.0645	0.0090	0.1539
0.1000	0.5000	0.7749	-0.0743	0.0077	0.1607

0.0800	0.6000	0.7595	-0.0799	0.0063	0.1546
0.0600	0.7000	0.6988	-0.0796	0.0047	0.1386
0.0400	0.8000	0.6031	-0.0748	0.0032	0.1135
0.0200	0.9000	0.4331	-0.0565	0.0017	0.0742
0.3600	0.0999	0.5200	0.0180	0.0145	0.0201
0.3200	0.2001	0.6140	-0.0219	0.0121	0.0552
0.2801	0.3000	0.6779	-0.0519	0.0112	0.0827
0.2400	0.3999	0.7245	-0.0730	0.0086	0.0996
0.2000	0.5000	0.7349	-0.0863	0.0070	0.1096
0.1600	0.6001	0.7408	-0.0902	0.0064	0.1100
0.1201	0.6998	0.6967	-0.0861	0.0047	0.1023
0.0800	0.8000	0.5732	-0.0756	0.0032	0.0870
0.0400	0.9000	0.3871	-0.0594	0.0015	0.0587
0.5400	0.1000	0.4949	0.0050	0.0108	0.0143
0.4800	0.2000	0.5736	-0.0357	0.0094	0.0341
0.4200	0.3000	0.6228	-0.0658	0.0081	0.0506
0.3600	0.4000	0.6596	-0.0764	0.0067	0.0635
0.3000	0.5000	0.6601	-0.0999	0.0054	0.0715
0.2400	0.6000	0.6336	-0.0998	0.0043	0.0741
0.1800	0.7000	0.5789	-0.0938	0.0031	0.0719
0.1200	0.8000	0.4789	-0.0766	0.0020	0.0612
0.0600	0.9000	0.3267	-0.0495	0.0012	0.0414
0.7201	0.0999	0.3745	-0.0153	0.0060	0.0090
0.6400	0.2000	0.4392	-0.0483	0.0054	0.0179
0.5601	0.2999	0.4891	-0.0723	0.0047	0.0266
0.4800	0.4000	0.5194	-0.0896	0.0040	0.0340
0.3999	0.5001	0.5251	-0.0965	0.0032	0.0397
0.3200	0.6000	0.4914	-0.0969	0.0027	0.0418
0.2400	0.7000	0.4664	-0.0918	0.0020	0.0430
0.1600	0.8000	0.3666	-0.0731	0.0015	0.0377
0.0800	0.9000	0.2460	-0.0439	0.0009	0.0253
0.8101	0.0999	0.2719	-0.0202	0.0033	0.0063
0.7201	0.1999	0.3366	-0.0498	0.0030	0.0119
0.6300	0.3000	0.3805	-0.0678	0.0028	0.0161
0.5400	0.4000	0.4098	-0.0853	0.0025	0.0217
0.4500	0.5000	0.4284	-0.0917	0.0022	0.0257
0.3602	0.5998	0.4109	-0.0924	0.0018	0.0274
0.2700	0.7000	0.3789	-0.0853	0.0015	0.0289
0.1800	0.8000	0.3093	-0.0691	0.0010	0.0263
0.0900	0.9000	0.1937	-0.0406	0.0008	0.0174
			333.15K		
0.0902	0.1001	0.4471	-0.0027	0.0103	0.0776
0.0800	0.2000	0.6110	-0.0256	0.0099	0.1543
0.0722	0.2785	0.7304	-0.0406	0.0096	0.1923
0.0600	0.3999	0.8279	-0.0581	0.0086	0.2166
0.0501	0.4999	0.8590	-0.0658	0.0076	0.2140
0.0400	0.6000	0.8459	-0.0723	0.0063	0.1998
0.0300	0.6996	0.7871	-0.0722	0.0049	0.1747
0.0201	0.7999	0.6605	-0.0682	0.0032	0.1390
0.0100	0.8999	0.4943	-0.0549	0.0018	0.0886
0.1800	0.1000	0.4981	0.0137	0.0128	0.0424
0.1600	0.2000	0.6562	-0.0094	0.0116	0.1091
0.1400	0.3000	0.7574	-0.0332	0.0104	0.1486
0.1200	0.4000	0.8118	-0.0508	0.0090	0.1686
0.1000	0.5000	0.8383	-0.0611	0.0076	0.1759
0.0800	0.6000	0.8234	-0.0678	0.0063	0.1690
0.0600	0.7000	0.7611	-0.0690	0.0047	0.1515
0.0400	0.8000	0.6594	-0.0664	0.0032	0.1240

0.0200	0.9000	0.4739	-0.0503	0.0017	0.0806
0.3600	0.0999	0.5668	0.0297	0.0145	0.0248
0.3200	0.2001	0.6645	-0.0065	0.0120	0.0618
0.2801	0.3000	0.7367	-0.0340	0.0113	0.0905
0.2400	0.3999	0.7807	-0.0561	0.0086	0.1086
0.2000	0.5000	0.7918	-0.0697	0.0069	0.1191
0.1600	0.6001	0.7766	-0.0776	0.0064	0.1198
0.1201	0.6998	0.7336	-0.0748	0.0047	0.1114
0.0800	0.8000	0.6281	-0.0640	0.0032	0.0945
0.0400	0.9000	0.4197	-0.0517	0.0015	0.0632
0.5400	0.1000	0.5402	0.0129	0.0108	0.0175
0.4800	0.2000	0.6200	-0.0233	0.0094	0.0380
0.4200	0.3000	0.6698	-0.0495	0.0081	0.0552
0.3600	0.4000	0.7070	-0.0609	0.0067	0.0686
0.3000	0.5000	0.7073	-0.0813	0.0054	0.0773
0.2400	0.6000	0.6786	-0.0822	0.0042	0.0799
0.1800	0.7000	0.6204	-0.0786	0.0031	0.0773
0.1200	0.8000	0.5134	-0.0650	0.0020	0.0658
0.0600	0.9000	0.3496	-0.0418	0.0012	0.0444
0.7201	0.0999	0.4087	-0.0092	0.0060	0.0111
0.6400	0.2000	0.4732	-0.0383	0.0054	0.0202
0.5601	0.2999	0.5222	-0.0596	0.0047	0.0289
0.4800	0.4000	0.5513	-0.0744	0.0040	0.0366
0.3999	0.5001	0.5554	-0.0804	0.0032	0.0423
0.3200	0.6000	0.5203	-0.0802	0.0027	0.0446
0.2400	0.7000	0.4922	-0.0751	0.0020	0.0458
0.1600	0.8000	0.3884	-0.0603	0.0015	0.0402
0.0800	0.9000	0.2623	-0.0366	0.0009	0.0270
0.8101	0.0999	0.2960	-0.0155	0.0033	0.0076
0.7201	0.1999	0.3598	-0.0415	0.0030	0.0132
0.6300	0.3000	0.4033	-0.0573	0.0028	0.0173
0.5400	0.4000	0.4317	-0.0721	0.0025	0.0231
0.4500	0.5000	0.4493	-0.0771	0.0022	0.0270
0.3602	0.5998	0.4295	-0.0773	0.0018	0.0286
0.2700	0.7000	0.3956	-0.0703	0.0015	0.0301
0.1800	0.8000	0.3245	-0.0564	0.0010	0.0277
0.0900	0.9000	0.2063	-0.0332	0.0008	0.0186
			338.15K		
0.0902	0.1001	0.4850	0.0012	0.0102	0.0890
0.0800	0.2000	0.6620	-0.0194	0.0098	0.1715
0.0722	0.2785	0.7896	-0.0327	0.0096	0.2120
0.0600	0.3999	0.8956	-0.0491	0.0085	0.2382
0.0501	0.4999	0.9307	-0.0570	0.0075	0.2350
0.0400	0.6000	0.9196	-0.0636	0.0062	0.2191
0.0300	0.6996	0.8586	-0.0643	0.0049	0.1915
0.0201	0.7999	0.7456	-0.0609	0.0031	0.1521
0.0100	0.8999	0.5417	-0.0493	0.0018	0.0966
0.1800	0.1000	0.5419	0.0155	0.0128	0.0506
0.1600	0.2000	0.7096	-0.0044	0.0116	0.1215
0.1400	0.3000	0.8180	-0.0268	0.0104	0.1637
0.1200	0.4000	0.8771	-0.0437	0.0089	0.1851
0.1000	0.5000	0.9073	-0.0534	0.0076	0.1925
0.0800	0.6000	0.8943	-0.0604	0.0062	0.1852
0.0600	0.7000	0.8291	-0.0622	0.0046	0.1658
0.0400	0.8000	0.7200	-0.0605	0.0031	0.1358
0.0200	0.9000	0.5168	-0.0450	0.0017	0.0876
0.3600	0.0999	0.6172	0.0303	0.0143	0.0302
0.3200	0.2001	0.7196	-0.0047	0.0120	0.0694

0.2801	0.3000	0.7911	-0.0279	0.0114	0.1004
0.2400	0.3999	0.8412	-0.0503	0.0085	0.1188
0.2000	0.5000	0.8511	-0.0630	0.0069	0.1301
0.1600	0.6001	0.8419	-0.0719	0.0064	0.1317
0.1201	0.6998	0.8120	-0.0688	0.0048	0.1224
0.0800	0.8000	0.6798	-0.0575	0.0032	0.1033
0.0400	0.9000	0.4525	-0.0462	0.0014	0.0682
0.5400	0.1000	0.5889	0.0175	0.0108	0.0211
0.4800	0.2000	0.6704	-0.0169	0.0094	0.0426
0.4200	0.3000	0.7213	-0.0425	0.0080	0.0605
0.3600	0.4000	0.7576	-0.0552	0.0067	0.0746
0.3000	0.5000	0.7573	-0.0749	0.0054	0.0838
0.2400	0.6000	0.7271	-0.0760	0.0042	0.0863
0.1800	0.7000	0.6640	-0.0721	0.0030	0.0835
0.1200	0.8000	0.5489	-0.0590	0.0020	0.0711
0.0600	0.9000	0.3739	-0.0371	0.0011	0.0481
0.7201	0.0999	0.4453	-0.0032	0.0060	0.0137
0.6400	0.2000	0.5084	-0.0301	0.0054	0.0227
0.5601	0.2999	0.5576	-0.0503	0.0047	0.0319
0.4800	0.4000	0.5862	-0.0648	0.0040	0.0398
0.3999	0.5001	0.5882	-0.0714	0.0032	0.0455
0.3200	0.6000	0.5505	-0.0724	0.0027	0.0480
0.2400	0.7000	0.5197	-0.0690	0.0020	0.0489
0.1600	0.8000	0.4111	-0.0552	0.0014	0.0431
0.0800	0.9000	0.2801	-0.0328	0.0009	0.0289
0.8101	0.0999	0.3229	-0.0102	0.0033	0.0094
0.7201	0.1999	0.3859	-0.0335	0.0031	0.0149
0.6300	0.3000	0.4278	-0.0482	0.0028	0.0187
0.5400	0.4000	0.4567	-0.0620	0.0025	0.0250
0.4500	0.5000	0.4727	-0.0675	0.0022	0.0286
0.3602	0.5998	0.4513	-0.0687	0.0018	0.0301
0.2700	0.7000	0.4158	-0.0636	0.0015	0.0318
0.1800	0.8000	0.3419	-0.0520	0.0010	0.0290
0.0900	0.9000	0.2213	-0.0303	0.0008	0.0200
			343.15K		
0.0902	0.1001	0.5264	0.0052	0.0102	0.1028
0.0800	0.2000	0.7183	-0.0126	0.0098	0.1921
0.0722	0.2785	0.8545	-0.0251	0.0096	0.2358
0.0600	0.3999	0.9705	-0.0406	0.0085	0.2646
0.0501	0.4999	1.0103	-0.0480	0.0075	0.2612
0.0400	0.6000	1.0007	-0.0549	0.0061	0.2436
0.0300	0.6996	0.9374	-0.0564	0.0048	0.2130
0.0201	0.7999	0.7947	-0.0537	0.0030	0.1708
0.0100	0.8999	0.5920	-0.0433	0.0017	0.1086
0.1800	0.1000	0.5899	0.0187	0.0129	0.0616
0.1600	0.2000	0.7676	0.0020	0.0117	0.1372
0.1400	0.3000	0.8842	-0.0196	0.0103	0.1826
0.1200	0.4000	0.9500	-0.0356	0.0089	0.2057
0.1000	0.5000	0.9838	-0.0451	0.0076	0.2141
0.0800	0.6000	0.9708	-0.0526	0.0062	0.2062
0.0600	0.7000	0.9031	-0.0545	0.0045	0.1849
0.0400	0.8000	0.7861	-0.0540	0.0031	0.1518
0.0200	0.9000	0.5627	-0.0392	0.0016	0.0990
0.3600	0.0999	0.6718	0.0344	0.0142	0.0391
0.3200	0.2001	0.7795	0.0018	0.0120	0.0805
0.2801	0.3000	0.8497	-0.0194	0.0114	0.1120
0.2400	0.3999	0.9079	-0.0414	0.0085	0.1329
0.2000	0.5000	0.9212	-0.0536	0.0069	0.1457

0.1600	0.6001	0.9420	-0.0640	0.0064	0.1463
0.1201	0.6998	0.8939	-0.0611	0.0048	0.1363
0.0800	0.8000	0.7281	-0.0496	0.0032	0.1161
0.0400	0.9000	0.4903	-0.0397	0.0014	0.0771
0.5400	0.1000	0.6422	0.0218	0.0108	0.0282
0.4800	0.2000	0.7250	-0.0101	0.0095	0.0511
0.4200	0.3000	0.7766	-0.0336	0.0080	0.0697
0.3600	0.4000	0.8137	-0.0466	0.0066	0.0846
0.3000	0.5000	0.8123	-0.0649	0.0054	0.0943
0.2400	0.6000	0.7791	-0.0658	0.0041	0.0965
0.1800	0.7000	0.7115	-0.0626	0.0030	0.0936
0.1200	0.8000	0.5897	-0.0511	0.0019	0.0810
0.0600	0.9000	0.4012	-0.0313	0.0011	0.0559
0.7201	0.0999	0.4855	0.0013	0.0061	0.0201
0.6400	0.2000	0.5481	-0.0231	0.0054	0.0287
0.5601	0.2999	0.5969	-0.0417	0.0047	0.0380
0.4800	0.4000	0.6239	-0.0548	0.0039	0.0464
0.3999	0.5001	0.6240	-0.0612	0.0031	0.0523
0.3200	0.6000	0.5849	-0.0624	0.0027	0.0554
0.2400	0.7000	0.5510	-0.0596	0.0020	0.0556
0.1600	0.8000	0.4381	-0.0475	0.0014	0.0497
0.0800	0.9000	0.3014	-0.0276	0.0009	0.0345
0.8101	0.0999	0.3539	-0.0067	0.0034	0.0150
0.7201	0.1999	0.4155	-0.0273	0.0031	0.0198
0.6300	0.3000	0.4564	-0.0403	0.0028	0.0236
0.5400	0.4000	0.4842	-0.0528	0.0025	0.0305
0.4500	0.5000	0.4994	-0.0580	0.0022	0.0338
0.3602	0.5998	0.4768	-0.0591	0.0018	0.0351
0.2700	0.7000	0.4388	-0.0545	0.0014	0.0368
0.1800	0.8000	0.3625	-0.0447	0.0010	0.0341
0.0900	0.9000	0.2404	-0.0255	0.0007	0.0250

[a] Standard uncertainties u for each variables are u(T) = ± 0.001 K for densimeter, u(T) = ±0.01 K for viscometer, u(T) = ±0.03 K for refractometer; u(p) = 5%; u(x_1) = 0.0001, and the combined expanded uncertainties U_c are $U_c(\rho)$ = ±0.8 kg·m^{-3}; $U_c(V^E)$= ±2×10^{-7} m^3·mol^{-1}; $U_c(\eta)$ = ±0.007 mPa.s; $U_c(\Delta\eta)$ = ±0.009 mPa.s; $U_c(u)$= ±0.2 m.s^{-1}; Uc(n_D) = ±2.8×10^{-3} and Uc(Δn_D) = ±3.4×10^{-3} with 0.95 level of confidence (k ≈ 2).

Table A 13 Parameters of the Nagata−Tamura for Excess Molar Volumes V^E, Viscosity Deviations $\Delta\eta$, Deviations in Refractive Indices Δn_D and Deviations in Isentropic Compressibility $\Delta\kappa_S$ for the ethyl Oleate (1) + *n*-hexadecane (2) + 1-butanol (3) Ternary System and the Corresponding rmsd.

T/K	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	σ
					$10^6(V^E)$ / ($m^3 \cdot mol^{-1}$)					
293.15	-0.000004	-0.0001	-0.0033	0.0002	0.0135	-0.0019	-0.0014	-0.0147	-0.000004	0.0104
298.15	-0.0001	0.0003	-0.0039	-0.0006	0.0158	-0.0043	-0.0010	-0.0164	0.0033	0.0104
303.15	-0.0003	-0.0007	-0.0032	-0.0003	0.0131	-0.0031	-0.0002	-0.0144	0.0017	0.0118
308.15	-0.0008	-0.0025	-0.0064	0.0053	0.0224	-0.0019	-0.0046	-0.0229	-0.0005	0.0125
313.15	0.0014	0.0086	0.0029	-0.0170	0.0058	-0.0166	0.0106	-0.0117	0.0067	0.0202
318.15	0.0077	0.0384	0.0334	-0.0758	-0.0473	-0.0571	0.0522	0.0205	0.0197	0.0674
323.15	0.0009	0.0064	-0.0017	-0.0115	0.0186	-0.0114	0.0060	-0.0246	0.0007	0.0219
328.15	-0.0003	0.0007	-0.0092	0.0007	0.0348	-0.0037	-0.0039	-0.0375	-0.0021	0.0207
333.15	0.0002	0.0027	-0.0087	-0.0020	0.0375	-0.0055	-0.0032	-0.0422	-0.0032	0.0238
338.15	0.0001	0.0023	-0.0091	-0.0011	0.0384	-0.0043	-0.0045	-0.0436	-0.0049	0.0261
343.15	0.0005	0.0026	-0.0089	0.0003	0.0409	-0.0034	-0.0069	-0.0485	-0.0097	0.0304
					$\Delta\eta$ / (mPa·s)					
293.15	-0.0028	-0.0122	-0.0067	0.0242	-0.0002	0.0232	-0.0152	0.0018	-0.0227	0.0092
298.15	-0.0021	-0.0100	-0.0058	0.0218	0.0016	0.0205	-0.0139	-0.0002	-0.0227	0.0054
303.15	-0.0015	-0.0071	-0.0046	0.0168	0.0033	0.0141	-0.0115	-0.0023	-0.0152	0.0051
308.15	-0.0010	-0.0050	-0.0028	0.0119	0.0011	0.0114	-0.0073	-0.0004	-0.0138	0.0039
313.15	-0.0009	-0.0048	-0.0027	0.0112	0.0015	0.0093	-0.0072	-0.0005	-0.0102	0.0033
318.15	-0.0008	-0.0038	-0.0026	0.0093	0.0020	0.0083	-0.0062	-0.0010	-0.0097	0.0030
323.15	-0.0006	0.0002	-0.0041	0.0008	0.0084	0.0015	-0.0015	-0.0059	0.0002	0.0033
328.15	-0.0008	0.0020	-0.0070	-0.0028	0.0163	-0.0027	-0.0002	-0.0113	0.0067	0.0040
333.15	-0.0013	0.0047	-0.0117	-0.0097	0.0281	-0.0086	0.0037	-0.0194	0.0167	0.0057
338.15	-0.0014	0.0045	-0.0127	-0.0083	0.0306	-0.0083	0.0022	-0.0212	0.0153	0.0058
343.15	-0.0018	0.0044	-0.0151	-0.0088	0.0354	-0.0084	0.0024	-0.0242	0.0168	0.0060
					Δn_D					
293.15	-0.00005	-0.0002	0.00002	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
298.15	-0.0001	-0.0002	0.00003	0.0004	-0.0003	0.0003	-0.0002	0.0002	-0.0003	0.0001
303.15	-0.00005	-0.0002	0.00002	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0003	0.0001
308.15	-0.00005	-0.0002	0.00001	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
313.15	-0.0001	-0.0002	0.0000	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
318.15	-0.0001	-0.0002	-0.00001	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
323.15	-0.00005	-0.0002	-0.00001	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
328.15	-0.00005	-0.0002	-0.00001	0.0003	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
333.15	-0.00005	-0.0002	0.0000	0.0002	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
338.15	-0.00004	-0.0002	0.00001	0.0002	-0.0002	0.0002	-0.0001	0.0002	-0.0002	0.0001
343.15	-0.00004	-0.0001	0.00000	0.0001	-0.0001	0.0001	-0.0001	0.0001	-0.0001	0.0001
					$10^{10}\,\Delta\kappa_s$ / (Pa^{-1})					
293.15	-0.0005	-0.0002	-0.0018	-0.0015	0.0028	0.0002	0.0014	-0.0016	0.0031	0.0012
298.15	-0.0005	-0.0004	-0.0016	-0.0011	0.0021	0.0010	0.0013	-0.0011	0.0014	0.0011
303.15	-0.0006	-0.0005	-0.0017	-0.0010	0.0026	0.0009	0.0012	-0.0018	0.0013	0.0011
308.15	-0.0007	-0.0010	-0.0017	-0.0003	0.0014	0.0015	0.0008	-0.0003	0.0010	0.0010
313.15	-0.0008	-0.0013	-0.0017	0.0003	0.0010	0.0020	0.0005	0.0010	0.0004	0.0010
318.15	-0.0010	-0.0016	-0.0018	0.0006	0.0007	0.0024	0.0003	0.0005	0.00001	0.0010
323.15	-0.0011	-0.0019	-0.0019	0.0009	0.0005	0.0029	0.0003	0.0008	-0.0003	0.0010
328.15	-0.0012	-0.0024	-0.0022	0.0014	0.0004	0.0035	-0.0001	0.0010	-0.0008	0.0010
333.15	-0.0014	-0.0027	-0.0024	0.0016	0.0002	0.0040	-0.0001	0.0013	-0.0012	0.0011

338.15	-0.0016	-0.0033	-0.0027	0.0024	0.0001	0.0050	-0.0004	0.0016	-0.0021	0.0011
343.15	-0.0019	-0.0044	-0.0036	0.0039	0.0013	0.0070	-0.0010	0.0007	-0.0041	0.0021

Table A 14 Density of the examined 1-butanol, 1-propanol, methyl and ethyl esters at temperatures 293.15 to 413.15 K and pressures 0.1 to 60 MPa

ρ^a/kg.m^{-3}							
				T^b/K			
P^c/MPa	1-butanol	1-propanol	Ethyl laurate	Ethyl linoleate	Ethyl myristate	Ethyl oleate	Methyl laurate
				293.15K			
0.1	809.7	803.8	861.9	876.7	860 .8	868.8	869.1
1	810.3	804.5	862.5	877.2	861.3	869.3	869.7
5	813.1	807.5	865.1	879.6	863.8	871.7	872.2
10	816.4	811.1	868.2	882.4	866.8	874.6	875.3
15	819.7	814.5	871.3	885.2	869.8	877.4	878.3
20	822.9	817.9	874.2	887.9	872.6	880.1	881.3
25	825.9	821.1	877.1	890.6	875.4	882.8	884.1
30	828.9	824.2	879.9	893.1	878.1	885.4	886.8
35	831.8	827.2	882.6	895.6	880.7	887.9	889.5
40	834.6	830.1	885.2	898.1	883.2	890.3	892.1
45	837.2	832.9	887.7	900.4	885.7	892.6	894.5
50	839.8	835.5	890.1	902.7	888.0	894.9	896.9
55	842.3	838.0	892.4	904.9	-	897.1	899.3
60	844.6	840.4	894.7	907.0	-	899.2	901.5
				298.15K			
0.1	805.9	799.8	858.0	873.0	857.0	865.2	865.2
1	806.5	800.5	858.6	873.6	857.5	865.7	865.8
5	809.4	803.6	861.3	876.0	860.1	868.1	868.4
10	812.8	807.2	864.5	878.9	863.1	871.1	871.5
15	816.2	810.8	867.6	881.7	866.2	873.9	874.6
20	819.4	814.2	870.6	884.5	869.1	876.7	877.6
25	822.5	817.5	873.5	887.2	871.9	879.4	880.5
30	825.6	820.7	876.4	889.8	874.7	882.1	883.3
35	828.5	823.8	879.1	892.4	877.3	884.6	886.0
40	831.3	826.7	881.8	894.9	879.9	887.1	888.7
45	834.0	829.6	884.4	897.3	882.4	889.5	891.2
50	836.7	832.3	886.9	899.6	884.8	891.9	893.7
55	839.2	834.9	889.3	901.9	887.2	894.1	896.1
60	841.6	837.4	891.6	904.0	889.4	896.3	898.4
				303.15K			
0.1	802.0	795.8	854.1	869.4	853.2	861.5	861.3
1	802.7	796.5	854.8	867.0	853.8	862.1	861.9
5	805.6	799.6	857.4	872.4	856.3	864.6	864.5
10	809.1	803.4	860.7	875.4	859.5	867.6	867.8
15	812.6	807.0	863.9	878.3	862.6	870.5	870.9
20	815.9	810.5	867.0	881.1	865.6	873.3	874.0
25	819.1	813.9	870.0	883.9	868.5	876.1	876.9
30	822.2	817.2	872.0	886.6	871.3	878.8	879.8
35	825.2	820.3	875.7	889.2	874.0	881.4	882.6
40	828.1	823.3	878.4	891.7	876.6	883.9	885.3
45	830.8	826.2	881.1	894.1	879.2	886.4	887.9
50	833.5	829.0	883.6	896.5	881.7	888.8	890.4
55	836.0	831.6	886.1	898.8	884.0	891.1	892.8
60	838.5	834.2	888.4	901.0	886.3	893.3	895.2
				308.15K			
0.1	798.1	791.7	850.2	865.7	849.4	857.9	857.3
1	798.8	792.5	850.9	866.3	850.0	858.5	858.0
5	801.8	795.6	853.6	868.8	852.6	861.0	860.7
10	805.4	799.5	857.0	871.9	855.9	864.1	864.0

15	809.0	803.2	860.2	874.8	859.0	867.1	867.2
20	812.3	806.8	863.4	877.7	862.1	870.0	870.3
25	815.6	810.3	866.5	880.5	865.0	872.8	873.4
30	818.8	813.6	869.4	883.3	867.9	875.5	876.3
35	821.8	816.8	872.3	885.9	870.7	878.2	879.1
40	824.8	819.9	875.1	888.5	873.4	880.8	881.9
45	827.6	822.8	877.8	891.0	876.0	883.3	884.5
50	830.3	825.7	880.4	893.4	878.5	885.7	887.1
55	832.9	828.4	882.9	895.7	880.9	888.0	889.6
60	835.4	830.9	885.3	898.0	883.2	890.3	892.0
313.15K							
0.1	794.2	787.6	846.3	862.1	845.6	854.3	853.4
1	794.9	788.3	847.0	862.7	846.2	854.9	854.0
5	798.0	791.6	849.8	865.2	848.9	857.4	856.8
10	801.7	795.6	853.2	868.4	852.3	860.6	860.2
15	805.3	799.4	856.6	871.4	855.5	863.6	863.5
20	808.8	803.0	859.8	874.4	858.6	866.6	866.7
25	812.2	806.6	863.0	877.2	861.6	869.5	869.8
30	815.4	810.0	866.0	880.0	864.6	872.3	872.8
35	818.5	813.3	868.9	882.7	867.4	875.0	875.7
40	821.5	816.4	871.8	885.3	870.1	877.6	878.5
45	824.4	819.4	874.5	887.9	872.8	880.2	881.2
50	827.1	822.3	877.1	890.3	875.3	882.6	883.8
55	829.7	825.1	879.7	892.7	877.8	885.0	886.3
60	832.2	827.7	882.1	895.0	880.2	887.3	888.8
318.15K							
0.1	790.3	783.4	842.4	858.4	841.8	850.6	849.5
1	791.0	784.2	843.1	859.0	842.5	851.2	850.1
5	794.1	787.5	846	861.6	845.2	853.9	853
10	797.9	791.6	849.5	864.8	848.6	857.1	856.4
15	801.6	795.5	852.9	867.9	851.9	860.2	859.8
20	805.2	799.3	856.2	871.0	855.1	863.3	863.1
25	808.6	802.9	859.4	873.9	858.2	866.2	866.3
30	811.9	806.4	862.5	876.7	861.2	869.1	869.3
35	815.1	809.8	865.5	879.5	864.1	871.8	872.3
40	818.1	813.0	868.4	882.2	866.9	874.5	875.2
45	821.1	816.0	871.2	884.7	869.6	877.1	877.9
50	823.9	819.0	873.9	887.2	872.2	879.6	880.6
55	826.5	821.7	876.5	889.6	874.7	882	883.1
60	829.1	824.4	878.9	892.0	877.1	884.3	885.6
323.15K							
0.1	786.3	779.2	838.5	854.7	838.0	847.0	845.5
1	787.0	780.0	839.2	855.4	838.7	847.6	846.2
5	790.2	783.4	842.1	858.0	841.5	850.3	849.1
10	794.1	787.6	845.8	861.3	845.0	853.6	852.7
15	797.9	791.6	849.3	864.5	848.4	856.8	856.1
20	801.6	795.5	852.7	867.6	851.7	859.9	859.5
25	805.1	799.2	855.9	870.6	854.8	862.9	862.7
30	808.5	802.8	859.1	873.5	857.9	865.8	865.9
35	811.7	806.2	862.2	876.3	860.8	868.7	868.9
40	814.8	809.5	865.1	879.0	863.7	871.4	871.8
45	817.8	812.6	867.9	881.6	866.4	874.0	874.6
50	820.6	815.6	870.7	884.2	869.1	876.6	877.3
55	823.3	818.4	873.3	886.6	871.6	879.0	879.9
60	825.9	821.1	875.8	889.0	874.0	881.4	882.4
328.15K							
0.1	782.2	774.9	834.6	851.1	834.3	843.4	841.6

1	783.0	775.7	835.3	851.7	834.9	844.0	842.3
5	786.3	779.3	838.3	854.5	837.8	846.8	845.3
10	790.3	783.5	842.0	857.8	841.4	850.1	848.9
15	794.2	787.7	845.6	861.1	844.8	853.4	852.5
20	797.9	791.6	849.1	864.2	848.2	856.6	855.9
25	801.5	795.4	852.4	867.3	851.4	859.6	859.2
30	804.9	799.1	855.7	870.2	854.5	862.6	862.4
35	808.3	802.6	858.8	873.1	857.6	865.5	865.5
40	811.4	805.9	861.8	875.9	860.5	868.3	868.5
45	814.5	809.1	864.7	878.6	863.3	871.0	871.4
50	817.4	812.2	867.5	881.1	866.0	873.6	874.1
55	820.1	815.1	870.2	883.6	868.6	876.0	876.8
60	822.8	817.8	872.7	886.0	871.0	878.4	879.3
333.15K							
0.1	778.1	770.6	830.7	847.5	830.5	839.7	837.6
1	778.9	771.4	831.4	848.1	831.2	840.4	838.4
5	782.3	775.1	834.5	850.9	834.2	843.2	841.4
10	786.4	779.5	838.3	854.3	837.8	846.7	845.2
15	790.4	783.7	842.0	857.7	841.3	850.0	848.8
20	794.2	787.8	845.5	860.9	844.8	853.3	852.3
25	797.9	791.7	849.0	864.0	848.1	856.4	855.7
30	801.4	795.4	852.3	867.0	851.3	859.4	859.0
35	804.8	799.0	855.5	869.9	854.3	862.4	862.1
40	808.1	802.4	858.5	872.8	857.3	865.2	865.2
45	811.2	805.7	861.5	875.5	860.1	867.9	868.1
50	814.1	808.8	864.3	878.1	862.9	870.5	870.9
55	816.9	811.7	867.0	880.6	865.5	873.1	873.6
60	819.5	814.5	869.6	883.0	868.0	875.5	876.2
343.15K							
0.1	769.7	761.7	822.8	840.2	822.9	832.5	829.8
1	770.5	762.6	823.6	840.8	823.6	833.2	830.5
5	774.1	766.4	826.9	843.8	826.8	836.1	833.8
10	778.4	771.1	830.9	847.4	830.6	839.7	837.7
15	782.6	775.6	834.7	850.8	834.3	843.2	841.5
20	786.7	779.9	838.4	854.2	837.9	846.6	845.2
25	790.5	784.0	842.0	857.4	841.3	849.9	848.7
30	794.3	787.9	845.5	860.6	844.7	853.0	852.1
35	797.8	791.7	848.8	863.6	847.9	856.1	855.4
40	801.2	795.2	852.0	866.5	850.9	859.0	858.6
45	804.4	798.6	855.1	869.4	853.9	861.9	861.6
50	807.5	801.8	858.0	872.1	856.7	864.6	864.5
55	810.4	804.9	860.8	874.7	859.4	867.2	867.3
60	813.1	807.7	863.4	877.2	862.0	869.7	869.9
353.15K							
0.1	761.0	752.4	815.0	832.8	815.3	825.2	821.8
1	761.8	753.3	815.7	833.6	816.1	826.0	822.6
5	765.7	757.5	819.2	836.6	819.4	829.1	826.0
10	770.3	762.4	823.4	840.4	823.4	832.8	830.2
15	774.7	767.2	827.5	844.0	827.3	836.5	834.2
20	779.0	771.7	831.4	847.5	831.0	840.0	838.0
25	783.0	776.0	835.1	850.9	834.6	843.4	841.7
30	786.9	780.2	838.7	854.2	838.1	846.7	845.3
35	790.6	784.1	842.2	857.3	841.4	849.9	848.7
40	794.2	787.9	845.5	860.4	844.6	852.9	852.0
45	797.5	791.4	848.7	863.3	847.7	855.8	855.2
50	800.7	794.7	851.7	866.1	850.6	858.7	858.2
55	803.7	797.9	854.6	868.8	853.4	861.3	861.0

60	806.5	800.8	857.3	871.4	856.1	863.9	863.8
			363.15K				
0.1	751.9	742.9	807.2	825.5	807.7	817.9	813.8
1	752.8	743.9	808.0	826.3	808.5	818.7	814.7
5	756.9	748.2	811.6	829.5	812.0	822.0	818.3
10	761.8	753.5	816.0	833.4	816.2	825.9	822.6
15	766.5	758.5	820.2	837.2	820.3	829.7	826.9
20	771.0	763.3	824.3	840.9	824.2	833.4	830.9
25	775.3	767.9	828.2	844.4	828.0	837.0	834.8
30	779.4	772.2	832.0	847.8	831.6	840.4	838.5
35	783.3	776.4	835.6	851.1	835.0	843.7	842.1
40	786.9	780.2	839.1	854.3	838.4	846.9	845.5
45	790.4	783.9	842.3	857.3	841.5	849.9	848.8
50	793.6	787.3	845.5	860.2	844.5	852.8	851.9
55	796.7	790.5	848.5	862.9	847.4	855.5	854.8
60	799.5	793.5	851.3	865.6	850.2	858.2	857.6
			373.15K				
0.1	742.2	--	798.9	817.9	799.8	810.3	805.5
1	743.6	733.9	800.1	819.0	801.0	811.5	806.8
5	747.9	738.6	804.0	822.4	804.7	814.9	810.6
10	753.2	744.2	808.6	826.5	809.1	819.1	815.2
15	758.2	749.5	813.1	830.5	813.4	823.1	819.6
20	762.9	754.7	817.4	834.3	817.5	826.9	823.8
25	767.5	759.5	821.5	838.0	821.4	830.6	827.9
30	771.8	764.1	825.4	841.6	825.2	834.2	831.8
35	775.9	768.5	829.2	845.0	828.8	837.6	835.6
40	779.8	772.6	832.8	848.2	832.2	840.9	839.1
45	783.4	776.5	836.2	851.4	835.5	844.0	842.5
50	786.9	780.1	839.4	854.3	838.6	847.0	845.7
55	790.1	783.5	842.5	857.2	841.6	849.9	848.8
60	793.0	786.6	845.4	859.9	844.4	852.6	851.6
			393.15K				
0.1	--	--	783.0	803.3	784.6	795.7	789.5
1	723.8	712.1	784.2	804.4	785.8	797.0	790.8
5	728.8	717.6	788.5	808.2	789.8	800.7	795.0
10	734.7	724.1	793.6	812.7	794.7	805.3	800.1
15	740.3	730.3	798.6	817.0	799.4	809.6	805.0
20	745.7	736.2	803.3	821.2	803.9	813.8	809.7
25	750.8	741.7	807.8	825.2	808.2	817.9	814.1
30	755.6	746.9	812.1	829.1	812.3	821.7	818.4
35	760.1	751.8	816.2	832.7	816.2	825.4	822.5
40	764.4	756.4	820.0	836.2	819.9	829.0	826.3
45	768.5	760.7	823.7	839.6	823.5	832.3	829.9
50	772.2	764.6	827.2	842.8	826.8	835.5	833.4
55	775.7	768.2	830.4	845.8	829.9	838.5	836.6
60	778.9	771.5	833.4	848.7	832.9	841.4	839.7
			413.15K				
0.1	--	--	767.0	788.7	769.4	781.3	773.5
1	701.8	687.8	768.1	789.7	770.4	782.3	774.6
5	707.6	694.3	772.9	793.8	774.9	786.5	779.3
10	714.5	702.0	778.6	798.8	780.3	791.5	784.9
15	721.1	709.3	784.0	803.5	785.5	796.3	790.3
20	727.3	716.1	789.2	808.1	790.4	800.9	795.5
25	733.1	722.6	794.2	812.4	795.1	805.3	800.4
30	738.6	728.6	798.9	816.6	799.6	809.5	805.1
35	743.8	734.2	803.3	820.6	803.8	813.4	809.5
40	748.5	739.3	807.5	824.4	807.8	817.2	813.6

45	752.9	744.1	811.4	827.9	811.6	820.8	817.5
50	757.0	748.4	815.1	831.3	815.1	824.2	821.2
55	760.7	752.2	818.5	834.5	818.5	827.4	824.6
60	764.0	755.7	821.7	837.5	821.5	830.4	827.8

[a]$U_c(\rho)$=1.7 kg m^{-3} (293.15K ≤ T≤363.15K)and 2.7 kg m^{-3} (373.15K ≤ T≤413.15K).
[a]$U_c(T)$=0.01K.
[a]$U_c(P)$=0.05 .

Table A 15 Teja-Rice, McAllister-3 and McAllister-4 model parameters for viscosity modeling of investigated binary mixtures.

Model	Model parameters		
	ethyl laurate (1) + 1-propanol (2)		
	293.15 K		
Teja-Rice	ψ12= 2.9416		
McAllister-3	υ12= 9.7210	υ21= 1.83933	
McAllister-4	υ1122= 0.95251	υ1112= 13.9471	υ2221= 4.7386
	298.15 K		
Teja-Rice	ψ12= 2.6914		
McAllister-3	υ12= 7.6976	υ21= 1.7980	
McAllister-4	υ1122= 1.0036	υ1112= 1.0614	υ2221= 4.0684
	303.15 K		
Teja-Rice	ψ12= 2.4460		
McAllister-3	υ12= 6.1291	υ21= 1.7483	
McAllister-4	υ1122= 1.0547	υ1112= 8.0595	υ2221= 3.5160
		308.15 K	
Teja-Rice	ψ12= 2.2371		
McAllister-3	υ12= 4.9106	υ21= 1.7519	
McAllister-4	υ1122= 1.0995	υ1112= 6.2393	υ2221= 3.0832
	313.15 K		
Teja-Rice	ψ12= 2.0231		
McAllister-3	υ12= 3.9819	υ21= 1.6646	
McAllister-4	υ1122= 1.1403	υ1112= 4.8875	υ2221= 2.6516
	318.15 K		
Teja-Rice	ψ12= 1.8545		
McAllister-3	υ12= 3.2446	υ21= 1.6314	
McAllister-4	υ1122= 1.17999	υ1112= 3.8426	υ2221= 2.3418
	323.15 K		
Teja-Rice	ψ12= 1.6940		
McAllister-3	υ12= 2.6678	υ21= 1.5957	
McAllister-4	υ1122= 1.3066	υ1112= 2.9992	υ2221=1.9498
	328.15 K		
Teja-Rice	ψ12= 1.5393		
McAllister-3	υ12= 2.2044	υ21= 1.5964	
McAllister-4	υ1122= 1.2915	υ1112= 2.4656	υ2221= 1.7992
	333.15 K		
Teja-Rice	ψ12= 1.3892		
McAllister-3	υ12= 1.7619	υ21= 1.6423	
McAllister-4	υ1122= 1.3458	υ1112= 1.9950	υ2221= 1.5982
	338.15 K		
Teja-Rice	ψ12= 1.2638		
McAllister-3	υ12= 1.5351	υ21= 1.5659	
McAllister-4	υ1122= 1.3875	υ1112= 1.6394	υ2221=1.4350
	343.15 K		
Teja-Rice	ψ12= 1.1449		
McAllister-3	υ12= 1.2871	υ21= 1.5584	
McAllister-4	υ1122= 1.4376	υ1112= 1.3486	υ2221= 1.2881
	ethyl oleate (1) + 1-butanol (2)		

		293.15K	
Teja-Rice	ψ12= 1.2580		
McAllister-3	υ12= 6.1759	υ21= 6.2001	
McAllister-4	υ1122= 6.0435	υ1112= 6.4090	υ2221= 5.1709
		298.15K	
Teja-Rice	ψ12= 1.1889		
McAllister-3	υ12= 5.4887	υ21= 5.4914	
McAllister-4	υ1122= 5.3265	υ1112= 5.7080	υ2221= 4.6031
		303.15K	
Teja-Rice	ψ12= 1.277		
McAllister-3	υ12= 4.8436	υ21= 4.9110	
McAllister-4	υ1122= 4.72247	υ1112= 5.0461	υ2221= 4.1114
308.15K		308.15 K	
Teja-Rice	ψ12= 1.308		
McAllister-3	υ12= 4.3229	υ21= 4.4273	
McAllister-4	υ1122= 4.1745	υ1112= 4.5340	υ2221= 3.7301
		313.15K	
Teja-Rice	ψ12= 1.33709		
McAllister-3	υ12= 3.8387	υ21= 4.0233	
McAllister-4	υ1122= 3.7275	υ1112= 4.0448	υ2221= 3.3848
		318.15K	
Teja-Rice	ψ12= 1.373		
McAllister-3	υ12= 3.5027	υ21= 3.6555	
McAllister-4	υ1122= 3.3630	υ1112= 3.7017	υ2221= 3.0883
		323.15K	
Teja-Rice	ψ12= 1.41		
McAllister-3	υ12= 3.1768	υ21= 3.3513	
McAllister-4	υ1122= 3.036	υ1112= 3.3756	υ2221= 2.8374
		328.15K	
Teja-Rice	ψ12= 1.449		
McAllister-3	υ12= 2.8919	υ21= 3.0926	
McAllister-4	υ1122= 2.7670	υ1112= 3.0855	υ2221= 2.6110
		333.15K	
Teja-Rice	ψ12= 1.491		
McAllister-3	υ12= 2.6256	υ21= 2.8634	
McAllister-4	υ1122= 2.4855	υ1112= 2.8280	υ2221= 2.4313
		338.15K	
Teja-Rice	ψ12= 1.5370		
McAllister-3	υ12= 2.4440	υ21= 2.6516	
McAllister-4	υ1122= 2.2972	υ1112= 2.6376	υ2221=2.2513
		343.15K	
Teja-Rice	ψ12= 1.5806		
McAllister-3	υ12= 2.2611	υ21= 2.4655	
McAllister-4	υ1122= 2.1120	υ1112= 2.4480	υ2221= 2.0990
		ethyl oleate (1) +1-propanol (2)	
		293.15K	
Teja-Rice	ψ12= 2.1110		
McAllister-3	υ12= 5.8454	υ21= 7.7030	
McAllister-4	υ1122= 5.5215	υ1112= 6.653	υ2221= 6.2659
		298.15K	

Teja-Rice	ψ12= 2.064		
McAllister-3	υ12= 5.2071	υ21= 6.7688	
McAllister-4	υ1122= 4.8750	υ1112= 5.9145	υ2221= 5.5520
		303.15K	
Teja-Rice	ψ12= 2.0543		
McAllister-3	υ12= 4.6140	υ21= 6.0250	
McAllister-4	υ1122= 4.3215	υ1112= 5.2475	υ2221= 4.9522
		308.15K	
Teja-Rice	ψ12= 2.061		
McAllister-3	υ12= 4.1104	υ21= 5.4164	
McAllister-4	υ1122= 3.8610	υ1112= 4.6817	υ2221= 4.4537
		313.15K	
Teja-Rice	ψ12= 2.068		
McAllister-3	υ12= 3.6630	υ21= 4.8985	
McAllister-4	υ1122= 3.4264	υ1112= 4.1891	υ2221= 4.0556
		318.15K	
Teja-Rice	ψ12= 2.094		
McAllister-3	υ12= 3.3369	υ21= 4.4433	
McAllister-4	υ1122= 3.1119	υ1112= 3.8194	υ2221= 3.6777
		323.15K	
Teja-Rice	ψ12= 2.119		
McAllister-3	υ12= 3.0336	υ21= 4.0548	
McAllister-4	υ1122= 2.8093	υ1112= 3.4863	υ2221= 3.3736
		328.15K	
Teja-Rice	ψ12= 2.149		
McAllister-3	υ12= 2.7668	υ21= 3.7295	
McAllister-4	υ1122= 2.5530	υ1112= 3.1952	υ2221= 3.1068
		333.15 K	
Teja-Rice	ψ12= 2.179		
McAllister-3	υ12= 2.5127	υ21= 3.4333	
McAllister-4	υ1122= 2.3108	υ1112= 2.9147	υ2221= 2.8753
		338.15K	
Teja-Rice	ψ12= 2.228		
McAllister-3	υ12= 2.3412	υ21= 3.1764	
McAllister-4	υ1122= 2.1315	υ1112= 2.7196	υ2221= 2.6664
		343.15K	
Teja-Rice	ψ12= 2.2785		
McAllister-3	υ12= 2.1633	υ21= 2.9525	
McAllister-4	υ1122= 1.9605	υ1112= 2.5233	υ2221= 2.4806
		ethyl oleate (1) + *n*-hexadecane (2)	
		293.15K	
Teja-Rice	ψ12= 0.9412		
McAllister-3	υ12= 6.3160	υ21= 5.0022	
McAllister-4	υ1122= 5.6685	υ1112= 6.5294	υ2221= 4.8105
		298.15K	
Teja-Rice	ψ12= 0.9426		
McAllister-3	υ12= 5.6371	υ21= 4.4430	
McAllister-4	υ1122= 5.0205	υ1112= 5.8320	υ2221= 4.2950
		303.15K	
Teja-Rice	ψ12= 0.9437		

McAllister-3	υ12= 5.0020	υ21= 3.9780	
McAllister-4	υ1122= 4.4955	υ1112= 5.1600	υ2221= 3.8340
		308.15K	
Teja-Rice	ψ12= 0.9536		
McAllister-3	υ12= 4.4733	υ21= 3.5998	
McAllister-4	υ1122= 4.02947	υ1112= 4.6177	υ2221=3.4743
		313.15K	
Teja-Rice	ψ12= 0.959		
McAllister-3	υ12= 3.9983	υ21= 3.2627	
McAllister-4	υ1122= 3.6090	υ1112= 4.1320	υ2221= 3.1641
		318.15K	
Teja-Rice	ψ12= 0.965		
McAllister-3	υ12= 3.6524	υ21= 2.9797	
McAllister-4	υ1122= 3.3048	υ1112= 3.7708	υ2221= 2.8810
		323.15K	
Teja-Rice	ψ12= 0.9698		
McAllister-3	υ12= 3.3316	υ21= 2.7290	
McAllister-4	υ1122= 3.0255	υ1112= 3.4280	υ2221= 2.6393
		328.15K	
Teja-Rice	ψ12= 0.9739		
McAllister-3	υ12= 3.0440	υ21= 2.5192	
McAllister-4	υ1122= 2.7781	υ1112= 3.1366	υ2221= 2.4305
		333.15 K	
Teja-Rice	ψ12= 0.975		
McAllister-3	υ12= 2.7730	υ21= 2.3213	
McAllister-4	υ1122= 2.5258	υ1112= 2.8656	υ2221= 2.2545
		338.15K	
Teja-Rice	ψ12= 0.9821		
McAllister-3	υ12= 2.5823	υ21= 2.1652	
McAllister-4	υ1122= 2.3631	υ1112= 2.6621	υ2221= 2.0935
Teja-Rice	ψ12= 0.9867		
McAllister-3	υ12= 2.3880	υ21= 2.0212	
McAllister-4	υ1122= 2.2050	υ1112= 2.4555	υ2221= 1.9485
		n-hexadecane (1) + 1-butanol (2)	
		293.15 K	
Teja-Rice	ψ_{12}= 0.7810		
McAllister-3	υ_{12}= 3.6067	υ_{21}= 4.2044	
McAllister-4	υ_{1122}= 3.6911	υ_{1112}= 3.8457	υ_{2221}= 4.0290
		298.15 K	
Teja-Rice	ψ_{12}= 0.7890		
McAllister-3	υ_{12}= 3.2442	υ_{21}= 3.7380	
McAllister-4	υ_{1122}= 3.3333	υ_{1112}= 3.4366	υ_{2221}= 3.5570
		303.15K	
Teja-Rice	ψ_{12}= 0.7859		
McAllister-3	υ_{12}= 2.9261	υ_{21}= 3.3056	
McAllister-4	υ_{1122}= 3.027	υ_{1112}= 3.0695	υ_{2221}= 3.1184
		308.15 K	
Teja-Rice	ψ_{12}= 0.7999		
McAllister-3	υ_{12}= 2.6483	υ_{21}= 2.9619	

McAllister-4	υ_{1122}= 2.7402	υ_{1112}= 2.7683	υ_{2221}= 2.7773
		313.15 K	
Teja-Rice	ψ_{12}= 0.8148		
McAllister-3	υ_{12}= 2.4146	υ_{21}= 2.6740	
McAllister-4	υ_{1122}= 2.5005	υ_{1112}= 2.5133	υ_{2221}= 2.4944
		318.15 K	
Teja-Rice	ψ_{12}= 0.8388		
McAllister-3	υ_{12}= 2.1964	υ_{21}= 2.4210	
McAllister-4	υ_{1122}= 2.2910	υ_{1112}= 2.2783	υ_{2221}= 2.2363
		323.15 K	
Teja-Rice	ψ12= 0.8539		
McAllister-3	υ12= 2.0175	υ21= 2.1995	
McAllister-4	υ1122= 2.1075	υ1112= 2.0787	υ2221= 2.0197
		328.15 K	
Teja-Rice	ψ12= 0.8710		
McAllister-3	υ12= 1.8557	υ21= 2.0138	
McAllister-4	υ1122= 1.9422	υ1112= 1.9138	υ2221= 1.8379
		333.15 K	
Teja-Rice	ψ12= 0.8910		
McAllister-3	υ12= 1.7117	υ21= 1.8503	
McAllister-4	υ1122= 1.7992	υ1112= 1.7619	υ2221= 1.6771
		338.15 K	
Teja-Rice	ψ12= 0.9120		
McAllister-3	υ12= 1.5888	υ21= 1.7075	
McAllister-4	υ1122= 1.6680	υ1112= 1.6325	υ2221= 1.5369
		343.15 K	
Teja-Rice	ψ12= 0.9247		
McAllister-3	υ12= 1.4791	υ21= 1.5803	
McAllister-4	υ1122= 1.5495	υ1112= 1.5163	υ2221= 1.4134
		n-hexadecane (1) + 1-propanol (2)	
		293.15 K	
Teja-Rice	ψ12= 1.3731		
McAllister-3	υ12= 4.8697	υ21= 3.5028	
McAllister-4	υ1122= 3.6704	υ1112= 4.3020	υ2221= 3.8750
		298.15 K	
Teja-Rice	ψ12= 1.3422		
McAllister-3	υ12= 3.1170	υ21= 4.3123	
McAllister-4	υ1122= 3.2859	υ1112= 3.8100	υ2221= 3.4700
		303.15 K	
Teja-Rice	ψ12= 1.3245		
McAllister-3	υ12= 3.8147	υ21= 3.8263	
McAllister-4	υ1122= 2.9284	υ1112= 3.1100	υ2221= 3.3900
		308.15 K	
Teja-Rice	ψ12= 1.3182		
McAllister-3	υ12= 2.5496	υ21= 3.4165	
McAllister-4	υ1122= 2.6571	υ1112= 2.8000	υ2221= 3.0120
		313.15 K	
Teja-Rice	ψ12= 1.3130		
McAllister-3	υ12= 2.2981	υ21= 3.0770	
McAllister-4	υ1122= 2.4186	υ1112= 2.5413	υ2221= 2.7051
		318.15 K	

Teja-Rice	ψ12= 1.3125		
McAllister-3	υ12= 2.1116	υ21= 2.7744	
McAllister-4	υ1122= 2.1932	υ1112= 2.3100	υ2221= 2.4420
	323.15 K		
Teja-Rice	ψ12= 1.3146		
McAllister-3	υ12= 1.9328	υ21= 2.5241	
McAllister-4	υ1122= 2.0053	υ1112= 2.1099	υ2221=2.2145
	328.15 K		
Teja-Rice	ψ12= 1.3194		
McAllister-3	υ12= 1.7772	υ21=2.3069	
McAllister-4	υ1122= 1.8558	υ1112= 1.9154	υ2221= 2.0078
	333.15 K		
Teja-Rice	ψ12= 1.3248		
McAllister-3	υ12= 1.6385	υ21=2.1126	
McAllister-4	υ1122= 1.7116	υ1112= 1.7717	υ2221= 1.8411
	338.15 K		
Teja-Rice	ψ12= 1.3371		
McAllister-3	υ12= 1.5110	υ21= 1.9442	
McAllister-4	υ1122= 1.5761	υ1112= 1.6502	υ2221=1.6856
	343.15 K		
Teja-Rice	ψ12= 1.3389		
McAllister-3	υ12= 1.3957	υ21= 1.7811	
McAllister-4	υ1122= 1.4384	υ1112= 1.5403	υ2221= 1.5553

Table A 16 Derived properties of 1-butanol.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / $kJ \cdot kg^{-1} \cdot K^{-1}$	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / $kJ \cdot kg^{-1} \cdot K^{-1}$	pint / MPa
	293.15 K				298.15 K			
0.1	0.9363	0.9220	0.3288	288.59	0.9684	0.9410	0.3383	289.62
1	0.9269	0.9164	0.3278	288.86	0.9583	0.9351	0.3373	289.94
5	0.8873	0.8929	0.3240	290.01	0.9161	0.9105	0.3334	291.35
10	0.8425	0.8662	0.3197	291.38	0.8684	0.8826	0.3291	293.02
15	0.8022	0.8420	0.3160	292.68	0.8257	0.8575	0.3253	294.63
20	0.7658	0.8200	0.3128	293.90	0.7872	0.8347	0.3220	296.15
25	0.7326	0.7999	0.3100	295.06	0.7522	0.8139	0.3192	297.61
30	0.7023	0.7814	0.3075	296.16	0.7203	0.7948	0.3167	299.00
35	0.6745	0.7644	0.3053	297.20	0.6911	0.7773	0.3146	300.32
40	0.6490	0.7487	0.3034	298.18	0.6643	0.7611	0.3127	301.59
45	0.6253	0.7340	0.3017	299.11	0.6396	0.7461	0.3111	302.79
50	0.6034	0.7204	0.3002	299.98	0.6167	0.7322	0.3097	303.94
55	0.5831	0.7077	0.2990	300.80	0.5955	0.7191	0.3085	305.04
60	0.5641	0.6958	0.2979	301.57	0.5758	0.7070	0.3075	306.08
	303.15 K				308.15 K			
0.1	1.0020	0.9602	0.3478	290.40	1.0373	0.9797	0.3572	290.93
1	0.9912	0.9541	0.3468	290.78	1.0258	0.9732	0.3562	291.37
5	0.9461	0.9283	0.3427	292.44	0.9775	0.9463	0.3520	293.30
10	0.8954	0.8992	0.3383	294.44	0.9235	0.9159	0.3476	295.62
15	0.8501	0.8731	0.3345	296.35	0.8754	0.8888	0.3437	297.86
20	0.8093	0.8494	0.3313	298.19	0.8322	0.8642	0.3405	300.01
25	0.7724	0.8279	0.3284	299.95	0.7933	0.8420	0.3377	302.08
30	0.7388	0.8083	0.3260	301.64	0.7579	0.8217	0.3353	304.08
35	0.7082	0.7902	0.3239	303.26	0.7258	0.8031	0.3332	306.00
40	0.6801	0.7736	0.3221	304.81	0.6963	0.7860	0.3315	307.85
45	0.6543	0.7582	0.3206	306.30	0.6693	0.7702	0.3301	309.64
50	0.6304	0.7439	0.3193	307.74	0.6443	0.7556	0.3289	311.37
55	0.6082	0.7306	0.3182	309.11	0.6213	0.7420	0.3279	313.03
60	0.5877	0.7181	0.3173	310.43	0.5998	0.7293	0.3271	314.64
	313.15K				318.15K			
0.1	1.0744	0.9994	0.3666	291.21	1.1133	1.0195	0.3759	291.25
1	1.0620	0.9927	0.3655	291.71	1.1000	1.0124	0.3748	291.82
5	1.0104	0.9645	0.3613	293.92	1.0447	0.9828	0.3704	294.30
10	0.9528	0.9328	0.3567	296.58	0.9833	0.9498	0.3658	297.31
15	0.9017	0.9045	0.3528	299.15	0.9289	0.9204	0.3619	300.22
20	0.8559	0.8791	0.3496	301.62	0.8805	0.8940	0.3587	303.03
25	0.8148	0.8561	0.3468	304.02	0.8371	0.8702	0.3560	305.75
30	0.7776	0.8352	0.3445	306.33	0.7979	0.8487	0.3537	308.39
35	0.7438	0.8161	0.3425	308.56	0.7624	0.8290	0.3518	310.94
40	0.7130	0.7985	0.3409	310.72	0.7300	0.8109	0.3503	313.42
45	0.6846	0.7823	0.3396	312.81	0.7004	0.7943	0.3491	315.82
50	0.6586	0.7673	0.3385	314.83	0.6732	0.7790	0.3481	318.15
55	0.6345	0.7534	0.3376	316.79	0.6481	0.7648	0.3474	320.41
60	0.6123	0.7404	0.3369	318.69	0.6249	0.7515	0.3468	322.61
	323.15K				328.15K			
0.1	1.1541	1.0398	0.3850	291.04	1.1971	1.0605	0.3941	290.60
1	1.1399	1.0324	0.3839	291.68	1.1817	1.0526	0.3930	291.31
5	1.0806	1.0014	0.3795	294.46	1.1182	1.0202	0.3884	294.39
10	1.0150	0.9669	0.3748	297.83	1.0481	0.9842	0.3837	298.12
15	0.9572	0.9363	0.3709	301.09	0.9866	0.9523	0.3798	301.74
20	0.9059	0.9090	0.3677	304.24	0.9323	0.9240	0.3767	305.26
25	0.8601	0.8844	0.3650	307.30	0.8838	0.8986	0.3741	308.66

30	0.8188	0.8622	0.3629	310.27	0.8403	0.8757	0.3720	311.97
35	0.7815	0.8419	0.3611	313.15	0.8011	0.8549	0.3704	315.19
40	0.7475	0.8234	0.3597	315.95	0.7655	0.8359	0.3691	318.32
45	0.7165	0.8064	0.3586	318.67	0.7331	0.8185	0.3682	321.37
50	0.6881	0.7907	0.3578	321.31	0.7034	0.8024	0.3675	324.34
55	0.6620	0.7762	0.3572	323.89	0.6761	0.7876	0.3670	327.23
60	0.6378	0.7626	0.3568	326.39	0.6510	0.7738	0.3668	330.05
	333.15				343.15			
0.1	1.2422	1.0814	0.4031	289.93	1.3397	1.1243	0.4207	287.89
1	1.2257	1.0732	0.4019	290.70	1.3205	1.1152	0.4195	288.82
5	1.1575	1.0392	0.3973	294.09	1.2416	1.0778	0.4147	292.86
10	1.0826	1.0015	0.3925	298.21	1.1559	1.0368	0.4099	297.78
15	1.0172	0.9685	0.3887	302.20	1.0817	1.0010	0.4062	302.55
20	0.9595	0.9391	0.3856	306.08	1.0168	0.9695	0.4032	307.20
25	0.9083	0.9129	0.3831	309.85	0.9595	0.9415	0.4010	311.71
30	0.8624	0.8893	0.3812	313.51	0.9086	0.9165	0.3994	316.11
35	0.8212	0.8679	0.3797	317.08	0.8631	0.8939	0.3982	320.40
40	0.7839	0.8484	0.3785	320.55	0.8221	0.8734	0.3975	324.59
45	0.7500	0.8305	0.3777	323.93	0.7849	0.8548	0.3971	328.68
50	0.7190	0.8141	0.3772	327.23	0.7511	0.8376	0.3970	332.67
55	0.6906	0.7990	0.3770	330.45	0.7202	0.8219	0.3972	336.58
60	0.6644	0.7849	0.3770	333.60	0.6919	0.8073	0.3976	340.40
	353.15 K				363.15 K			
0.1	1.4476	1.1686	0.4378	284.99	1.5674	1.2144	0.4545	281.26
1	1.4252	1.1586	0.4366	286.07	1.5412	1.2033	0.4532	282.52
5	1.3339	1.1173	0.4317	290.82	1.4349	1.1578	0.4482	288.02
10	1.2355	1.0726	0.4269	296.59	1.3218	1.1091	0.4436	294.71
15	1.1512	1.0340	0.4234	302.20	1.2259	1.0674	0.4403	301.22
20	1.0781	1.0002	0.4207	307.66	1.1434	1.0313	0.4381	307.55
25	1.0140	0.9704	0.4189	312.97	1.0718	0.9997	0.4367	313.73
30	0.9575	0.9439	0.4176	318.16	1.0089	0.9717	0.4360	319.75
35	0.9071	0.9202	0.4169	323.22	0.9533	0.9467	0.4359	325.64
40	0.8620	0.8987	0.4166	328.17	0.9038	0.9243	0.4362	331.40
45	0.8214	0.8792	0.4167	333.00	0.8593	0.9040	0.4369	337.03
50	0.7846	0.8614	0.4171	337.74	0.8192	0.8856	0.4380	342.55
55	0.7510	0.8451	0.4178	342.37	0.7829	0.8687	0.4394	347.96
60	0.7204	0.8300	0.4188	346.90	0.7497	0.8532	0.4410	353.26
	373.15 K				393.15 K			
0.1	1.7013	1.2618	0.4705	276.66	--	--	--	--
1	1.6697	1.2494	0.4692	278.23	1.9695	1.3466	0.5001	267.80
5	1.5457	1.1994	0.4643	284.55	1.7993	1.2860	0.4959	275.99
10	1.4153	1.1463	0.4600	292.24	1.6254	1.2235	0.4929	285.95
15	1.3060	1.1015	0.4572	299.71	1.4832	1.1719	0.4917	295.63
20	1.2130	1.0629	0.4556	306.99	1.3648	1.1285	0.4919	305.07
25	1.1328	1.0294	0.4548	314.09	1.2646	1.0913	0.4932	314.27
30	1.0630	1.0000	0.4548	321.02	1.1787	1.0591	0.4951	323.26
35	1.0016	0.9738	0.4553	327.80	1.1041	1.0308	0.4978	332.06
40	0.9472	0.9505	0.4564	334.43	1.0388	1.0058	0.5009	340.68
45	0.8987	0.9294	0.4578	340.92	0.9811	0.9835	0.5044	349.12
50	0.8550	0.9104	0.4596	347.29	0.9297	0.9634	0.5083	357.41
55	0.8156	0.8930	0.4617	353.53	0.8836	0.9452	0.5125	365.54
60	0.7799	0.8771	0.4641	359.65	0.8421	0.9287	0.5169	373.54
	413.15							
0.1	--	--	--	--				
1	2.3359	1.4509	0.5305	255.61				
5	2.1005	1.3784	0.5281	266.11				
10	1.8677	1.3058	0.5279	278.86				

15	1.6830	1.2475	0.5298	291.26
20	1.5328	1.1995	0.5333	303.33
25	1.4082	1.1592	0.5378	315.11
30	1.3030	1.1248	0.5431	326.63
35	1.2131	1.0949	0.5490	337.91
40	1.1352	1.0688	0.5554	348.97
45	1.0672	1.0457	0.5622	359.81
50	1.0072	1.0250	0.5693	370.46
55	0.9538	1.0064	0.5767	380.92
60	0.9061	0.9895	0.5844	391.22

Table A 17 Derived properties of 1-propanol.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa
	293.15 K				298.15 K			
0.1	0.9741	0.9762	0.3568	293.68	1.0088	0.9972	0.3675	294.63
1	0.9654	0.9702	0.3553	293.61	0.9993	0.9909	0.3659	294.62
5	0.9283	0.9446	0.3490	293.30	0.9597	0.9642	0.3594	294.54
10	0.8860	0.9153	0.3418	292.85	0.9145	0.9336	0.3520	294.36
15	0.8475	0.8885	0.3352	292.32	0.8736	0.9058	0.3453	294.11
20	0.8124	0.8639	0.3293	291.73	0.8364	0.8803	0.3393	293.79
25	0.7803	0.8413	0.3238	291.07	0.8024	0.8569	0.3337	293.40
30	0.7507	0.8203	0.3188	290.36	0.7711	0.8353	0.3287	292.94
35	0.7233	0.8009	0.3142	289.58	0.7424	0.8152	0.3240	292.42
40	0.6980	0.7828	0.3100	288.74	0.7158	0.7966	0.3197	291.83
45	0.6745	0.7659	0.3061	287.85	0.6911	0.7793	0.3158	291.19
50	0.6526	0.7501	0.3025	286.91	0.6681	0.7630	0.3122	290.50
55	0.6322	0.7352	0.2991	285.92	0.6468	0.7478	0.3088	289.75
60	0.6130	0.7212	0.2960	284.88	0.6268	0.7335	0.3057	288.95
	303.15 K				308.15 K			
0.1	1.0450	1.0185	0.3781	295.35	1.0830	1.0401	0.3888	295.84
1	1.0349	1.0119	0.3765	295.39	1.0722	1.0331	0.3871	295.93
5	0.9925	0.9839	0.3698	295.55	1.0267	1.0040	0.3802	296.33
10	0.9443	0.9521	0.3622	295.66	0.9752	0.9708	0.3725	296.75
15	0.9007	0.9232	0.3554	295.70	0.9289	0.9407	0.3655	297.08
20	0.8612	0.8968	0.3492	295.65	0.8869	0.9134	0.3592	297.33
25	0.8252	0.8725	0.3436	295.54	0.8488	0.8883	0.3536	297.50
30	0.7922	0.8503	0.3385	295.35	0.8140	0.8653	0.3484	297.59
35	0.7619	0.8296	0.3338	295.09	0.7820	0.8441	0.3437	297.62
40	0.7340	0.8105	0.3296	294.77	0.7526	0.8245	0.3395	297.57
45	0.7081	0.7927	0.3256	294.39	0.7255	0.8062	0.3355	297.46
50	0.6840	0.7761	0.3220	293.95	0.7003	0.7892	0.3320	297.28
55	0.6617	0.7605	0.3187	293.45	0.6769	0.7733	0.3287	297.05
60	0.6408	0.7459	0.3156	292.90	0.6551	0.7584	0.3256	296.75
	313.15K				318.15K			
0.1	1.1228	1.0620	0.3994	296.09	1.1645	1.0842	0.4100	296.12
1	1.1112	1.0547	0.3977	296.24	1.1520	1.0766	0.4082	296.33
5	1.0624	1.0242	0.3906	296.90	1.0996	1.0447	0.4010	297.26
10	1.0074	0.9896	0.3827	297.64	1.0408	1.0087	0.3929	298.33
15	0.9580	0.9584	0.3756	298.28	0.9883	0.9763	0.3857	299.29
20	0.9135	0.9301	0.3693	298.83	0.9410	0.9469	0.3793	300.16
25	0.8731	0.9042	0.3636	299.30	0.8983	0.9203	0.3736	300.94
30	0.8364	0.8805	0.3584	299.69	0.8594	0.8958	0.3684	301.64
35	0.8027	0.8587	0.3537	300.00	0.8240	0.8734	0.3638	302.25
40	0.7718	0.8386	0.3495	300.24	0.7914	0.8527	0.3596	302.79
45	0.7433	0.8198	0.3456	300.40	0.7615	0.8336	0.3557	303.25
50	0.7169	0.8024	0.3420	300.51	0.7339	0.8158	0.3523	303.64
55	0.6924	0.7862	0.3388	300.54	0.7083	0.7992	0.3491	303.96
60	0.6697	0.7710	0.3358	300.52	0.6845	0.7837	0.3462	304.22
	323.15K				328.15K			
0.1	1.2082	1.1068	0.4205	295.93	1.2541	1.1298	0.4310	295.53
1	1.1948	1.0989	0.4187	296.21	1.2396	1.1214	0.4292	295.88
5	1.1385	1.0655	0.4113	297.42	1.1791	1.0866	0.4216	297.39
10	1.0756	1.0280	0.4031	298.83	1.1118	1.0475	0.4133	299.16
15	1.0196	0.9943	0.3958	300.13	1.0521	1.0125	0.4060	300.82
20	0.9694	0.9640	0.3894	301.34	0.9988	0.9812	0.3995	302.37
25	0.9241	0.9364	0.3837	302.44	0.9508	0.9527	0.3938	303.82

30	0.8831	0.9113	0.3785	303.46	0.9075	0.9269	0.3888	305.17
35	0.8458	0.8883	0.3739	304.39	0.8681	0.9032	0.3842	306.43
40	0.8116	0.8670	0.3698	305.23	0.8322	0.8815	0.3802	307.60
45	0.7802	0.8474	0.3660	306.00	0.7993	0.8615	0.3766	308.68
50	0.7513	0.8292	0.3627	306.69	0.7690	0.8429	0.3733	309.69
55	0.7245	0.8123	0.3596	307.31	0.7410	0.8256	0.3704	310.62
60	0.6997	0.7965	0.3569	307.86	0.7151	0.8095	0.3677	311.48
		333.15				343.15		
0.1	1.3021	1.1531	0.4415	294.93	1.4051	1.2008	0.4624	293.17
1	1.2864	1.1443	0.4396	295.35	1.3869	1.1913	0.4604	293.74
5	1.2215	1.1079	0.4319	297.17	1.3117	1.1515	0.4526	296.23
10	1.1494	1.0672	0.4235	299.32	1.2290	1.1074	0.4441	299.21
15	1.0857	1.0310	0.4162	301.35	1.1565	1.0686	0.4368	302.04
20	1.0291	0.9985	0.4098	303.27	1.0926	1.0340	0.4306	304.75
25	0.9783	0.9692	0.4041	305.08	1.0356	1.0029	0.4251	307.32
30	0.9325	0.9427	0.3991	306.78	0.9846	0.9749	0.4204	309.79
35	0.8910	0.9184	0.3947	308.38	0.9385	0.9494	0.4163	312.14
40	0.8533	0.8962	0.3908	309.89	0.8969	0.9262	0.4128	314.38
45	0.8187	0.8757	0.3873	311.32	0.8589	0.9049	0.4096	316.53
50	0.7870	0.8567	0.3842	312.66	0.8242	0.8852	0.4069	318.58
55	0.7578	0.8392	0.3814	313.91	0.7923	0.8671	0.4046	320.54
60	0.7308	0.8228	0.3789	315.09	0.7629	0.8502	0.4025	322.41
		353.15 K				363.15 K		
0.1	1.5181	1.2502	0.4833	290.74	1.6418	1.3012	0.5042	287.73
1	1.4969	1.2397	0.4813	291.48	1.6170	1.2898	0.5022	288.66
5	1.4097	1.1964	0.4734	294.72	1.5158	1.2428	0.4945	292.74
10	1.3147	1.1488	0.4650	298.61	1.4065	1.1916	0.4865	297.65
15	1.2322	1.1072	0.4580	302.33	1.3127	1.1472	0.4800	302.38
20	1.1599	1.0705	0.4521	305.91	1.2311	1.1083	0.4747	306.94
25	1.0960	1.0377	0.4471	309.35	1.1595	1.0739	0.4704	311.34
30	1.0392	1.0083	0.4428	312.65	1.0962	1.0432	0.4669	315.59
35	0.9882	0.9817	0.4392	315.83	1.0398	1.0156	0.4640	319.70
40	0.9422	0.9575	0.4362	318.90	0.9891	0.9906	0.4617	323.68
45	0.9005	0.9354	0.4336	321.85	0.9434	0.9678	0.4599	327.53
50	0.8625	0.9151	0.4315	324.69	0.9020	0.9470	0.4586	331.26
55	0.8278	0.8964	0.4297	327.43	0.8642	0.9278	0.4576	334.88
60	0.7959	0.8791	0.4282	330.08	0.8296	0.9101	0.4569	338.39
		373.15 K				393.15 K		
0.1	--	--	--	--	--	--	--	--
1	1.7479	1.3416	0.5236	285.42	2.0429	1.4511	0.5691	278.27
5	1.6302	1.2908	0.5163	290.45	1.8840	1.3926	0.5640	285.61
10	1.5046	1.2360	0.5091	296.52	1.7186	1.3311	0.5598	294.51
15	1.3979	1.1889	0.5034	302.38	1.5810	1.2794	0.5574	303.14
20	1.3059	1.1480	0.4991	308.05	1.4648	1.2352	0.5563	311.52
25	1.2258	1.1121	0.4957	313.54	1.3653	1.1969	0.5562	319.67
30	1.1554	1.0802	0.4931	318.86	1.2790	1.1634	0.5570	327.61
35	1.0931	1.0517	0.4913	324.02	1.2035	1.1337	0.5585	335.35
40	1.0374	1.0260	0.4900	329.03	1.1368	1.1072	0.5605	342.91
45	0.9874	1.0026	0.4893	333.90	1.0775	1.0833	0.5630	350.29
50	0.9423	0.9814	0.4889	338.64	1.0243	1.0617	0.5659	357.50
55	0.9013	0.9619	0.4890	343.25	0.9765	1.0421	0.5691	364.57
60	0.8639	0.9440	0.4893	347.75	0.9331	1.0241	0.5727	371.48
		413.15						
0.1	--	--	--	--				
1	2.3796	1.5693	0.6217	271.46				
5	2.1670	1.5047	0.6218	281.88				
10	1.9514	1.4384	0.6241	294.55				

15	1.7765	1.3840	0.6281	306.87
20	1.6317	1.3383	0.6333	318.87
25	1.5097	1.2993	0.6394	330.58
30	1.4055	1.2656	0.6462	342.03
35	1.3154	1.2361	0.6536	353.23
40	1.2367	1.2099	0.6615	364.20
45	1.1674	1.1866	0.6697	374.96
50	1.1058	1.1656	0.6783	385.51
55	1.0506	1.1466	0.6873	395.88
60	1.0010	1.1293	0.6965	406.07

Table A 18 Derived properties of ethyle laurate.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa
	293.15 K				298.15 K			
0.1	0.7977	0.9042	0.3460	332.19	0.8232	0.9099	0.3469	329.47
1	0.7905	0.8998	0.3454	332.66	0.8155	0.9053	0.3463	329.97
5	0.7601	0.8810	0.3433	334.75	0.7832	0.8857	0.3441	332.17
10	0.7254	0.8594	0.3411	337.29	0.7464	0.8633	0.3417	334.84
15	0.6938	0.8396	0.3392	339.77	0.7130	0.8428	0.3397	337.45
20	0.6650	0.8216	0.3377	342.19	0.6826	0.8241	0.3381	339.99
25	0.6385	0.8049	0.3365	344.55	0.6547	0.8070	0.3368	342.47
30	0.6142	0.7895	0.3355	346.85	0.6292	0.7911	0.3358	344.89
35	0.5917	0.7752	0.3348	349.10	0.6056	0.7765	0.3350	347.25
40	0.5708	0.7620	0.3342	351.30	0.5838	0.7628	0.3344	349.56
45	0.5515	0.7496	0.3339	353.45	0.5636	0.7501	0.3340	351.82
50	0.5334	0.7380	0.3337	355.54	0.5448	0.7383	0.3338	354.03
55	0.5166	0.7271	0.3336	357.60	0.5273	0.7271	0.3337	356.18
60	0.5008	0.7169	0.3336	359.60	0.5109	0.7167	0.3337	358.30
	303.15 K				308.15 K			
0.1	0.8497	0.9157	0.3476	326.59	0.8774	0.9215	0.3481	323.54
1	0.8416	0.9109	0.3470	327.11	0.8687	0.9165	0.3475	324.09
5	0.8072	0.8904	0.3446	329.41	0.8322	0.8952	0.3450	326.50
10	0.7681	0.8671	0.3421	332.22	0.7907	0.8710	0.3423	329.43
15	0.7328	0.8460	0.3400	334.95	0.7534	0.8491	0.3401	332.30
20	0.7008	0.8267	0.3383	337.62	0.7195	0.8291	0.3383	335.09
25	0.6715	0.8090	0.3369	340.22	0.6887	0.8109	0.3369	337.81
30	0.6446	0.7926	0.3358	342.76	0.6605	0.7941	0.3357	340.47
35	0.6199	0.7776	0.3350	345.24	0.6346	0.7786	0.3348	343.06
40	0.5971	0.7636	0.3344	347.66	0.6108	0.7643	0.3342	345.60
45	0.5760	0.7506	0.3340	350.03	0.5887	0.7510	0.3337	348.07
50	0.5564	0.7385	0.3337	352.34	0.5683	0.7386	0.3334	350.50
55	0.5381	0.7271	0.3336	354.61	0.5492	0.7270	0.3333	352.87
60	0.5211	0.7165	0.3336	356.82	0.5315	0.7161	0.3333	355.18
	313.15K				318.15K			
0.1	0.9064	0.9274	0.3485	320.33	0.9366	0.9334	0.3487	316.98
1	0.8971	0.9222	0.3479	320.91	0.9267	0.9279	0.3480	317.58
5	0.8582	0.9000	0.3452	323.42	0.8852	0.9048	0.3452	320.21
10	0.8142	0.8749	0.3423	326.50	0.8385	0.8787	0.3422	323.41
15	0.7746	0.8522	0.3400	329.49	0.7966	0.8552	0.3397	326.54
20	0.7389	0.8315	0.3381	332.40	0.7589	0.8339	0.3377	329.58
25	0.7065	0.8127	0.3366	335.25	0.7247	0.8145	0.3362	332.55
30	0.6768	0.7954	0.3354	338.02	0.6936	0.7967	0.3349	335.44
35	0.6497	0.7795	0.3345	340.74	0.6652	0.7804	0.3339	338.27
40	0.6247	0.7649	0.3338	343.38	0.6390	0.7654	0.3332	341.03
45	0.6017	0.7512	0.3333	345.97	0.6150	0.7514	0.3327	343.73
50	0.5804	0.7386	0.3330	348.50	0.5927	0.7385	0.3324	346.37
55	0.5606	0.7267	0.3329	350.98	0.5721	0.7264	0.3323	348.95
60	0.5421	0.7157	0.3329	353.40	0.5529	0.7151	0.3323	351.48
	323.15K				328.15K			
0.1	0.9681	0.9395	0.3487	313.48	1.0011	0.9456	0.3486	309.86
1	0.9576	0.9337	0.3480	314.11	0.9898	0.9396	0.3478	310.51
5	0.9133	0.9097	0.3450	316.85	0.9426	0.9145	0.3446	313.37
10	0.8637	0.8825	0.3418	320.19	0.8898	0.8863	0.3413	316.85
15	0.8194	0.8582	0.3393	323.45	0.8429	0.8611	0.3387	320.24
20	0.7795	0.8361	0.3372	326.62	0.8008	0.8384	0.3365	323.54
25	0.7435	0.8162	0.3356	329.71	0.7629	0.8178	0.3348	326.76

30	0.7108	0.7979	0.3342	332.73	0.7285	0.7990	0.3334	329.90
35	0.6810	0.7812	0.3332	335.68	0.6973	0.7819	0.3324	332.96
40	0.6537	0.7658	0.3325	338.55	0.6687	0.7661	0.3316	335.96
45	0.6285	0.7515	0.3320	341.36	0.6424	0.7515	0.3311	338.88
50	0.6054	0.7383	0.3317	344.11	0.6182	0.7380	0.3308	341.74
55	0.5839	0.7260	0.3315	346.80	0.5959	0.7255	0.3306	344.54
60	0.5639	0.7145	0.3315	349.43	0.5751	0.7138	0.3306	347.28
		333.15				343.15		
0.1	1.0355	0.9518	0.3483	306.11	1.1091	0.9644	0.3472	298.28
1	1.0235	0.9455	0.3474	306.79	1.0953	0.9576	0.3463	299.02
5	0.9731	0.9194	0.3441	309.76	1.0378	0.9292	0.3426	302.24
10	0.9170	0.8901	0.3407	313.39	0.9742	0.8976	0.3389	306.16
15	0.8672	0.8640	0.3379	316.91	0.9183	0.8696	0.3359	309.97
20	0.8227	0.8405	0.3356	320.35	0.8686	0.8446	0.3335	313.68
25	0.7828	0.8193	0.3339	323.70	0.8243	0.8222	0.3316	317.29
30	0.7467	0.8001	0.3325	326.96	0.7844	0.8019	0.3301	320.81
35	0.7139	0.7825	0.3314	330.15	0.7484	0.7835	0.3290	324.25
40	0.6840	0.7663	0.3306	333.26	0.7156	0.7666	0.3282	327.61
45	0.6566	0.7514	0.3301	336.30	0.6857	0.7511	0.3277	330.89
50	0.6313	0.7377	0.3297	339.27	0.6583	0.7368	0.3274	334.09
55	0.6081	0.7249	0.3296	342.18	0.6331	0.7236	0.3273	337.22
60	0.5865	0.7130	0.3296	345.02	0.6098	0.7114	0.3273	340.29
		353.15 K				363.15 K		
0.1	1.1895	0.9774	0.3455	290.08	1.2772	0.9906	0.3433	281.57
1	1.1736	0.9699	0.3445	290.87	1.2589	0.9825	0.3422	282.43
5	1.1078	0.9391	0.3405	294.35	1.1836	0.9490	0.3380	286.19
10	1.0357	0.9050	0.3365	298.59	1.1017	0.9124	0.3337	290.77
15	0.9728	0.8751	0.3333	302.70	1.0308	0.8805	0.3304	295.21
20	0.9173	0.8486	0.3308	306.70	0.9688	0.8524	0.3278	299.53
25	0.8680	0.8249	0.3289	310.60	0.9141	0.8274	0.3258	303.73
30	0.8240	0.8036	0.3274	314.40	0.8654	0.8051	0.3243	307.83
35	0.7844	0.7843	0.3263	318.10	0.8219	0.7850	0.3233	311.82
40	0.7485	0.7667	0.3255	321.71	0.7827	0.7667	0.3226	315.71
45	0.7160	0.7506	0.3250	325.24	0.7473	0.7501	0.3221	319.51
50	0.6862	0.7358	0.3247	328.69	0.7150	0.7348	0.3220	323.23
55	0.6589	0.7222	0.3247	332.07	0.6855	0.7208	0.3220	326.86
60	0.6338	0.7096	0.3248	335.36	0.6584	0.7079	0.3222	330.41
		373.15 K				393.15 K		
0.1	1.3729	1.0042	0.3406	272.85	1.5905	1.0324	0.3341	255.10
1	1.3517	0.9954	0.3395	273.78	1.5622	1.0220	0.3329	256.20
5	1.2653	0.9591	0.3349	277.85	1.4479	0.9798	0.3281	261.03
10	1.1722	0.9198	0.3305	282.81	1.3274	0.9349	0.3236	266.89
15	1.0923	0.8858	0.3271	287.61	1.2261	0.8969	0.3204	272.57
20	1.0230	0.8561	0.3245	292.28	1.1397	0.8641	0.3181	278.09
25	0.9623	0.8299	0.3226	296.82	1.0651	0.8356	0.3165	283.45
30	0.9087	0.8066	0.3212	301.24	1.0000	0.8106	0.3156	288.67
35	0.8609	0.7857	0.3202	305.55	0.9427	0.7883	0.3151	293.75
40	0.8181	0.7668	0.3197	309.76	0.8919	0.7684	0.3150	298.72
45	0.7795	0.7497	0.3194	313.86	0.8465	0.7505	0.3152	303.56
50	0.7446	0.7340	0.3193	317.87	0.8056	0.7342	0.3157	308.30
55	0.7127	0.7197	0.3195	321.79	0.7687	0.7194	0.3164	312.93
60	0.6836	0.7065	0.3199	325.63	0.7351	0.7058	0.3173	317.46
	413.15							
0.1	1.8460	1.0620	0.3269	237.58				
1	1.8079	1.0499	0.3257	238.92				
5	1.6567	1.0015	0.3212	244.76				
10	1.5011	0.9513	0.3173	251.85				

15	1.3731	0.9097	0.3149	258.71
20	1.2659	0.8744	0.3136	265.38
25	1.1749	0.8442	0.3130	271.87
30	1.0965	0.8179	0.3130	278.18
35	1.0284	0.7949	0.3135	284.34
40	0.9685	0.7744	0.3144	290.36
45	0.9154	0.7561	0.3156	296.24
50	0.8681	0.7396	0.3170	301.99
55	0.8257	0.7247	0.3187	307.61
60	0.7873	0.7111	0.3205	313.13

Table A 19 Derived properties of ethyle linoleate.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa
		293.15 K				298.15 K		
0.1	0.6848	0.8329	0.3387	356.44	0.7040	0.8366	0.3395	354.19
1	0.6804	0.8295	0.3379	356.38	0.6994	0.8331	0.3387	354.15
5	0.6616	0.8150	0.3346	356.11	0.6795	0.8181	0.3352	353.93
10	0.6395	0.7979	0.3307	355.73	0.6563	0.8004	0.3312	353.62
15	0.6190	0.7819	0.3271	355.31	0.6347	0.7839	0.3274	353.26
20	0.5998	0.7669	0.3238	354.84	0.6145	0.7685	0.3240	352.86
25	0.5818	0.7528	0.3207	354.34	0.5957	0.7540	0.3207	352.41
30	0.5649	0.7396	0.3178	353.79	0.5780	0.7404	0.3178	351.92
35	0.5490	0.7270	0.3151	353.20	0.5614	0.7275	0.3150	351.39
40	0.5340	0.7152	0.3126	352.58	0.5457	0.7153	0.3124	350.82
45	0.5199	0.7039	0.3103	351.91	0.5310	0.7038	0.3100	350.21
50	0.5065	0.6933	0.3081	351.22	0.5170	0.6929	0.3078	349.56
55	0.4939	0.6831	0.3061	350.49	0.5039	0.6825	0.3057	348.88
60	0.4818	0.6734	0.3042	349.72	0.4914	0.6727	0.3037	348.17
		303.15 K				308.15 K		
0.1	0.7240	0.8404	0.3401	351.79	0.7447	0.8442	0.3407	349.23
1	0.7191	0.8368	0.3393	351.76	0.7395	0.8405	0.3398	349.21
5	0.6981	0.8212	0.3357	351.59	0.7174	0.8243	0.3360	349.10
10	0.6736	0.8030	0.3314	351.35	0.6915	0.8055	0.3316	348.93
15	0.6509	0.7859	0.3276	351.05	0.6676	0.7879	0.3276	348.70
20	0.6297	0.7700	0.3240	350.71	0.6453	0.7715	0.3238	348.42
25	0.6099	0.7551	0.3206	350.32	0.6246	0.7562	0.3204	348.09
30	0.5914	0.7411	0.3176	349.89	0.6052	0.7418	0.3172	347.72
35	0.5740	0.7279	0.3147	349.42	0.5870	0.7283	0.3143	347.30
40	0.5577	0.7154	0.3120	348.90	0.5699	0.7155	0.3115	346.84
45	0.5423	0.7037	0.3096	348.34	0.5539	0.7034	0.3090	346.34
50	0.5278	0.6925	0.3072	347.75	0.5388	0.6920	0.3066	345.79
55	0.5141	0.6819	0.3051	347.12	0.5245	0.6812	0.3044	345.21
60	0.5011	0.6718	0.3031	346.45	0.5110	0.6709	0.3023	344.59
		313.15K				318.15K		
0.1	0.7662	0.8481	0.3410	346.53	0.7884	0.8520	0.3412	343.69
1	0.7607	0.8442	0.3401	346.52	0.7826	0.8479	0.3402	343.69
5	0.7373	0.8275	0.3361	346.47	0.7578	0.8306	0.3362	343.70
10	0.7100	0.8080	0.3316	346.36	0.7291	0.8105	0.3314	343.66
15	0.6848	0.7899	0.3274	346.20	0.7025	0.7918	0.3271	343.57
20	0.6614	0.7730	0.3236	345.98	0.6779	0.7744	0.3231	343.42
25	0.6396	0.7572	0.3200	345.72	0.6551	0.7582	0.3195	343.21
30	0.6193	0.7424	0.3167	345.40	0.6338	0.7430	0.3161	342.96
35	0.6003	0.7285	0.3137	345.04	0.6139	0.7288	0.3129	342.66
40	0.5825	0.7155	0.3108	344.64	0.5953	0.7154	0.3100	342.31
45	0.5658	0.7031	0.3082	344.19	0.5779	0.7028	0.3073	341.92
50	0.5500	0.6915	0.3058	343.70	0.5615	0.6909	0.3048	341.48
55	0.5351	0.6804	0.3035	343.17	0.5460	0.6796	0.3025	341.01
60	0.5211	0.6700	0.3014	342.60	0.5314	0.6689	0.3004	340.49
		323.15K				328.15K		
0.1	0.8115	0.8559	0.3413	340.72	0.8355	0.8599	0.3412	337.63
1	0.8054	0.8517	0.3403	340.74	0.8289	0.8555	0.3402	337.67
5	0.7791	0.8338	0.3360	340.81	0.8012	0.8370	0.3358	337.80
10	0.7488	0.8130	0.3311	340.84	0.7691	0.8154	0.3307	337.90
15	0.7208	0.7937	0.3267	340.81	0.7397	0.7956	0.3261	337.95
20	0.6950	0.7758	0.3226	340.73	0.7125	0.7771	0.3219	337.93
25	0.6710	0.7591	0.3188	340.59	0.6873	0.7600	0.3180	337.86

30	0.6487	0.7435	0.3153	340.40	0.6639	0.7440	0.3144	337.73
35	0.6279	0.7290	0.3121	340.16	0.6422	0.7291	0.3111	337.56
40	0.6085	0.7153	0.3091	339.87	0.6219	0.7151	0.3081	337.33
45	0.5902	0.7024	0.3064	339.54	0.6029	0.7019	0.3052	337.05
50	0.5732	0.6902	0.3038	339.15	0.5851	0.6895	0.3026	336.72
55	0.5571	0.6787	0.3014	338.73	0.5683	0.6778	0.3002	336.35
60	0.5419	0.6679	0.2992	338.26	0.5526	0.6667	0.2979	335.93
	333.15K				343.15K			
0.1	0.8603	0.8639	0.3410	334.43	0.9127	0.8720	0.3402	327.73
1	0.8534	0.8593	0.3399	334.48	0.9049	0.8671	0.3391	327.81
5	0.8240	0.8401	0.3354	334.68	0.8720	0.8465	0.3342	328.14
10	0.7901	0.8179	0.3302	334.86	0.8341	0.8228	0.3287	328.49
15	0.7591	0.7974	0.3254	334.98	0.7996	0.8010	0.3237	328.77
20	0.7305	0.7785	0.3210	335.03	0.7680	0.7810	0.3191	328.97
25	0.7040	0.7609	0.3171	335.03	0.7389	0.7625	0.3149	329.12
30	0.6796	0.7445	0.3134	334.97	0.7120	0.7453	0.3111	329.20
35	0.6568	0.7292	0.3100	334.86	0.6871	0.7293	0.3076	329.22
40	0.6356	0.7149	0.3069	334.69	0.6639	0.7143	0.3043	329.18
45	0.6158	0.7014	0.3040	334.47	0.6424	0.7003	0.3013	329.09
50	0.5972	0.6888	0.3014	334.20	0.6223	0.6872	0.2986	328.95
55	0.5798	0.6768	0.2989	333.89	0.6034	0.6748	0.2961	328.75
60	0.5635	0.6656	0.2966	333.52	0.5857	0.6632	0.2937	328.50
	353.15 K				363.15 K			
0.1	0.9690	0.8802	0.3390	320.69	1.0294	0.8886	0.3374	313.37
1	0.9602	0.8750	0.3378	320.80	1.0195	0.8830	0.3361	313.53
5	0.9232	0.8530	0.3327	321.28	0.9779	0.8595	0.3307	314.18
10	0.8809	0.8277	0.3268	321.81	0.9306	0.8326	0.3246	314.91
15	0.8425	0.8046	0.3215	322.26	0.8879	0.8082	0.3191	315.55
20	0.8075	0.7835	0.3168	322.64	0.8491	0.7859	0.3142	316.12
25	0.7754	0.7640	0.3124	322.94	0.8138	0.7655	0.3097	316.61
30	0.7459	0.7460	0.3084	323.18	0.7814	0.7466	0.3056	317.02
35	0.7187	0.7292	0.3048	323.35	0.7516	0.7292	0.3019	317.36
40	0.6934	0.7137	0.3015	323.46	0.7241	0.7131	0.2985	317.64
45	0.6700	0.6991	0.2984	323.51	0.6986	0.6980	0.2954	317.85
50	0.6482	0.6855	0.2956	323.50	0.6749	0.6840	0.2926	318.00
55	0.6278	0.6728	0.2931	323.44	0.6529	0.6708	0.2900	318.09
60	0.6087	0.6607	0.2907	323.32	0.6324	0.6584	0.2876	318.12
	373.15 K				393.15 K			
0.1	1.0941	0.8971	0.8886	305.86	1.2372	0.9147	0.8971	290.58
1	1.0830	0.8912	0.8830	306.06	1.2230	0.9080	0.8912	290.89
5	1.0361	0.8661	0.8595	306.91	1.1636	0.8796	0.8661	292.22
10	0.9832	0.8376	0.8326	307.87	1.0973	0.8479	0.8376	293.77
15	0.9357	0.8118	0.8082	308.74	1.0386	0.8195	0.8118	295.21
20	0.8928	0.7884	0.7859	309.52	0.9861	0.7940	0.7884	296.55
25	0.8538	0.7670	0.7655	310.22	0.9389	0.7708	0.7670	297.78
30	0.8183	0.7474	0.7466	310.84	0.8962	0.7498	0.7474	298.93
35	0.7857	0.7293	0.7292	311.38	0.8574	0.7305	0.7293	299.98
40	0.7557	0.7126	0.7131	311.85	0.8220	0.7129	0.7126	300.95
45	0.7281	0.6971	0.6980	312.25	0.7895	0.6965	0.6971	301.83
50	0.7025	0.6826	0.6840	312.58	0.7597	0.6814	0.6826	302.64
55	0.6787	0.6691	0.6708	312.85	0.7321	0.6673	0.6691	303.37
60	0.6566	0.6564	0.6584	313.05	0.7066	0.6542	0.6564	304.04
	413.15							
0.1	1.3987	0.9330	0.9147	275.49				
1	1.3805	0.9254	0.9080	275.96				
5	1.3053	0.8940	0.8796	277.96				
10	1.2227	0.8592	0.8479	280.35				

15	1.1503	0.8286	0.8195	282.59
20	1.0864	0.8013	0.7940	284.72
25	1.0295	0.7768	0.7708	286.72
30	0.9786	0.7547	0.7498	288.62
35	0.9327	0.7346	0.7305	290.41
40	0.8911	0.7163	0.7129	292.10
45	0.8533	0.6995	0.6965	293.70
50	0.8187	0.6840	0.6814	295.20
55	0.7869	0.6697	0.6673	296.62
60	0.7576	0.6564	0.6542	297.96

Table A 20 Derived properties of the ethyl myristate.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / $kJ \cdot kg^{-1} \cdot K^{-1}$	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / $kJ \cdot kg^{-1} \cdot K^{-1}$	pint / MPa
	293.15 K				298.15 K			
0.1	0.7417	0.8753	0.3518	345.85	0.7636	0.8799	0.3528	343.46
1	0.7365	0.8715	0.3510	345.88	0.7581	0.8760	0.3519	343.50
5	0.7142	0.8551	0.3474	345.98	0.7345	0.8589	0.3482	343.67
10	0.6882	0.8359	0.3433	346.06	0.7070	0.8390	0.3439	343.82
15	0.6641	0.8180	0.3396	346.08	0.6816	0.8206	0.3400	343.91
20	0.6418	0.8014	0.3362	346.06	0.6581	0.8034	0.3365	343.96
25	0.6209	0.7858	0.3330	345.98	0.6362	0.7873	0.3332	343.96
30	0.6015	0.7712	0.3301	345.87	0.6158	0.7723	0.3302	343.91
35	0.5833	0.7575	0.3274	345.71	0.5968	0.7582	0.3274	343.81
40	0.5662	0.7445	0.3250	345.50	0.5789	0.7449	0.3248	343.67
45	0.5501	0.7323	0.3227	345.26	0.5621	0.7324	0.3224	343.48
50	0.5349	0.7208	0.3206	344.97	0.5463	0.7206	0.3203	343.26
55	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-
	303.15 K				308.15 K			
0.1	0.7864	0.8846	0.3536	340.91	0.8100	0.8893	0.3542	338.20
1	0.7805	0.8804	0.3527	340.96	0.8038	0.8850	0.3532	338.27
5	0.7555	0.8627	0.3488	341.19	0.7773	0.8666	0.3492	338.55
10	0.7265	0.8422	0.3443	341.41	0.7466	0.8453	0.3445	338.86
15	0.6997	0.8231	0.3403	341.58	0.7184	0.8255	0.3403	339.10
20	0.6750	0.8053	0.3365	341.70	0.6923	0.8072	0.3364	339.29
25	0.6520	0.7888	0.3331	341.77	0.6682	0.7902	0.3329	339.42
30	0.6306	0.7733	0.3300	341.78	0.6457	0.7743	0.3297	339.50
35	0.6106	0.7589	0.3271	341.75	0.6248	0.7594	0.3267	339.53
40	0.5919	0.7452	0.3245	341.67	0.6053	0.7455	0.3239	339.51
45	0.5744	0.7324	0.3220	341.54	0.5870	0.7323	0.3214	339.45
50	0.5579	0.7203	0.3198	341.37	0.5698	0.7200	0.3191	339.34
55	0.5424	0.7089	0.3177	341.16	0.5537	0.7083	0.3169	339.18
60	0.5278	0.6980	0.3157	340.91	0.5385	0.6972	0.3150	338.99
	313.15 K				318.15 K			
0.1	0.8346	0.8940	0.3546	335.33	0.8602	0.8988	0.3549	332.33
1	0.8280	0.8895	0.3536	335.42	0.8532	0.8941	0.3539	332.43
5	0.7999	0.8705	0.3494	335.77	0.8234	0.8743	0.3495	332.85
10	0.7675	0.8484	0.3446	336.15	0.7891	0.8515	0.3444	333.31
15	0.7377	0.8280	0.3402	336.47	0.7576	0.8304	0.3399	333.70
20	0.7103	0.8091	0.3362	336.73	0.7287	0.8109	0.3357	334.03
25	0.6849	0.7916	0.3325	336.93	0.7020	0.7928	0.3319	334.30
30	0.6613	0.7752	0.3291	337.08	0.6773	0.7760	0.3285	334.52
35	0.6394	0.7599	0.3261	337.17	0.6544	0.7604	0.3253	334.68
40	0.6190	0.7456	0.3232	337.22	0.6330	0.7457	0.3224	334.79
45	0.5999	0.7322	0.3206	337.21	0.6131	0.7320	0.3197	334.84
50	0.5820	0.7195	0.3183	337.16	0.5944	0.7190	0.3173	334.85
55	0.5652	0.7076	0.3160	337.06	0.5769	0.7068	0.3150	334.81
60	0.5494	0.6963	0.3140	336.92	0.5604	0.6953	0.3129	334.72
	323.15K				328.15 K			
0.1	0.8868	0.9036	0.3551	329.19	0.9144	0.9085	0.3551	325.93
1	0.8793	0.8988	0.3540	329.31	0.9065	0.9035	0.3539	326.06
5	0.8477	0.8782	0.3494	329.79	0.8729	0.8821	0.3491	326.61
10	0.8114	0.8545	0.3442	330.33	0.8345	0.8576	0.3437	327.23
15	0.7782	0.8327	0.3394	330.80	0.7994	0.8351	0.3388	327.78
20	0.7477	0.8127	0.3351	331.21	0.7673	0.8144	0.3344	328.27

25	0.7197	0.7941	0.3312	331.55	0.7378	0.7952	0.3303	328.68
30	0.6938	0.7768	0.3276	331.84	0.7106	0.7775	0.3267	329.04
35	0.6697	0.7607	0.3244	332.06	0.6854	0.7610	0.3233	329.33
40	0.6474	0.7457	0.3214	332.23	0.6621	0.7456	0.3203	329.57
45	0.6266	0.7316	0.3187	332.35	0.6403	0.7313	0.3174	329.75
50	0.6071	0.7184	0.3161	332.42	0.6200	0.7178	0.3149	329.87
55	0.5889	0.7060	0.3138	332.43	0.6010	0.7051	0.3125	329.95
60	0.5717	0.6943	0.3117	332.40	0.5832	0.6931	0.3103	329.97
		333.15 K				343.15 K		
0.1	0.9432	0.9134	0.3549	322.55	1.0041	0.9234	0.3541	315.47
1	0.9347	0.9082	0.3537	322.69	0.9946	0.9178	0.3528	315.65
5	0.8991	0.8861	0.3487	323.32	0.9543	0.8939	0.3475	316.42
10	0.8584	0.8606	0.3431	324.03	0.9086	0.8667	0.3415	317.31
15	0.8213	0.8374	0.3381	324.66	0.8672	0.8419	0.3361	318.12
20	0.7875	0.8160	0.3335	325.22	0.8296	0.8192	0.3313	318.84
25	0.7565	0.7964	0.3293	325.71	0.7953	0.7984	0.3269	319.49
30	0.7279	0.7782	0.3256	326.14	0.7639	0.7793	0.3230	320.07
35	0.7016	0.7613	0.3221	326.50	0.7349	0.7615	0.3194	320.58
40	0.6771	0.7455	0.3190	326.80	0.7082	0.7451	0.3161	321.02
45	0.6544	0.7308	0.3161	327.05	0.6834	0.7298	0.3131	321.40
50	0.6332	0.7170	0.3135	327.24	0.6604	0.7154	0.3104	321.72
55	0.6135	0.7041	0.3111	327.37	0.6390	0.7020	0.3079	321.99
60	0.5950	0.6919	0.3089	327.45	0.6190	0.6894	0.3057	322.19
		353.15 K				363.15 K		
0.1	1.0700	0.9336	0.3528	308.03	1.1412	0.9440	0.3511	300.30
1	1.0592	0.9275	0.3515	308.25	1.1289	0.9375	0.3497	300.56
5	1.0137	0.9018	0.3458	309.19	1.0774	0.9098	0.3436	301.68
10	0.9623	0.8727	0.3394	310.27	1.0195	0.8787	0.3369	302.99
15	0.9160	0.8463	0.3338	311.26	0.9678	0.8506	0.3310	304.19
20	0.8742	0.8223	0.3287	312.17	0.9213	0.8253	0.3257	305.30
25	0.8363	0.8004	0.3241	312.99	0.8793	0.8022	0.3210	306.31
30	0.8016	0.7802	0.3200	313.74	0.8411	0.7811	0.3168	307.24
35	0.7698	0.7617	0.3163	314.41	0.8063	0.7617	0.3130	308.09
40	0.7406	0.7445	0.3129	315.00	0.7743	0.7439	0.3095	308.87
45	0.7136	0.7286	0.3099	315.53	0.7449	0.7273	0.3065	309.56
50	0.6886	0.7137	0.3071	316.00	0.7178	0.7120	0.3036	310.19
55	0.6654	0.6998	0.3046	316.40	0.6927	0.6977	0.3011	310.75
60	0.6438	0.6868	0.3022	316.74	0.6694	0.6843	0.2988	311.24
		373.15 K				393.15 K		
0.1	1.2180	0.9547	0.3491	292.37	1.3896	0.9766	0.3439	276.19
1	1.2040	0.9476	0.3474	292.67	1.3714	0.9684	0.3422	276.62
5	1.1456	0.9179	0.3411	294.00	1.2961	0.9345	0.3354	278.47
10	1.0804	0.8847	0.3341	295.55	1.2134	0.8970	0.3281	280.65
15	1.0225	0.8550	0.3280	297.00	1.1410	0.8640	0.3218	282.70
20	0.9708	0.8282	0.3225	298.33	1.0772	0.8347	0.3163	284.62
25	0.9244	0.8040	0.3177	299.57	1.0205	0.8083	0.3115	286.43
30	0.8823	0.7820	0.3134	300.72	0.9697	0.7846	0.3073	288.12
35	0.8441	0.7619	0.3096	301.78	0.9239	0.7631	0.3036	289.71
40	0.8093	0.7433	0.3061	302.75	0.8825	0.7435	0.3003	291.21
45	0.7773	0.7263	0.3031	303.64	0.8448	0.7254	0.2974	292.60
50	0.7479	0.7104	0.3003	304.46	0.8104	0.7089	0.2949	293.91
55	0.7207	0.6957	0.2978	305.20	0.7787	0.6935	0.2926	295.13
60	0.6956	0.6820	0.2955	305.87	0.7496	0.6793	0.2906	296.27
		413.15 K						
0.1	1.5863	0.9994	0.3382	260.21				
1	1.5626	0.9902	0.3365	260.80				
5	1.4656	0.9521	0.3298	263.39				

10	1.3609	0.9106	0.3226	266.46
15	1.2707	0.8746	0.3166	269.37
20	1.1923	0.8430	0.3116	272.13
25	1.1234	0.8150	0.3073	274.75
30	1.0623	0.7900	0.3036	277.25
35	1.0079	0.7675	0.3004	279.61
40	0.9591	0.7472	0.2977	281.87
45	0.9149	0.7286	0.2954	284.01
50	0.8749	0.7116	0.2934	286.05
55	0.8384	0.6960	0.2917	287.99
60	0.8049	0.6816	0.2902	289.83

Table A 21 Derived properties of the ethyl oleate.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa
	293.15 K				298.15 K			
0.1	0.6983	0.8354	0.3372	350.58	0.7180	0.8392	0.3380	348.38
1	0.6937	0.8319	0.3364	350.57	0.7131	0.8356	0.3372	348.38
5	0.6738	0.8171	0.3332	350.50	0.6921	0.8203	0.3339	348.36
10	0.6505	0.7997	0.3295	350.37	0.6676	0.8023	0.3300	348.30
15	0.6289	0.7834	0.3261	350.19	0.6448	0.7855	0.3264	348.19
20	0.6087	0.7682	0.3229	349.97	0.6236	0.7698	0.3232	348.03
25	0.5899	0.7540	0.3200	349.71	0.6039	0.7551	0.3201	347.83
30	0.5722	0.7405	0.3173	349.40	0.5854	0.7413	0.3173	347.58
35	0.5556	0.7279	0.3149	349.06	0.5680	0.7284	0.3148	347.30
40	0.5400	0.7160	0.3126	348.67	0.5518	0.7161	0.3124	346.97
45	0.5253	0.7046	0.3104	348.25	0.5364	0.7045	0.3102	346.60
50	0.5114	0.6939	0.3085	347.79	0.5219	0.6936	0.3081	346.19
55	0.4983	0.6838	0.3066	347.29	0.5083	0.6832	0.3062	345.75
60	0.4858	0.6741	0.3049	346.77	0.4953	0.6733	0.3044	345.27
	303.15 K				308.15 K			
0.1	0.7385	0.8431	0.3387	346.01	0.7597	0.8470	0.3392	343.48
1	0.7333	0.8394	0.3379	346.02	0.7542	0.8432	0.3384	343.51
5	0.7111	0.8235	0.3344	346.06	0.7307	0.8267	0.3347	343.61
10	0.6852	0.8048	0.3303	346.07	0.7035	0.8074	0.3305	343.68
15	0.6613	0.7875	0.3266	346.02	0.6783	0.7895	0.3266	343.70
20	0.6390	0.7714	0.3232	345.93	0.6549	0.7729	0.3231	343.67
25	0.6183	0.7563	0.3201	345.79	0.6331	0.7573	0.3198	343.60
30	0.5989	0.7421	0.3172	345.60	0.6129	0.7428	0.3168	343.47
35	0.5808	0.7288	0.3145	345.37	0.5939	0.7291	0.3141	343.30
40	0.5638	0.7162	0.3120	345.10	0.5761	0.7162	0.3115	343.08
45	0.5478	0.7044	0.3097	344.79	0.5595	0.7041	0.3092	342.82
50	0.5327	0.6932	0.3076	344.43	0.5438	0.6926	0.3070	342.52
55	0.5185	0.6825	0.3057	344.04	0.5290	0.6818	0.3049	342.18
60	0.5051	0.6724	0.3038	343.61	0.5150	0.6715	0.3031	341.80
	313.15 K				318.15 K			
0.1	0.7817	0.8510	0.3396	340.81	0.8046	0.8550	0.3398	337.99
1	0.7759	0.8470	0.3387	340.85	0.7984	0.8508	0.3389	338.05
5	0.7511	0.8299	0.3349	341.01	0.7722	0.8331	0.3349	338.26
10	0.7223	0.8100	0.3305	341.15	0.7418	0.8125	0.3303	338.48
15	0.6958	0.7915	0.3265	341.24	0.7138	0.7934	0.3262	338.64
20	0.6712	0.7743	0.3228	341.27	0.6880	0.7758	0.3224	338.74
25	0.6484	0.7583	0.3194	341.26	0.6641	0.7593	0.3189	338.78
30	0.6271	0.7434	0.3163	341.19	0.6418	0.7439	0.3157	338.78
35	0.6073	0.7294	0.3135	341.08	0.6211	0.7296	0.3127	338.72
40	0.5888	0.7162	0.3108	340.92	0.6017	0.7161	0.3100	338.62
45	0.5714	0.7038	0.3084	340.71	0.5836	0.7034	0.3075	338.47
50	0.5550	0.6921	0.3062	340.47	0.5665	0.6914	0.3052	338.28
55	0.5396	0.6810	0.3041	340.18	0.5505	0.6801	0.3031	338.04
60	0.5251	0.6705	0.3021	339.85	0.5354	0.6694	0.3011	337.76
	323.15 K				328.15 K			
0.1	0.8283	0.8590	0.3399	335.05	0.8529	0.8631	0.3399	331.98
1	0.8217	0.8547	0.3389	335.12	0.8460	0.8586	0.3388	332.06
5	0.7940	0.8363	0.3348	335.39	0.8166	0.8396	0.3345	332.39
10	0.7619	0.8150	0.3300	335.68	0.7827	0.8175	0.3296	332.76
15	0.7325	0.7954	0.3257	335.90	0.7517	0.7972	0.3251	333.05
20	0.7053	0.7771	0.3218	336.07	0.7231	0.7785	0.3211	333.29
25	0.6802	0.7602	0.3182	336.18	0.6967	0.7611	0.3174	333.46

30	0.6569	0.7444	0.3149	336.24	0.6723	0.7449	0.3140	333.58
35	0.6352	0.7297	0.3119	336.24	0.6496	0.7298	0.3108	333.65
40	0.6149	0.7159	0.3091	336.20	0.6285	0.7156	0.3080	333.66
45	0.5960	0.7029	0.3065	336.10	0.6087	0.7024	0.3053	333.62
50	0.5783	0.6907	0.3041	335.96	0.5903	0.6899	0.3029	333.54
55	0.5616	0.6791	0.3019	335.78	0.5729	0.6781	0.3007	333.40
60	0.5459	0.6682	0.2999	335.55	0.5566	0.6670	0.2986	333.22
		333.15K				343.15K		
0.1	0.8784	0.8672	0.3396	328.79	0.9325	0.8755	0.3389	322.09
1	0.8711	0.8626	0.3386	328.88	0.9242	0.8705	0.3377	322.22
5	0.8400	0.8428	0.3341	329.28	0.8892	0.8493	0.3329	322.75
10	0.8042	0.8200	0.3290	329.72	0.8492	0.8250	0.3275	323.34
15	0.7714	0.7991	0.3244	330.09	0.8129	0.8027	0.3226	323.86
20	0.7414	0.7798	0.3202	330.39	0.7796	0.7822	0.3181	324.31
25	0.7137	0.7619	0.3164	330.63	0.7491	0.7634	0.3141	324.70
30	0.6881	0.7453	0.3129	330.82	0.7210	0.7459	0.3104	325.02
35	0.6644	0.7298	0.3097	330.95	0.6950	0.7297	0.3071	325.27
40	0.6423	0.7153	0.3068	331.02	0.6709	0.7146	0.3040	325.47
45	0.6217	0.7018	0.3041	331.04	0.6485	0.7004	0.3012	325.61
50	0.6025	0.6890	0.3016	331.01	0.6277	0.6872	0.2986	325.70
55	0.5845	0.6771	0.2993	330.93	0.6082	0.6748	0.2963	325.73
60	0.5675	0.6657	0.2972	330.80	0.5899	0.6631	0.2941	325.71
		353.15 K				363.15 K		
0.1	0.9907	0.8840	0.3376	315.02	1.0533	0.8926	0.3359	307.66
1	0.9814	0.8786	0.3364	315.18	1.0428	0.8869	0.3346	307.85
5	0.9420	0.8559	0.3312	315.86	0.9985	0.8625	0.3292	308.69
10	0.8973	0.8299	0.3255	316.63	0.9484	0.8348	0.3231	309.64
15	0.8568	0.8062	0.3203	317.31	0.9033	0.8097	0.3176	310.51
20	0.8199	0.7846	0.3156	317.92	0.8625	0.7868	0.3128	311.30
25	0.7863	0.7647	0.3114	318.46	0.8254	0.7659	0.3084	312.00
30	0.7554	0.7464	0.3076	318.92	0.7915	0.7467	0.3044	312.63
35	0.7270	0.7294	0.3041	319.32	0.7604	0.7290	0.3009	313.19
40	0.7007	0.7136	0.3009	319.65	0.7317	0.7126	0.2976	313.67
45	0.6764	0.6989	0.2980	319.93	0.7053	0.6974	0.2947	314.09
50	0.6538	0.6852	0.2954	320.14	0.6808	0.6832	0.2920	314.45
55	0.6327	0.6724	0.2930	320.29	0.6580	0.6699	0.2895	314.74
60	0.6130	0.6603	0.2907	320.39	0.6368	0.6575	0.2873	314.97
		373.15 K				393.15 K		
0.1	1.1207	0.9014	0.3339	300.06	1.2704	0.9195	0.3289	284.48
1	1.1087	0.8952	0.3324	300.30	1.2551	0.9124	0.3272	284.82
5	1.0588	0.8691	0.3267	301.31	1.1915	0.8828	0.3211	286.28
10	1.0027	0.8396	0.3203	302.48	1.1209	0.8496	0.3144	287.99
15	0.9524	0.8131	0.3147	303.56	1.0586	0.8202	0.3085	289.58
20	0.9072	0.7890	0.3097	304.54	1.0032	0.7937	0.3034	291.07
25	0.8663	0.7671	0.3052	305.44	0.9535	0.7699	0.2988	292.45
30	0.8291	0.7471	0.3012	306.25	0.9088	0.7483	0.2948	293.73
35	0.7951	0.7287	0.2975	306.99	0.8682	0.7286	0.2912	294.92
40	0.7639	0.7117	0.2942	307.65	0.8313	0.7105	0.2880	296.02
45	0.7352	0.6959	0.2913	308.24	0.7976	0.6939	0.2852	297.04
50	0.7086	0.6813	0.2886	308.75	0.7666	0.6785	0.2826	297.98
55	0.6840	0.6676	0.2861	309.20	0.7380	0.6642	0.2803	298.84
60	0.6612	0.6549	0.2839	309.59	0.7116	0.6509	0.2782	299.62
		413.15						
0.1	1.4411	0.9384	0.3231	268.92				
1	1.4214	0.9303	0.3215	269.40				
5	1.3405	0.8970	0.3153	271.48				

10	1.2519	0.8604	0.3087	273.94
15	1.1749	0.8282	0.3029	276.26
20	1.1071	0.7998	0.2980	278.45
25	1.0471	0.7743	0.2938	280.52
30	0.9936	0.7515	0.2901	282.47
35	0.9455	0.7308	0.2869	284.31
40	0.9021	0.7119	0.2840	286.05
45	0.8627	0.6947	0.2816	287.70
50	0.8267	0.6788	0.2794	289.25
55	0.7938	0.6642	0.2775	290.71
60	0.7635	0.6507	0.2759	292.09

Table A 22 Derived properties of methyle laurate.

p / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa	κ_T / GPa^{-1}	αp / 10^{-3} K^{-1}	cp-cv / kJ·kg^{-1}·K^{-1}	pint / MPa
	293.15 K				298.15 K			
0.1	0.7977	0.9042	0.3460	332.19	0.8232	0.9099	0.3469	329.47
1	0.7905	0.8998	0.3454	332.66	0.8155	0.9053	0.3463	329.97
5	0.7601	0.8810	0.3433	334.75	0.7832	0.8857	0.3441	332.17
10	0.7254	0.8594	0.3411	337.29	0.7464	0.8633	0.3417	334.84
15	0.6938	0.8396	0.3392	339.77	0.7130	0.8428	0.3397	337.45
20	0.6650	0.8216	0.3377	342.19	0.6826	0.8241	0.3381	339.99
25	0.6385	0.8049	0.3365	344.55	0.6547	0.8070	0.3368	342.47
30	0.6142	0.7895	0.3355	346.85	0.6292	0.7911	0.3358	344.89
35	0.5917	0.7752	0.3348	349.10	0.6056	0.7765	0.3350	347.25
40	0.5708	0.7620	0.3342	351.30	0.5838	0.7628	0.3344	349.56
45	0.5515	0.7496	0.3339	353.45	0.5636	0.7501	0.3340	351.82
50	0.5334	0.7380	0.3337	355.54	0.5448	0.7383	0.3338	354.03
55	0.5166	0.7271	0.3336	357.60	0.5273	0.7271	0.3337	356.18
60	0.5008	0.7169	0.3336	359.60	0.5109	0.7167	0.3337	358.30
	303.15 K				308.15 K			
0.1	0.8497	0.9157	0.3476	326.59	0.8774	0.9215	0.3481	323.54
1	0.8416	0.9109	0.3470	327.11	0.8687	0.9165	0.3475	324.09
5	0.8072	0.8904	0.3446	329.41	0.8322	0.8952	0.3450	326.50
10	0.7681	0.8671	0.3421	332.22	0.7907	0.8710	0.3423	329.43
15	0.7328	0.8460	0.3400	334.95	0.7534	0.8491	0.3401	332.30
20	0.7008	0.8267	0.3383	337.62	0.7195	0.8291	0.3383	335.09
25	0.6715	0.8090	0.3369	340.22	0.6887	0.8109	0.3369	337.81
30	0.6446	0.7926	0.3358	342.76	0.6605	0.7941	0.3357	340.47
35	0.6199	0.7776	0.3350	345.24	0.6346	0.7786	0.3348	343.06
40	0.5971	0.7636	0.3344	347.66	0.6108	0.7643	0.3342	345.60
45	0.5760	0.7506	0.3340	350.03	0.5887	0.7510	0.3337	348.07
50	0.5564	0.7385	0.3337	352.34	0.5683	0.7386	0.3334	350.50
55	0.5381	0.7271	0.3336	354.61	0.5492	0.7270	0.3333	352.87
60	0.5211	0.7165	0.3336	356.82	0.5315	0.7161	0.3333	355.18
	313.15K				318.15K			
0.1	0.9064	0.9274	0.3485	320.33	0.9366	0.9334	0.3487	316.98
1	0.8971	0.9222	0.3479	320.91	0.9267	0.9279	0.3480	317.58
5	0.8582	0.9000	0.3452	323.42	0.8852	0.9048	0.3452	320.21
10	0.8142	0.8749	0.3423	326.50	0.8385	0.8787	0.3422	323.41
15	0.7746	0.8522	0.3400	329.49	0.7966	0.8552	0.3397	326.54
20	0.7389	0.8315	0.3381	332.40	0.7589	0.8339	0.3377	329.58
25	0.7065	0.8127	0.3366	335.25	0.7247	0.8145	0.3362	332.55
30	0.6768	0.7954	0.3354	338.02	0.6936	0.7967	0.3349	335.44
35	0.6497	0.7795	0.3345	340.74	0.6652	0.7804	0.3339	338.27
40	0.6247	0.7649	0.3338	343.38	0.6390	0.7654	0.3332	341.03
45	0.6017	0.7512	0.3333	345.97	0.6150	0.7514	0.3327	343.73
50	0.5804	0.7386	0.3330	348.50	0.5927	0.7385	0.3324	346.37
55	0.5606	0.7267	0.3329	350.98	0.5721	0.7264	0.3323	348.95
60	0.5421	0.7157	0.3329	353.40	0.5529	0.7151	0.3323	351.48
	323.15K				328.15K			
0.1	0.9681	0.9395	0.3487	313.4830	1.0011	0.9456	0.3483	309.86
1	0.9576	0.9337	0.3480	314.1085	0.9898	0.9396	0.3474	310.51
5	0.9133	0.9097	0.3450	316.8505	0.9426	0.9145	0.3441	313.37
10	0.8637	0.8825	0.3418	320.1939	0.8898	0.8863	0.3407	316.85
15	0.8194	0.8582	0.3393	323.4488	0.8429	0.8611	0.3379	320.24
20	0.7795	0.8361	0.3372	326.6203	0.8008	0.8384	0.3356	323.54
25	0.7435	0.8162	0.3356	329.7126	0.7629	0.8178	0.3339	326.76

30	0.7108	0.7979	0.3342	332.7298	0.7285	0.7990	0.3325	329.90
35	0.6810	0.7812	0.3332	335.6755	0.6973	0.7819	0.3314	332.96
40	0.6537	0.7658	0.3325	338.5527	0.6687	0.7661	0.3306	335.96
45	0.6285	0.7515	0.3320	341.3646	0.6424	0.7515	0.3301	338.88
50	0.6054	0.7383	0.3317	344.1138	0.6182	0.7380	0.3297	341.74
55	0.5839	0.7260	0.3315	346.8028	0.5959	0.7255	0.3296	344.54
60	0.5639	0.7145	0.3315	349.4340	0.5751	0.7138	0.3296	347.28
			333.15K				343.15K	
0.1	1.0355	0.9518	0.3483	306.11	1.1091	0.9644	0.3472	298.28
1	1.0235	0.9455	0.3474	306.79	1.0953	0.9576	0.3463	299.02
5	0.9731	0.9194	0.3441	309.76	1.0378	0.9292	0.3426	302.24
10	0.9170	0.8901	0.3407	313.39	0.9742	0.8976	0.3389	306.16
15	0.8672	0.8640	0.3379	316.91	0.9183	0.8696	0.3359	309.97
20	0.8227	0.8405	0.3356	320.35	0.8686	0.8446	0.3335	313.68
25	0.7828	0.8193	0.3339	323.70	0.8243	0.8222	0.3316	317.29
30	0.7467	0.8001	0.3325	326.96	0.7844	0.8019	0.3301	320.81
35	0.7139	0.7825	0.3314	330.15	0.7484	0.7835	0.3290	324.25
40	0.6840	0.7663	0.3306	333.26	0.7156	0.7666	0.3282	327.61
45	0.6566	0.7514	0.3301	336.30	0.6857	0.7511	0.3277	330.89
50	0.6313	0.7377	0.3297	339.27	0.6583	0.7368	0.3274	334.09
55	0.6081	0.7249	0.3296	342.18	0.6331	0.7236	0.3273	337.22
60	0.5865	0.7130	0.3296	345.02	0.6098	0.7114	0.3273	340.29
			353.15K				363.15K	
0.1	1.1895	0.9774	0.3455	290.08	1.2772	0.9906	0.3433	281.57
1	1.1736	0.9699	0.3445	290.87	1.2589	0.9825	0.3422	282.43
5	1.1078	0.9391	0.3405	294.35	1.1836	0.9490	0.3380	286.19
10	1.0357	0.9050	0.3365	298.59	1.1017	0.9124	0.3337	290.77
15	0.9728	0.8751	0.3333	302.70	1.0308	0.8805	0.3304	295.21
20	0.9173	0.8486	0.3308	306.70	0.9688	0.8524	0.3278	299.53
25	0.8680	0.8249	0.3289	310.60	0.9141	0.8274	0.3258	303.73
30	0.8240	0.8036	0.3274	314.40	0.8654	0.8051	0.3243	307.83
35	0.7844	0.7843	0.3263	318.10	0.8219	0.7850	0.3233	311.82
40	0.7485	0.7667	0.3255	321.71	0.7827	0.7667	0.3226	315.71
45	0.7160	0.7506	0.3250	325.24	0.7473	0.7501	0.3221	319.51
50	0.6862	0.7358	0.3247	328.69	0.7150	0.7348	0.3220	323.23
55	0.6589	0.7222	0.3247	332.07	0.6855	0.7208	0.3220	326.86
60	0.6338	0.7096	0.3248	335.36	0.6584	0.7079	0.3222	330.41
			373.15 K				393.15 K	
0.1	1.3729	1.0042	0.3406	272.85	1.5905	1.0324	0.3341	255.10
1	1.3517	0.9954	0.3395	273.78	1.5622	1.0220	0.3329	256.20
5	1.2653	0.9591	0.3349	277.85	1.4479	0.9798	0.3281	261.03
10	1.1722	0.9198	0.3305	282.81	1.3274	0.9349	0.3236	266.89
15	1.0923	0.8858	0.3271	287.61	1.2261	0.8969	0.3204	272.57
20	1.0230	0.8561	0.3245	292.28	1.1397	0.8641	0.3181	278.09
25	0.9623	0.8299	0.3226	296.82	1.0651	0.8356	0.3165	283.45
30	0.9087	0.8066	0.3212	301.24	1.0000	0.8106	0.3156	288.67
35	0.8609	0.7857	0.3202	305.55	0.9427	0.7883	0.3151	293.75
40	0.8181	0.7668	0.3197	309.76	0.8919	0.7684	0.3150	298.72
45	0.7795	0.7497	0.3194	313.86	0.8465	0.7505	0.3152	303.56
50	0.7446	0.7340	0.3193	317.87	0.8056	0.7342	0.3157	308.30
55	0.7127	0.7197	0.3195	321.79	0.7687	0.7194	0.3164	312.93
60	0.6836	0.7065	0.3199	325.63	0.7351	0.7058	0.3173	317.46
		413.15						
0.1	1.8460	1.0620	0.3269	237.58				
1	1.8079	1.0499	0.3257	238.92				
5	1.6567	1.0015	0.3212	244.76				
10	1.5011	0.9513	0.3173	251.85				

15	1.3731	0.9097	0.3149	258.71
20	1.2659	0.8744	0.3136	265.38
25	1.1749	0.8442	0.3130	271.87
30	1.0965	0.8179	0.3130	278.18
35	1.0284	0.7949	0.3135	284.34
40	0.9685	0.7744	0.3144	290.36
45	0.9154	0.7561	0.3156	296.24
50	0.8681	0.7396	0.3170	301.99
55	0.8257	0.7247	0.3187	307.61
60	0.7873	0.7111	0.3205	313.13

Table A 23 Isobaric and isochoric molar heat capacity at 0.1 MPa for 1-butanol, 1-propanol, ethyl laurate, ethyl linoleate, ethyl myristate, and ethyl oleate and methyl laurate.

T/K	1-butanol	1-propanol	Ethyl laurate	Ethyl linoleate	Ethyl myristate	Ethyl oleate	Methyl laurate
				c_P / J·Mole^{-1}·K^{-1}			
293.15	147.92	146.54	525.33	685.74	582.81	688.39	351.96
298.15	150.85	149.62	533.20	695.94	592.67	699.18	354.15
303.15	153.55	152.48	540.47	705.72	601.84	709.38	356.11
308.15	156.01	155.20	547.15	714.80	610.42	718.78	357.53
313.15	158.26	157.81	553.15	723.15	618.29	727.57	358.36
318.15	160.33	160.37	558.76	730.95	625.77	735.72	358.97
323.15	162.27	162.95	563.71	738.31	632.50	743.01	359.24
328.15	164.11	165.60	568.10	744.98	638.67	749.56	358.86
333.15	165.87	168.46	571.87	750.94	644.14	755.49	358.26
338.15	167.55	171.62	574.54	755.76	648.40	759.75	356.90
343.15	169.23	174.78	577.21	760.58	652.67	764.01	355.54
				c_V / J·Mole^{-1}·K^{-1}			
293.15	123.55	125.10	442.87	581.27	492.60	583.70	277.86
298.15	125.77	127.54	450.48	591.23	502.22	594.23	279.86
303.15	127.78	129.76	457.54	600.80	511.19	604.22	281.67
308.15	129.54	131.84	464.04	609.73	519.61	613.46	282.98
313.15	131.09	133.82	469.91	617.98	527.36	622.13	283.74
318.15	132.47	135.74	475.43	625.72	534.77	630.22	284.31
323.15	133.73	137.69	480.32	633.06	541.46	637.48	284.56
328.15	134.91	139.71	484.70	639.76	547.65	644.06	284.23
333.15	136.00	141.93	488.50	645.79	553.16	650.05	283.69
338.15	137.03	144.47	491.24	650.73	557.52	654.44	282.46
343.15	138.05	147.01	493.98	655.67	561.89	658.83	281.23

9 Biography of the Author

Mohamed (Ahmed) Aissa je rođen 26.09.1980. godine u gradu Q. Alkhyar, Libija. Osnovnu i srednju školu je završio u Al – Khums, Libija.

Studije Hemijskog inženjerstva je završio na AL – Tahadi Univerzitetu u Al - Briga, Libija 2003. godine. Nekoliko godina je radio kao procesni inženjer u Libian Iron and Steel company u Misrata, Libija.

Master studije je završio na Tehnološko – metalurškom fakultetu univerziteta u Beogradu sa prosečnom ocenom 9.63. Master završni rad pod naslovom "Uticaj izbora termodinamičkog modela na simulaciju procesa atmosferske destilacije sirove nafte" je uradio i odbranio pod mentorstvom prof. dr Mirjane Kijevčanin.

U periodu 2012-2013. je radio na Al – Mergeb Univerzitetu u Libiji kao predavač na predmetima Termodinmika, Mehanika fluida i Petrohemijsko inženjerstvo.

Mohamed (Ahmed) Aissa je upisao doktorske studije na Tehnološko – metalurškom fakultetu univerziteta u Beogradu 2013. na katedri za Hemijsko inženjerstvo.U okviru doktorskih studija kandidat je položio 11 ispita predviđenih studijskim programom sa prosečnom ocenom 9,92 i školske 2014/2015. godine odbranio Završni ispit sa ocenom 10.

Mohamed (Ahmed) Aissa je koautor 2 rada objavljena u vodećem međunarodnim časopisima (M21) i 3 saopštenja sa skupa nacionalnog značaja štampana u celosti (M63).

Spisak objavljenih naučnih radova i saopštenja

Rad u vrhunskom međunarodnom časopisu, M21

1. **Mohamed A. Aissa**, Gorica R. Ivaniš, Ivona R. Radović, and Mirjana Lj. Kijevčanin, Experimental Investigation and Modeling of Thermophysical Properties of Pure Methyl and Ethyl Esters at High Pressures, Energy & Fuels, DOI: 10.1021/acs.energyfuels.7b00561; IF(2016)= 3.091; ISSN: 0887-0624.
2. **Mohamed A. Aissa**, Ivona R. Radović, and Mirjana Lj. Kijevčanin, A systematic study on volumetric and transport properties of binary systems 1-propanol + n-hexadecane, 1-butanol + n-hexadecane and 1-propanol + ethyl oleate at different temperatures: Experimental and modeling, Fluid Phase Equilibria; DOI:10.1016/j.fluid.2018.05.028; IF(2016)= 2.473; ISSN: 0378-3812.

Saopštenje sa skupa nacionalnog značaja štampano u celosti, M63

1. **Mohamed A. Aissa** and Gorica Ivaniš , Densities and derived thermodynamic properties of methyl and ethyl laurate at high pressures, Četvrta konferencija mladih hemičara Srbije, 2016, Kratki izvodi radova sa Četvrte konferencije mladih hemičara Srbije, pp. 108-108.

2. **Mohamed A. Aissa**, Gorica Ivaniš, Ivona Radović and Mirjana Kijevčanin, Experimental measurement of volumetric, transport, ultrasonic and refractive index properties of binary mixtures (ethyl oleate + n-hexadecane) at different temperatures and atmospheric pressure, 53. savetovanje Srpskog hemijskog društva, 2016, Zbornik radova sa 53. savetovanja Srpskog hemijskog društva, pp. 39-42.
3. **Mohamed A. Aissa**, Gorica R. Ivaniš, Ivona R. Radović, Mirjana Lj. Kijevčanin, Experimental determination of volumetric, ultrasonic, transport and refractive index properties of the binary mixture (1-propanol + ethyl oleate) at atmospheric pressure, Zbornik radova sa 54. savetovanja Srpskog hemijskog društva, 2017, pp.108-112.

Образац 5.

Изјава о ауторству

Име и презиме аутора **Mohamed Ahmed M. Aissa**

Број индекса **4046/2013**

Изјављујем

да је докторска дисертација под насловом

THERMODYNAMIC CHARACTERIZATION OF MULTICOMPONENT MIXTURES OF ESTERS AND ALCOHOLS AT ATMOSPHERIC AND ELEVATED TEMPERATURES AND PRESSURES

- резултат сопственог истраживачког рада;
- да дисертација у целини ни у деловима није била предложена за стицање друге дипломе према студијским програмима других високошколских установа;
- да су резултати коректно наведени и
- да нисам кршио/ла ауторска права и користио/ла интелектуалну својину других лица.

Потпис аутора

У Београду, 21/10/2019

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Образац 6.

Изјава о истоветности штампане и електронске верзије докторског рада

Име и презиме аутора **Mohamed Ahmed M. Aissa**

Број индекса **4046/2013**

Студијски програм **Хемијско инжењерство**

Наслов рада **THERMODYNAMIC CHARACTERIZATION OF MULTICOMPONENT MIXTURES OF ESTERS AND ALCOHOLS AT ATMOSPHERIC AND ELEVATED TEMPERATURES AND PRESSURES**

Ментор **проф. Др Мирјана Кијевчанин**

Изјављујем да је штампана верзија мог докторског рада истоветна електронској верзији коју сам предао/ла ради похрањена у **Дигиталном репозиторијуму Универзитета у Београду.**

Дозвољавам да се објаве моји лични подаци везани за добијање академског назива доктора наука, као што су име и презиме, година и место рођења и датум одбране рада.

Ови лични подаци могу се објавити на мрежним страницама дигиталне библиотеке, у електронском каталогу и у публикацијама Универзитета у Београду.

Потпис аутора

У Београду, 21/10/2019

Образац 7.

Изјава о коришћењу

Овлашћујем Универзитетску библиотеку „Светозар Марковић“ да у Дигитални репозиторијум Универзитета у Београду унесе моју докторску дисертацију под насловом:

THERMODYNAMIC CHARACTERIZATION OF MULTICOMPONENT MIXTURES OF ESTERS AND ALCOHOLS AT ATMOSPHERIC AND ELEVATED TEMPERATURES AND PRESSURES

која је моје ауторско дело.

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Потпис аутора

У Београду, 21/10/2019

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