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# Theoretical Evaluation of Ultrasonic Velocity in Binary Liquid Mixtures of Alcohols [S] + Benzene

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**ABSTRACT**

Ultrasonic velocities and densities of the binary liquid mixtures of benzene with 1-propanol, 2-propanol, 1-butanol, 2-butanol and 3-butanol at 303.15 to 318.15 K, over the entire composition range were measured. The theoretical values of ultrasonic velocity were evaluated using the Nomoto's Relation (NR), Ideal Mixture Relation (IMR), Free Length Theory (FLT) and Collision Factor Theory (CFT). The validity of these relations and theories were tested by comparing the computed sound velocities with experimental values. Further, the molecular interaction parameter (α) was computed by using the experimental and the theoretical ultrasonic velocity values. The variation of this parameter with composition of the mixtures has been discussed in terms of molecular interaction in these mixtures.

***Keywords*:** alcohols, benzene, sound, mixtures, NR, IMR, FLT, CFT.

## 1. INTRODUCTION

Among the non-spectroscopic methods in the study of molecular interactions, the ultrasonic velocity measurement finds extensive applications owing to its ability of characterising the physico-chemical behavior of liquid systems from speed data. The ultrasonic velocity of liquid is fundamentally related to the binding forces between the atoms or the molecules. According to physical concept of liquid model[1-3], molecules in the liquid state are so loosely packed as to leave some free space in between them. The intermolecular free space and its dependent properties are related to intermolecular interactions and may reveal the some information regarding the interaction, which may be occurring when the liquids are mixed together.

Acoustical and thermodynamic properties are of great significance in studying the physico-chemical behavior and molecular interactions in pure liquid components and their mixtures. Literature survey shows that ultrasonic study of liquid mixture is highly useful in understanding the nature of molecular interactions[4,5] and physico-chemical behavior of the liquid mixtures[6-8] further, these ultrasonic velocities and other related properties of liquid mixtures are valuable in testing the various theories of liquid state.

The theoretical evaluation of sound velocity in liquids and liquid mixtures as a function of composition is of considerable interest. Also a comparison of theoretically obtained sound velocities with those of experimental is found to be useful in knowing the thermodynamics of liquid and liquid mixtures and provides a better means to test the validity of the various empirical relations and theories. In recent years various theories[9-12] have been in use for computing ultrasonic velocity in liquid mixtures and the deviation in theoretical sound velocity from that of the experimental has been attributed mainly to the molecular interactions prevailing in liquid mixtures.

The measurements of ultrasonic velocity in solutions formed by liquid components reveals the degree of deviation from ideality whenever there are interactions among the component molecules. The deviations have been used to gain insight into nature and degree of interactions among the interacting systems. In the case of liquid mixtures the data on composition dependency of ultrasonic velocity help to understand the nature of molecular interactions in terms of some physical parameters. A departure from linearity in the ultrasonic velocity versus composition behavior in liquid mixtures is an indication of the existence of interaction between different species[13]. Various theories which were originally proposed for binary mixtures[14] Ramasamy and Anbananthan[15] carried out the ultrasonic investigations on some binary and ternary liquid mixtures and correlated the experimental findings of ultrasonic velocity with the theoretical relations suggested by Nomoto[16] and Van Deal and Van Geel[17,18] and interpreted the results in terms of molecular interactions.

In the present investigation, the ultrasonic velocity of binary liquid mixtures of benzene with alcohols have been theoretically evaluated by using various theories at 303.15 – 318.15 K and these theoretical values are compared with experimental values. Further, the intermolecular interaction parameter (α) has been discussed in the light of deviations observed by plotting the experimental and the theoretical values of ultrasonic velocity against the mole fraction of alcohols.

## 2. EXPERIMENTAL

Ultrasonic velocity of pure liquids and liquid mixtures were measured at 3MHz with variable path single beam interferometer having gold plated quartz crystal at the bottom and double walled gold plated cell having grooves at inside walls to check the overlapping of stationary waves to produce clarity nodes and internodes. The accuracy of velocity measurements is ± 0.1 $ms^{-1}$. The temperature during the experiment was controlled by circulating water around the liquid cell from the thermostatically controlled adequately stirred water bath (accurately ± 0.1 ºC).

The densities of pure liquids and liquid mixtures were determined from the weight measurements on using the specific gravity bottle immersed in the thermostat at the experimental temperature and the accuracy in the measurements is ± 0.1 $Kgm^{-3}$.

The liquids used in the present work were of AR grade and were purified according to the standard procedure in the literature[19]. The liquid mixtures were prepared by mixing calculated amount of pure liquids.

## 3. THEORETICAL ASPECTS

Nomoto[16] established an empirical formula for ultrasonic velocity in binary liquid mixture

$$U_{NR} = [(X_1R_1 + X_2 R_2)/(X_1V_1 + X_2V_2)]^3 \quad (1)$$

Where $U_{NR}$ = ultrasonic velocity as per Nomoto,

R = Rao constant, is related to molecular weight M and density ρ by,

$$R = (M/\rho)U^{1/3} = V_M U^{1/3} \quad (2)$$

Where $V_M$ = molar volume, obey the additivity, $V_M = X_1V_1 + X_2V_2$

Van Deal and Van Geel[17,18] proposed the following expression for the estimation of sound velocity $u_{IMR}$ in an ideal mixture using the sound velocities in the pure components According to Jacobson's theory[11] of free length, the ultrasonic velocity is given by

$$U_{IMR} = [1/(X_1M_1 + X_2M_2)^{1/2}]\{1/[X_1/M_1U_1^2) + (X_2/M_2U_2^2)]^{1/2}\} \quad (3)$$

According to Jacobson's theory[11] of free length, the ultrasonic velocity is given by

$$U = K/(L_F \rho^{1/2}) = KY/(2V_A \rho^{1/2}) \quad (4)$$

For the Binary liquid mixture Eq. (4) is

$$U = K(X_1Y_1 + X_2Y_2)/2[V_M - (X_1V_{0,1} + X_2V_{0,2})]\rho^{1/2} \quad (5)$$

Y is an adjustable parameter in the evaluation of velocity in liquid mixtures. Y is obtained from velocity in pure liquids using equation Eq.(4):

$$Y = 2V_A U\rho^{1/2} / K \tag{6}$$

Where K is the temperature – dependent Jacobson's constant[11], $V_a$ is the available molar volume, which is the difference between the molar volumes at T(K) and 0(K), is a direct measure of the compactness and the strength of bonding between the molecules of a liquid in mixture. $V_a$ is given by

$$V_a = V_M - V_0 \tag{7}$$

When Y in Eq. (5) is replaced according to Eq. (6) and when the resulting expression is rearranged, one gets

$$U_{(FLT)} = \{[X_1 (V_{M1} - V_{0,1}) U_1 \rho_1^{1/2}] + [X_2 (V_{M2} - V_{0,2}) U_2 \rho_2^{1/2}]\} / [V_M - (X_1 V_{0,1} + X_2 V_{0,2})] \rho^{1/2} \tag{8}$$

Eq. (8) says that according to the free length theory the square root of the inverse of the adiabatic compressibility of liquid mixture ($u\rho^{1/2}$) is the sum of the available volume fraction average of the square root of the inverse of adiabatic compressibilities of the individual components.

Collision Factor Theory (CFT)

According to Schaaffs[12] the sound velocity in pure liquid is given by

$$U = U_\infty SB / V_M \tag{9}$$

where $u_\infty$=1600m/s; s = collision factor and $B/V_M$ = space filling factor, B is the actual volume of molecules per mole.

For binary liquid mixtures this formula was modified by Nutsch – Kuhnekies[20] as:

$$u_{(CFT)} = (u_\infty / V) [(x_1 s_1 + x_2 s_2) (x_1 B_1 + x_2 B_2)] \tag{10}$$

B = b/4, where b is the vander Waals parameter given by

$$B = (M/\rho) [1-(RT/Mu^2)\{(1+Mu^2/3RT)^{1/2} -1\}] \tag{11}$$

s as an adjustable parameter, obtained from velocities in pure components.

$$s = (V / B) (u / u_{\infty}) \quad (12)$$

The degree of intermolecular interaction (molecular association) is given by,

$$\alpha = (u_{exp}^{2} / u_{im}^{2}) - 1 \quad (13)$$

## 4. RESULT AND DISCUSSION

The experimental and computed ultrasonic velocity using NR – Eq. (1), IMR – Eq. (3), FLT – Eq. (8) and CFT – Eq. (10) and also the percentage relative deviation between experimental predicted ultrasonic velocity values for the alcohols + benzene systems at 303.15 K – 318.15 K are given in Table 1. Molecular interaction parameters (α) are also given in Table 1. The variations of experimental and theoretical ultrasonic velocities with the concentration of alcohols are represented in Fig.1.

The predictive abilities of various ultrasonic theories depend upon the strength of the interaction prevailing in a system; these theories generally fail to predict accurately the ultrasonic velocities where strong interactions supposed to exist and the average absolute percentage relative deviation is small in systems where the interactions are less or nil. The theoretically found ultrasonic velocities of liquid mixtures reveal that CFT shows better agreement than the other relations.

Compared to FLT, CFT succeeds in making accurate predictions of ultrasonic velocities, the error range being only 0.04% (benzene + 2-butyl alcohol at 318.15 K) to 0.70% (benzene + 2-propyl alcohol at 318.15K) compared to 1.72% (benzene + 1-butyl alcohol at 303.15K, benzene + 3-butyl alcohol at 318.15 K) to 2.16% (benzene + 1-propyl alcohol at 308.15 and 313.15 K) of the former. Agnihotri and Adgaonkar[21] also arrived at the same conclusion for ethylbenzene + n-alkanol (s) systems. Both the NR and the IMR give satisfactory estimates of ultrasonic velocities for all the mixtures[22]. However, there is a better agreement between the estimated ultrasonic velocity values through the IMR and the experimental results. The average absolute percentage deviation for the IMR varies from 0.06% (benzene + 2-propyl alcohol at 313.15 K) to 0.66% (benzene + 3-butyl alcohol at 313.15 K) to 1.83% (benzene + 2-propyl alcohol).

The CFT consider that the elastic nature of spherical molecules is responsible for the molecular interaction. It is more valid in these mixtures. On the other hand, The FLT assumes that molecules are rigid spheres with no interaction between them and it is not valid in the present cases. Hence the deviation from the experimental ultrasonic velocity values is maximum in the CFT. Though both the IMR and NR fit the data reasonably well, the gives a better fit.

The deviation of the ratio $U_{exp}^{2} / U_{im}^{2}$ from unity (degree of interaction,α) and its variation as a function of mole fraction of alcohols is a direct measure of the nonideality of the system as a consequence of association or other type of interactions.

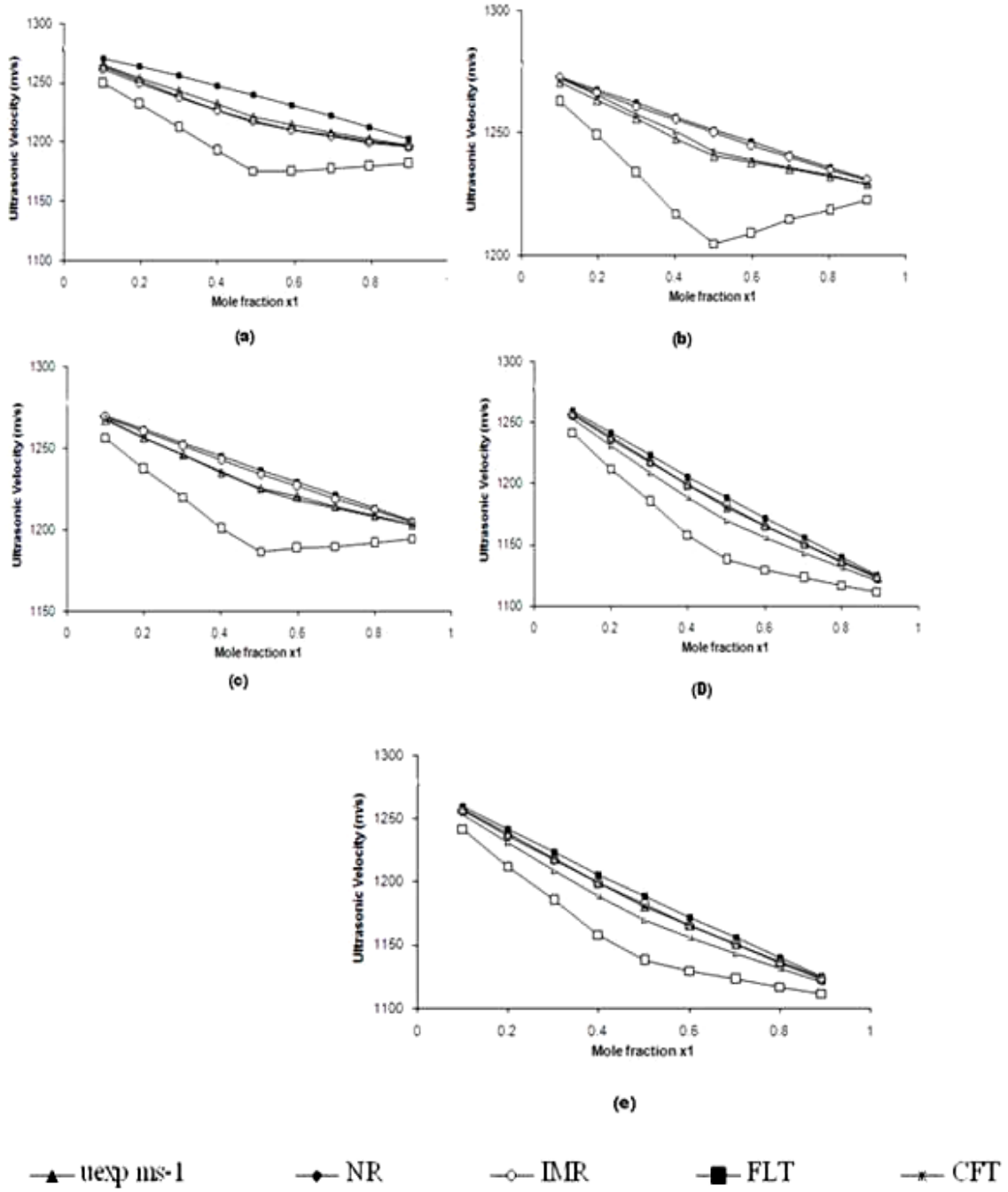


**Fig. 1.** Mole Fraction (x1) Vs Ultrasonic Velocity for the temperature 303.15 K (a) n-Propyl alcohol (1) – Benzene (2) system (b) iso-Propyl alcohol (1) – Benzene (2) system (c) n-Butyl alcohol (1) – Benzene (2) system (d) sec-Butyl alcohol (1) – Benzene (2) system (e) tert-Butyl alcohol (1) – Benzene (2) system

**Table 1.** Experimental and predicted ultrasonic velocities and their percentage derivation and molecular interaction parameter for the n-Propyl alcohol (1) – Benzene (2) system at different temperatures.

| Mole fraction $x_1$ | $U_{exp}$ ms$^{-1}$ | Predicted Ultrasonic Velocity | | | | Absolute Percentage Deviation | | | | αα |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NR | IMR | FLT | CFT | NR | IMR | FLT | CFT | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **303.15 K** | | | | | | | | | | |
| 0.0000 | 1278.2 | | | | | | | | | |
| 0.1051 | 1263.4 | 1270.4 | 1261.7 | 1249.0 | 1264.4 | 0.55 | 0.13 | 1.14 | 0.08 | 0.0026 |
| 0.1980 | 1251.3 | 1263.3 | 1248.9 | 1231.3 | 1254.0 | 0.96 | 0.19 | 1.60 | 0.22 | 0.0038 |
| 0.2998 | 1238.5 | 1255.3 | 1236.7 | 1212.0 | 1242.6 | 1.36 | 0.14 | 2.14 | 0.33 | 0.0029 |
| 0.3990 | 1226.5 | 1247.2 | 1226.3 | 1192.5 | 1231.3 | 1.69 | 0.02 | 2.77 | 0.39 | 0.0003 |
| 0.4944 | 1216.1 | 1239.3 | 1217.8 | 1175.4 | 1220.7 | 1.90 | 0.14 | 3.35 | 0.38 | 0.0027 |
| 0.5939 | 1210.3 | 1230.7 | 1210.2 | 1174.4 | 1214.1 | 1.69 | 0.1 | 2.96 | 0.31 | 0.001 |
| 0.6961 | 1205.2 | 1221.6 | 1203.9 | 1176.8 | 1208.1 | 1.36 | 0.11 | 2.35 | 0.24 | 0.0022 |
| 0.7974 | 1200.2 | 1212.3 | 1198.9 | 1178.7 | 1202.2 | 1.01 | 0.11 | 1.79 | 0.16 | 0.0021 |
| 0.8985 | 1196.6 | 1202.27 | 11.95.2 | 1181.5 | 1196.4 | 0.51 | 0.11 | 1.26 | 0.01 | 0.0023 |
| 1.0000 | 1192.8 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 1.23 | 0.11 | 2.15 | 0.24 | |
| **308.15 K** | | | | | | | | | | |
| 0.0000 | 1253.2 | | | | | | | | | |
| 0.1051 | 1239.1 | 1245.7 | 1237.4 | 1224.6 | 1239.8 | 0.54 | 0.14 | 1.17 | 0.05 | 0.0028 |
| 0.1980 | 1226.8 | 1239.0 | 1225.1 | 1207.2 | 1229.7 | 0.99 | 0.14 | 1.60 | 0.23 | 0.0028 |
| 0.2998 | 1214.8 | 1231.3 | 1213.4 | 1188.7 | 1218.7 | 1.36 | 0.12 | 2.15 | 0.32 | 0.0023 |
| 0.3990 | 1203.2 | 1223.6 | 1203.4 | 1170.2 | 1207.8 | 1.07 | 0.02 | 2.74 | 0.38 | 0.0004 |
| 0.4944 | 1193.4 | 1216.0 | 1195.2 | 1152.2 | 1197.2 | 1.89 | 0.15 | 3.45 | 0.32 | 0.0031 |
| 0.5939 | 1188.1 | 1207.8 | 1188.0 | 1153.1 | 1191.4 | 1.66 | 0.01 | 2.95 | 0.28 | 0.0001 |
| 0.6961 | 1183.1 | 1199.1 | 1182.0 | 1155.6 | 1185.8 | 1.36 | 0.09 | 2.32 | 0.23 | 0.0019 |
| 0.7974 | 1178.3 | 1190.3 | 1177.3 | 1157.0 | 1180.1 | 1.01 | 0.08 | 1.80 | 0.15 | 0.0017 |
| 0.8985 | 1175.2 | 1181.1 | 1173.9 | 1160.5 | 1174.9 | 0.50 | 0.11 | 1.25 | 0.03 | 0.0023 |
| 1.0000 | 1171.6 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 1.22 | 0.10 | 2.16 | 0.22 | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **313.15 K** | | | | | | | | | | |
| **0.0000** | **1227.4** | | | | | | | | | |
| **0.1051** | **1214.4** | **1220.6** | **1212.7** | **1199.6** | **1214.6** | **0.51** | **0.14** | **1.21** | **0.02** | **0.0028** |
| **0.1980** | **1203.1** | **1214.3** | **1201.3** | **1182.9** | **1205.1** | **0.93** | **0.15** | **1.68** | **0.17** | **0.0030** |
| **0.2998** | **1191.2** | **1207.4** | **1190.5** | **1165.4** | **1194.9** | **1.36** | **0.06** | **2.16** | **0.31** | **0.0012** |
| **0.3990** | **1180.4** | **120.3** | **1181.2** | **1148.3** | **1184.8** | **1.68** | **0.07** | **2.72** | **0.37** | **-0.0014** |
| **0.4944** | **1171.6** | **1193.3** | **1173.7** | **1131.8** | **1175.0** | **1.85** | **0.18** | **3.40** | **0.29** | **-0.0036** |
| **0.5939** | **1166.3** | **1185.8** | **1167.1** | **1132.9** | **1169.7** | **1.67** | **0.07** | **2.87** | **0.30** | **-0.0014** |
| **0.6961** | **1161.8** | **1177.8** | **1161.7** | **1135.0** | **1164.7** | **1.38** | **0.01** | **2.30** | **0.25** | **0.0003** |
| **0.7974** | **1158.1** | **1169.7** | **1157.5** | **1137.3** | **1159.7** | **1.00** | **0.06** | **1.80** | **0.14** | **0.0011** |
| **0.8985** | **1155.8** | **1161.3** | **1154.5** | **1141.0** | **1155.1** | **0.48** | **0.12** | **1.28** | **0.06** | **0.0023** |
| **1.0000** | **1152.6** | | | | | | | | | |
| | **Average Absolute Percentage Deviation** | | | | | **1.21** | **0.10** | **2.16** | **0.21** | |
| **318.15 K** | | | | | | | | | | |
| **0.0000** | **1205.6** | | | | | | | | | |
| **0.1051** | **1193.0** | **1199.2** | **1191.7** | **1178.6** | **1193.2** | **0.52** | **0.11** | **1.21** | **0.02** | **0.0023** |
| **0.1980** | **1181.8** | **1193.4** | **1180.8** | **1162.7** | **1184.2** | **0.98** | **0.08** | **1.62** | **0.20** | **0.0016** |
| **0.2998** | **1171.0** | **1186.8** | **1170.5** | **1146.1** | **1174.5** | **1.35** | **0.04** | **2.21** | **0.30** | **0.0008** |
| **0.3990** | **1160.8** | **1180.1** | **1161.8** | **1129.4** | **1164.7** | **1.66** | **0.09** | **2.71** | **0.34** | **-0.0017** |
| **0.4944** | **1152.1** | **1173.5** | **1154.7** | **1113.2** | **1155.3** | **1.86** | **0.23** | **3.38** | **0.28** | **-0.0045** |
| **0.5939** | **1147.5** | **1166.5** | **1148.5** | **1115.1** | **1150.7** | **1.65** | **0.09** | **2.83** | **0.27** | **-0.0018** |
| **0.6961** | **1143.4** | **1159.0** | **1143.4** | **1117.0** | **1145.9** | **1.36** | **0.00** | **2.31** | **0.22** | **0.0000** |
| **0.7974** | **1140.0** | **1151.3** | **1139.5** | **1120.1** | **1141.5** | **0.99** | **0.04** | **1.75** | **0.1** | **0.0008** |
| **0.8985** | **1138.1** | **1143.4** | **1136.8** | **1123.0** | **1137.1** | **0.47** | **0.11** | **1.33** | **0.08** | **0.0023** |
| **1.0000** | **1135.2** | | | | | | | | | |
| | **Average Absolute Percentage Deviation** | | | | | **1.21** | **0.09** | **2.14** | **0.20** | |

**Table 2**. Experimental and predicted ultrasonic velocities and their percentage derivation and molecular interaction parameter for the iso-Propyl alcohol (1) – Benzene (2) system at different temperatures.

| Mole fraction $x_1$ | $U_{exp}$ ms$^{-1}$ | Predicted Ultrasonic Velocity | | | | Absolute Percentage Deviation | | | | αα |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NR | IMR | FLT | CFT | NR | IMR | FLT | CFT | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **303.15 K** | | | | | | | | | | |
| 0.0000 | 1278.2 | | | | | | | | | |
| 0.1005 | 1253.9 | 1265.1 | 1252.8 | 1239.5 | 1258 | 0.89 | 0.09 | 1.15 | 0.32 | 0.0017 |
| 0.1999 | 1232.1 | 1251.8 | 1230.8 | 1214.4 | 1240.9 | 1.6 | 0.1 | 1.44 | 0.71 | 0.002 |
| 0.3015 | 1212.4 | 1237.9 | 1211.2 | 1188.5 | 1223.2 | 2.1 | 0.1 | 1.97 | 0.89 | 0.002 |
| 0.4002 | 1194.8 | 1224.1 | 1194.6 | 1165.2 | 1206.4 | 2.45 | 0.02 | 2.47 | 0.97 | 0.0004 |
| 0.5002 | 1178.3 | 1209.8 | 1179.9 | 1143.2 | 1189.7 | 2.68 | 0.13 | 2.98 | 0.97 | -0.0027 |
| 0.5996 | 1167.4 | 1195.3 | 1167.2 | 1135.8 | 1177.0 | 2.39 | 0.01 | 2.71 | 0.82 | 0.0003 |
| 0.6992 | 1157.3 | 1180.5 | 1156.4 | 1132.5 | 1165.3 | 2.00 | 0.08 | 2.14 | 0.7 | 0.0016 |
| 0.8002 | 1148.1 | 1165 | 1147.1 | 1128.5 | 1153.5 | 1.47 | 0.09 | 1.71 | 0.46 | 0.0017 |
| 0.9012 | 1140.4 | 1149.2 | 1139.4 | 1125 | 1141.6 | 0.77 | 0.08 | 1.35 | 0.11 | 0.0017 |
| 1.0000 | 1133.4 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 1.82 | 0.08 | 1.99 | 0.66 | |
| **308.15 K** | | | | | | | | | | |
| 0.0000 | 1253.2 | | | | | | | | | |
| 0.1005 | 1229.4 | 1240.2 | 1228.1 | 1215.9 | 1233.3 | 0.88 | 0.10 | 1.1 | 0.32 | 0.0021 |
| 0.1999 | 1207.5 | 1227.1 | 1206.4 | 1191.1 | 1216.4 | 1.63 | 0.09 | 1.36 | 0.74 | 0.0018 |
| 0.3015 | 1188.5 | 1213.4 | 1187.1 | 1166.6 | 1199.2 | 2.1 | 0.12 | 1.84 | 0.90 | 0.0024 |
| 0.4002 | 1171.1 | 1199.8 | 1170.6 | 1144.7 | 1182.8 | 2.45 | 0.04 | 2.26 | 1.00 | 0.0008 |
| 0.5002 | 1155.2 | 1185.7 | 1156.1 | 1122.3 | 1166.1 | 2.66 | 0.10 | 2.83 | 0.96 | -0.0019 |
| 0.5996 | 1144.2 | 1171.4 | 1143.7 | 1115.1 | 1153.6 | 2.38 | 0.05 | 2.55 | 0.82 | 0.0010 |
| 0.6992 | 1134.1 | 1156.7 | 1132.9 | 1113.8 | 1142.8 | 1.99 | 0.10 | 1.79 | 0.76 | 0.0020 |
| 0.8002 | 1124.4 | 1141.4 | 1123.8 | 1109.9 | 1131 | 1.52 | 0.06 | 1.29 | 0.59 | 0.0011 |
| 0.9012 | 1117.3 | 1125.8 | 1116.2 | 1106.3 | 1119.5 | 0.76 | 0.10 | 0.98 | 0.19 | 0.0020 |
| 1.0000 | 1110.2 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 1.82 | 0.08 | 1.78 | 0.70 | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **313.15 K** | | | | | | | | | | |
| **0.0000** | **1227.4** | | | | | | | | | |
| **0.1005** | **1204.8** | **1215** | **1203.5** | **1190.8** | **1208.1** | **0.85** | **0.11** | **1.16** | **0.27** | **0.0022** |
| **0.1999** | **1183.5** | **1202.6** | **1182.8** | **1166.2** | **1191.6** | **1.61** | **0.06** | **1.46** | **0.69** | **0.0012** |
| **0.3015** | **1165.2** | **1189.5** | **1164.3** | **1142** | **1174.9** | **2.09** | **0.08** | **1.99** | **0.84** | **0.0016** |
| **0.4002** | **1148.9** | **1176.5** | **1148.6** | **1120.8** | **1159.2** | **2.4** | **0.03** | **2.45** | **0.89** | **0.0005** |
| **0.5002** | **1133.8** | **1163.1** | **1134.8** | **1098.1** | **1142.8** | **2.58** | **0.08** | **3.14** | **0.79** | **-0.0017** |
| **0.5996** | **1123.4** | **1149.4** | **112.9** | **1091.1** | **1130.8** | **2.32** | **0.05** | **2.88** | **0.66** | **0.0010** |
| **0.6992** | **1113.2** | **1135.4** | **1112.7** | **1090.2** | **1120.7** | **2.00** | **0.05** | **2.07** | **0.67** | **0.0010** |
| **0.8002** | **1104.4** | **1120.9** | **1103.9** | **1086.2** | **1109.5** | **1.49** | **0.04** | **1.65** | **0.46** | **0.0008** |
| **0.9012** | **1098.0** | **1106** | **1096.7** | **1082.7** | **1098.4** | **0.73** | **0.11** | **1.4** | **0.04** | **0.0023** |
| **1.0000** | **1091.1** | | | | | | | | | |
| | **Average Absolute Percentage Deviation** | | | | | **1.79** | **0.07** | **2.02** | **0.59** | |
| **318.15 K** | | | | | | | | | | |
| **0.0000** | **1205.6** | | | | | | | | | |
| **0.1005** | **1182.9** | **1193.3** | **1181.7** | **1169.1** | **1186.1** | **88** | **0.10** | **1.16** | **0.27** | **0.0021** |
| **0.1999** | **1161.8** | **1180.8** | **1161** | **1144.8** | **1169.7** | **1.63** | **0.07** | **1.46** | **0.68** | **0.0014** |
| **0.3015** | **1143.4** | **1167.7** | **1142.5** | **1121.4** | **1153.1** | **12.2** | **0.08** | **1.93** | **0.85** | **0.0016** |
| **0.4002** | **1126.6** | **1154.7** | **1126.8** | **1100.3** | **1137.4** | **2.49** | **0.02** | **2.34** | **0.95** | **-0.0004** |
| **0.5002** | **1112.1** | **1141.2** | **1113** | **1076.9** | **1120.7** | **2.62** | **0.08** | **3.16** | **0.77** | **-0.0016** |
| **0.5996** | **1101.3** | **1127.5** | **1101.1** | **1070.4** | **1108.9** | **2.38** | **0.02** | **2.80** | **0.69** | **0.0004** |
| **0.6992** | **1091.0** | **1113.5** | **1090.9** | **1069.4** | **1098.8** | **2.06** | **0.01** | **1.98** | **0.72** | **0.0003** |
| **0.8002** | **1082.5** | **1099** | **1082.1** | **1065.4** | **1087.7** | **1.52** | **0.04** | **1.58** | **0.48** | **0.0007** |
| **0.9012** | **1076.2** | **1084.1** | **1074.9** | **1061.3** | **1076.6** | **0.73** | **0.12** | **1.39** | **0.04** | **0.0024** |
| **1.0000** | **1069.2** | | | | | | | | | |
| | **Average Absolute Percentage Deviation** | | | | | **1.83** | **0.06** | **1.98** | **0.61** | |

**Table 3.** Experimental and predicted ultrasonic velocities and their percentage derivation and molecular interaction parameter for the n-Butyl alcohol (1) – Benzene (2) system at different temperatures.

| Mole fraction $x_1$ | $U_{exp}$ $ms^{-1}$ | Predicted Ultrasonic Velocity | | | | Absolute Percentage Deviation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NR | IMR | FLT | CFT | NR | IMR | FLT | CFT | αα |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **303.15 K** | | | | | | | | | | |
| 0.0000 | 1278.2 | | | | | | | | | |
| 0.0998 | 1272.3 | 1272.8 | 1272.2 | 1262.6 | 1270.5 | 0.04 | 0.00 | 0.77 | 0.14 | 0.0001 |
| 0.1983 | 1265.1 | 1267.5 | 1266.5 | 1248.8 | 1263.3 | 0.19 | 0.11 | 1.29 | 0.14 | -0.0023 |
| 0.3002 | 1257.3 | 1262.0 | 1260.8 | 1233.5 | 1255.6 | 0.38 | 0.28 | 1.89 | 0.14 | -0.0056 |
| 0.4021 | 1250.3 | 1256.6 | 1255.2 | 1216.9 | 1247.5 | 0.51 | 0.40 | 2.67 | 0.22 | -0.0079 |
| 0.5026 | 1242.3 | 1251.3 | 1249.9 | 1204.6 | 1240.5 | 0.73 | 0.61 | 3.04 | 0.14 | -0.0122 |
| 0.6003 | 1238.8 | 1246.2 | 1244.9 | 1208.7 | 1237.7 | 0.60 | 0.49 | 2.43 | 0.09 | -0.0098 |
| 0.6993 | 1235.5 | 1241.1 | 1240.0 | 1214.7 | 1235.2 | 0.45 | 0.36 | 1.69 | 0.03 | -0.0072 |
| 0.8042 | 1232.4 | 1235.7 | 1234.9 | 1218.1 | 1231.8 | 0.27 | 0.20 | 1.16 | 0.05 | -0.0040 |
| 0.9015 | 1229.1 | 1230.8 | 1230.3 | 1222.7 | 1229.1 | 0.14 | 0.10 | 0.52 | 0.00 | -0.0020 |
| 1.0000 | 1225.8 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 0.37 | 0.28 | 1.72 | 0.11 | |
| **308.15 K** | | | | | | | | | | |
| 0.0000 | 1253.2 | | | | | | | | | |
| 0.0998 | 1247.4 | 1247.9 | 1247.4 | 1237.4 | 1245.6 | 0.04 | 0.00 | 0.08 | 0.15 | 0.0000 |
| 0.1983 | 1240.6 | 1242.8 | 1241.9 | 1224.1 | 1238.5 | 0.18 | 0.10 | 1.33 | 0.17 | -0.0021 |
| 0.3002 | 1232.5 | 1237.5 | 1236.3 | 1209.3 | 1231.0 | 0.40 | 0.31 | 1.88 | 0.13 | -0.0062 |
| 0.4021 | 1225.2 | 1232.2 | 1230.9 | 1193.2 | 1223.0 | 0.57 | 0.47 | 2.16 | 0.18 | -0.0093 |
| 0.5026 | 1217.9 | 1227.1 | 1225.7 | 1181.2 | 1216.2 | 0.76 | 0.64 | 3.01 | 0.14 | -0.0128 |
| 0.6003 | 1215.3 | 1222.1 | 1220.9 | 1185.7 | 1213.6 | 0.56 | 0.46 | 2.44 | 0.14 | -0.0091 |
| 0.6993 | 1212.1 | 1217.2 | 1216.1 | 1191.2 | 1211.2 | 0.42 | 0.33 | 1.72 | 0.08 | -0.0065 |
| 0.8042 | 1209.1 | 1211.9 | 1211.1 | 1194.5 | 1208.0 | 0.23 | 0.17 | 1.21 | 0.09 | -0.0033 |
| 0.9015 | 1205.6 | 1207.1 | 1206.7 | 1198.8 | 1205.3 | 0.13 | 0.09 | 0.56 | 0.03 | -0.0018 |
| 1.0000 | 1202.3 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 0.37 | 0.28 | 1.73 | 0.12 | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 313.15 K | | | | | |
| 0.0000 | 1227.4 | | | | | | | | | |
| 0.0998 | 1222.2 | 1222.6 | 1222.2 | 1211.8 | 1220.1 | 0.04 | 0.00 | 0.85 | 0.17 | 0.0000 |
| 0.1983 | 1216.0 | 1218.0 | 1217.2 | 1199.6 | 1213.7 | 0.16 | 0.10 | 1.35 | 0.19 | -0.0020 |
| 0.3002 | 1208.7 | 1213.2 | 1212.2 | 1185.5 | 1206.6 | 0.37 | 0.29 | 1.92 | 0.17 | -0.0058 |
| 0.4021 | 1201.4 | 1208.5 | 1207.3 | 1170.0 | 1199.2 | 0.59 | 0.49 | 2.61 | 0.18 | -0.0098 |
| 0.5026 | 1194.9 | 1203.8 | 1202.7 | 1159.1 | 1192.9 | 0.75 | 0.65 | 3.00 | 0.17 | -0.0129 |
| 0.6003 | 1192.6 | 1199.4 | 1198.3 | 1163.3 | 1190.7 | 0.57 | 0.47 | 2.46 | 0.16 | -0.0094 |
| 0.6993 | 1190.2 | 1194.9 | 1193.9 | 1169.2 | 1188.8 | 0.39 | 0.31 | 1.77 | 0.12 | -0.0062 |
| 0.8042 | 1187.6 | 1190.2 | 1189.5 | 1172.4 | 1186.0 | 0.22 | 0.16 | 1.28 | 0.13 | -0.0031 |
| 0.9015 | 1184.4 | 1185.9 | 1185.4 | 1177.0 | 1183.8 | 0.12 | 0.09 | 0.62 | 0.05 | -0.0018 |
| 1.0000 | 1181.5 | | | | | | | | | |
| | Average Absolute Percentage Deviation | | | | | 0.36 | 0.28 | 1.76 | 0.15 | |
| | | | | | 318.15 K | | | | | |
| 0.0000 | 1205.6 | | | | | | | | | |
| 0.0998 | 1200.2 | 1201.0 | 1200.5 | 1189.5 | 1198.2 | 0.07 | 0.02 | 0.89 | 0.17 | -0.0005 |
| 0.1983 | 1193.5 | 1196.4 | 1195.6 | 1177.8 | 1191.9 | 0.24 | 0.17 | 1.31 | 0.14 | -0.0035 |
| 0.3002 | 1186.6 | 1191.7 | 1190.7 | 1164.3 | 1185.0 | 0.43 | 0.34 | 1.88 | 0.14 | -0.0068 |
| 0.4021 | 1179.1 | 1187.0 | 1185.9 | 1149.4 | 1177.7 | 0.67 | 0.57 | 2.52 | 0.12 | -0.0114 |
| 0.5026 | 1173.1 | 1182.5 | 1181.3 | 1138.3 | 1171.4 | 0.80 | 0.70 | 2.97 | 0.15 | -0.0138 |
| 0.6003 | 1171.5 | 1178.1 | 1177.0 | 1142.8 | 1169.4 | 0.56 | 0.47 | 2.45 | 0.18 | -0.0093 |
| 0.6993 | 1169.0 | 1173.7 | 1172.7 | 1148.4 | 167.5 | 0.40 | 0.32 | 1.76 | 0.13 | -0.0063 |
| 0.8042 | 1166.1 | 1169.0 | 1168.3 | 1151.4 | 1164.8 | 0.25 | 0.19 | 1.26 | 0.11 | -0.0038 |
| 0.9015 | 1163.3 | 1164.8 | 1164.4 | 1155.7 | 1162.6 | 0.13 | 0.09 | 0.65 | 0.06 | -0.0019 |
| 1.0000 | 1160.5 | | | | | | | | | |
| | Average Absolute Percentage Deviation | | | | | 0.39 | 0.32 | 1.74 | 0.13 | |

**Table 4.** Experimental and predicted ultrasonic velocities and their percentage derivation and molecular interaction parameter for the sec-Butyl alcohol (1) – Benzene (2) alcohol system at different temperatures.

| Mole fraction $x_1$ | $U_{exp}$ $ms^{-1}$ | Predicted Ultrasonic Velocity | | | | Absolute Percentage Deviation | | | | αα |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NR | IMR | FLT | CFT | NR | IMR | FLT | CFT | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **303.15 K** | | | | | | | | | | |
| 0.0000 | 1278.2 | | | | | | | | | |
| 0.1013 | 1267.6 | 1269.6 | 1268.7 | 1256.3 | 1266.9 | 0.16 | 0.09 | 0.89 | 0.05 | -0.0017 |
| 0.2018 | 1256.2 | 1261.2 | 1259.6 | 1236.9 | 1256.2 | 0.40 | 0.27 | 1.54 | 0.00 | -0.0054 |
| 0.3029 | 1245.5 | 1252.9 | 1250.8 | 1219.6 | 1245.8 | 1.59 | 0.42 | 2.08 | 0.03 | -0.0084 |
| 0.4024 | 1235.1 | 1244.7 | 1242.4 | 1200.2 | 1234.9 | 0.78 | 0.59 | 2.82 | 0.01 | -0.0117 |
| 0.5045 | 1223.9 | 1236.5 | 1234.1 | 1186.5 | 1225.2 | 1.03 | 0.83 | 3.06 | 0.11 | -0.0165 |
| 0.5998 | 1218.1 | 1228.8 | 1226.6 | 1188.4 | 1219.9 | 0.88 | 0.70 | 2.44 | 0.15 | -0.0138 |
| 0.7001 | 1212.8 | 1220.9 | 1219.0 | 1189.5 | 1214.1 | 0.67 | 0.51 | 1.92 | 0.10 | -0.0101 |
| 0.8011 | 1207.9 | 1213.0 | 1211.5 | 1191.4 | 1208.3 | 0.42 | 0.30 | 1.37 | 0.04 | -0.0060 |
| 0.8981 | 1202.8 | 1205.4 | 1204.6 | 1194.3 | 1203.1 | 0.22 | 0.15 | 0.71 | 0.02 | -0.0030 |
| 1.0000 | 1197.6 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 0.57 | 0.43 | 1.87 | 0.06 | |
| **308.15 K** | | | | | | | | | | |
| 0.0000 | 1253.2 | | | | | | | | | |
| 0.1013 | 1243.3 | 1245.1 | 1244.3 | 1231.4 | 1242.3 | 0.15 | 0.08 | 0.96 | 0.08 | -0.0015 |
| 0.2018 | 1232.5 | 1237.2 | 1235.7 | 1213.2 | 1232.1 | 0.38 | 0.26 | 1.56 | 0.03 | -0.0052 |
| 0.3029 | 1221.5 | 1229.3 | 1227.4 | 1196.0 | 1222.0 | 0.64 | 0.48 | 2.09 | 0.04 | -0.0095 |
| 0.4024 | 1211.9 | 1221.6 | 1219.5 | 1177.9 | 1211.7 | 0.80 | 0.62 | 2.81 | 0.02 | -0.0124 |
| 0.5045 | 1201.7 | 1213.8 | 1211.6 | 1164.6 | 1202.4 | 1.01 | 0.83 | 3.09 | 0.06 | -0.0163 |
| 0.5998 | 1196.1 | 1206.6 | 1204.5 | 1166.5 | 1197.5 | 0.88 | 0.70 | 2.48 | 0.11 | -0.0139 |
| 0.7001 | 1191.3 | 1199.1 | 1197.3 | 1168.1 | 1192.1 | 0.66 | 0.50 | 1.95 | 0.07 | -0.0100 |
| 0.8011 | 1186.5 | 1191.6 | 1190.3 | 1169.9 | 1186.8 | 0.43 | 0.32 | 1.40 | 0.03 | -0.0063 |
| 0.8981 | 1181.5 | 1184.5 | 1183.7 | 1173.3 | 1182.1 | 0.22 | 0.16 | 0.72 | 0.01 | -0.0031 |
| 1.0000 | 1177.1 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 0.58 | 0.44 | 1.89 | 0.05 | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 313.15 K | | | | | |
| 0.0000 | 1227.4 | | | | | | | | | |
| 0.1013 | 1218.6 | 1220.2 | 12194 | 1206.2 | 1217.1 | 0.13 | 0.07 | 1.20 | 0.12 | -0.0013 |
| 0.2018 | 1208.8 | 1213.1 | 1211.8 | 1188.9 | 1207.7 | 0.35 | 0.25 | 1.64 | 0.09 | -0.0049 |
| 0.3029 | 1198.2 | 1206.0 | 1204.3 | 1173.2 | 1198.5 | 0.65 | 0.51 | 2.09 | 0.03 | -0.0101 |
| 0.4024 | 1189.2 | 1199.1 | 1197.2 | 1156.5 | 1189.1 | 0.83 | 0.67 | 2.75 | 0.01 | -0.0134 |
| 0.5045 | 1180.0 | 1192.1 | 1190.2 | 1144.5 | 1180.7 | 1.02 | 0.86 | 3.01 | 0.06 | -0.0170 |
| 0.5998 | 1175.5 | 1185.6 | 1183.8 | 1146.4 | 1176.4 | 0.86 | 0.71 | 2.47 | 0.07 | -0.0140 |
| 0.7001 | 1171.1 | 1178.9 | 1171.3 | 1148.2 | 1171.7 | 0.66 | 0.53 | 1.96 | 0.05 | -0.1050 |
| 0.8011 | 1167.0 | 1172.1 | 1171.0 | 1150.7 | 1167.2 | 0.44 | 0.34 | 1.40 | 0.02 | -0.0068 |
| 0.8981 | 1163.3 | 1165.8 | 1165.1 | 1154.7 | 1163.2 | 0.21 | 0.15 | 0.75 | 0.01 | -0.0031 |
| 1.0000 | 1159.1 | | | | | | | | | |
| | Average Absolute Percentage Deviation | | | | | 0.57 | 0.45 | 1.90 | 0.05 | |
| | | | | | 318.15 K | | | | | |
| 0.0000 | 1205.6 | | | | | | | | | |
| 0.1013 | 1196.8 | 1198.6 | 1197.8 | 1184.4 | 1195.3 | 0.15 | 0.09 | 1.04 | 0.12 | -0.0017 |
| 0.2018 | 1186.9 | 1191.7 | 1190.4 | 1168.1 | 1186.2 | 0.40 | 0.25 | 1.58 | 0.05 | -0.0058 |
| 0.3029 | 1176.8 | 1184.8 | 1183.1 | 1152.7 | 1177.2 | 0.68 | 0.54 | 2.05 | 0.04 | -0.0107 |
| 0.4024 | 1168.0 | 1178.1 | 1176.2 | 1136.4 | 1168.0 | 0.86 | 0.70 | 2.71 | 0.00 | -0.0139 |
| 0.5045 | 1159.1 | 1171.2 | 1169.4 | 1124.5 | 1159.7 | 1.05 | 0.89 | 2.98 | 0.05 | -0.0175 |
| 0.5998 | 1154.7 | 1164.9 | 1163.2 | 1126.6 | 1155.6 | 0.89 | 0.73 | 2.43 | 0.08 | -0.0145 |
| 0.7001 | 1150.8 | 1158.4 | 1156.8 | 1128.5 | 1151.2 | 0.66 | 0.53 | 1.93 | 0.03 | -0.0104 |
| 0.8011 | 1146.8 | 1151.8 | 1150.7 | 1130.6 | 1146.8 | 0.44 | 0.34 | 1.41 | 0.00 | -0.0067 |
| 0.8981 | 1143.1 | 1145.6 | 1144.9 | 1134.7 | 1143.0 | 0.22 | 0.16 | 0.74 | 0.01 | -0.0032 |
| 1.0000 | 1139.1 | | | | | | | | | |
| | Average Absolute Percentage Deviation | | | | | 0.59 | 0.47 | 1.87 | 0.04 | |

**Table 5.** Experimental and predicted ultrasonic velocities and their percentage derivation and molecular interaction parameter for the tert-Butyl alcohol (1) – Benzene (2) system at different temperatures.

| Mole fraction $x_1$ | $U_{exp}$ ms$^{-1}$ | Predicted Ultrasonic Velocity | | | | Absolute Percentage Deviation | | | | αα |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NR | IMR | FLT | CFT | NR | IMR | FLT | CFT | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **303.15 K** | | | | | | | | | | |
| 0.0000 | 1278.2 | | | | | | | | | |
| 0.1012 | 1253.1 | 1259.5 | 1256.3 | 1241.5 | 1257.1 | 0.50 | 0.26 | 0.93 | 0.32 | -0.0051 |
| 0.1998 | 1230.2 | 1241.4 | 1236.3 | 1212.1 | 1237.6 | 0.91 | 0.50 | 1.47 | 0.60 | -0.0098 |
| 0.3024 | 1208.3 | 1223.1 | 1216.7 | 1184.9 | 1218.0 | 1.22 | 0.69 | 1.94 | 0.80 | -0.0137 |
| 0.4014 | 1188.2 | 1205.8 | 1198.8 | 1158.1 | 1198.6 | 1.48 | 0.89 | 2.53 | 0.88 | -0.0176 |
| 0.5017 | 1169.1 | 1188.7 | 1181.7 | 1137.2 | 1180.4 | 1.68 | 1.08 | 2.73 | 0.97 | -0.0212 |
| 0.6029 | 1155.3 | 1171.8 | 1165.4 | 1129.5 | 1165.5 | 1.43 | 0.87 | 2.23 | 0.89 | -0.0172 |
| 0.7048 | 1142.4 | 1155.2 | 1149.8 | 1122.4 | 1150.6 | 1.12 | 0.64 | 1.75 | 0.72 | -0.0128 |
| 0.8024 | 1130.9 | 1139.5 | 1135.6 | 1116.9 | 1136.6 | 0.76 | 0.41 | 1.24 | 0.51 | -0.0082 |
| 0.8942 | 1120.6 | 1125.1 | 1122.9 | 1111.5 | 1123.3 | 0.41 | 0.20 | 0.81 | 0.25 | -0.0040 |
| 1.0000 | 1108.9 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 1.06 | 0.62 | 1.74 | 0.66 | |
| **308.15 K** | | | | | | | | | | |
| 0.0000 | 1253.2 | | | | | | | | | |
| 0.1012 | 1228.5 | 1234.7 | 1231.7 | 1216.4 | 1232.2 | 0.50 | 0.26 | 0.99 | 0.30 | -0.0052 |
| 0.1998 | 1206.1 | 1217.0 | 1212.0 | 1187.8 | 1213.1 | 0.90 | 0.49 | 1.51 | 0.58 | -0.0097 |
| 0.3024 | 1183.9 | 1199.0 | 1192.7 | 1161.4 | 1193.8 | 1.28 | 0.74 | 1.90 | 0.83 | -0.0146 |
| 0.4014 | 1164.2 | 1182.0 | 1175.1 | 1135.5 | 1174.8 | 1.53 | 0.94 | 2.47 | 0.91 | -0.0185 |
| 0.5017 | 1146.1 | 1165.2 | 1158.3 | 1114.7 | 1156.7 | 1.67 | 1.06 | 2.74 | 0.93 | -0.0209 |
| 0.6029 | 1132.8 | 1148.6 | 1142.2 | 1107.0 | 1142.2 | 1.39 | 0.83 | 2.27 | 0.83 | -0.0164 |
| 0.7048 | 1119.4 | 1132.2 | 1126.9 | 1100.5 | 1127.7 | 1.14 | 0.67 | 1.69 | 0.74 | -0.0132 |
| 0.8024 | 1108.2 | 1116.8 | 1112.9 | 1094.6 | 1113.9 | 0.78 | 0.43 | 1.23 | 0.51 | -0.0085 |
| 0.8942 | 1098.2 | 1102.7 | 1100.4 | 1088.8 | 1100.7 | 0.41 | 0.20 | 0.85 | 0.23 | -0.0040 |
| 1.0000 | 1086.7 | | | | | | | | | |
| **Average Absolute Percentage Deviation** | | | | | | 1.07 | 0.62 | 1.74 | 0.65 | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **313.15 K** | | | | | | | | | | |
| **0.0000** | **1227.4** | | | | | | | | | |
| **0.1012** | **1203.7** | **1209.4** | **1206.6** | **1190.7** | **1206.7** | **0.47** | **0.24** | **1.08** | **0.25** | **-0.0047** |
| **0.1998** | **1182.0** | **1192.2** | **1187.5** | **1163.1** | **1188.1** | **0.87** | **0.46** | **1.60** | **0.52** | **-0.0092** |
| **0.3024** | **1160.2** | **1174.8** | **1168.8** | **1138.1** | **1169.5** | **1.26** | **0.74** | **1.90** | **0.80** | **-0.0146** |
| **0.4014** | **1140.9** | **1158.3** | **1151.7** | **1113.0** | **1151.0** | **1.53** | **0.95** | **2.45** | **0.89** | **-0.0187** |
| **0.5017** | **1123.5** | **1142.0** | **1135.4** | **1092.8** | **1133.5** | **1.64** | **1.06** | **2.73** | **0.89** | **-0.0209** |
| **0.6029** | **1110.0** | **1125.9** | **1119.8** | **1085.3** | **1119.4** | **1.43** | **0.88** | **2.23** | **0.84** | **-0.0174** |
| **0.7048** | **1097.5** | **1110.0** | **1104.9** | **1078.8** | **1105.4** | **1.14** | **0.68** | **1.70** | **0.72** | **-0.0134** |
| **0.8024** | **1086.5** | **1095.1** | **1091.4** | **1073.0** | **1091.9** | **0.79** | **0.45** | **1.25** | **0.50** | **-0.0089** |
| **0.8942** | **1077.1** | **1081.4** | **1079.2** | **1067.7** | **1079.3** | **0.40** | **0.20** | **0.88** | **0.20** | **-0.0040** |
| **1.0000** | **1065.9** | | | | | | | | | |
| | **Average Absolute Percentage Deviation** | | | | | **1.06** | **0.63** | **1.76** | **0.62** | |
| **318.15 K** | | | | | | | | | | |
| **0.0000** | **1205.6** | | | | | | | | | |
| **0.1012** | **1182.0** | **1187.9** | **1185.0** | **1169.2** | **1184.9** | **0.49** | **0.25** | **1.08** | **0.25** | **-0.0050** |
| **0.1998** | **1160.0** | **1170.9** | **1166.1** | **1142.1** | **1166.6** | **0.90** | **0.49** | **1.58** | **0.53** | **-0.0097** |
| **0.3024** | **1138.9** | **1153.6** | **1147.6** | **1117.5** | **1148.2** | **1.29** | **0.76** | **1.88** | **0.82** | **-0.0150** |
| **0.4014** | **1119.3** | **1137.3** | **1130.7** | **1092.8** | **1129.3** | **1.60** | **1.02** | **2.37** | **0.95** | **-0.0201** |
| **0.5017** | **1102.3** | **1121.1** | **1114.6** | **1073.3** | **1112.7** | **1.71** | **1.11** | **2.63** | **0.94** | **-0.0219** |
| **0.6029** | **1089.1** | **1105.2** | **1099.2** | **1065.6** | **1098.7** | **1.47** | **0.92** | **2.16** | **0.88** | **-0.0182** |
| **0.7048** | **1077.0** | **1089.5** | **1084.4** | **1058.9** | **1084.8** | **1.16** | **0.69** | **1.68** | **0.73** | **-0.0137** |
| **0.8024** | **1066.1** | **1074.8** | **1071.1** | **1052.7** | **1071.5** | **0.81** | **0.47** | **1.25** | **0.51** | **-0.0093** |
| **0.8942** | **1056.8** | **1061.2** | **1059.1** | **1047.6** | **1059.1** | **0.42** | **0.21** | **0.87** | **0.22** | **-0.0043** |
| **1.0000** | **1045.9** | | | | | | | | | |
| | **Average Absolute Percentage Deviation** | | | | | **1.09** | **0.66** | **1.72** | **0.65** | |

While molecular interaction parameter values are positive as well as negative in the benzene + propanol [s] systems, they are only negative in the benzene + butanol [s] systems at all temperatures. This indicates the presence of somewhat stronger interaction in the propanol [s] systems compared to butanol [s] systems.

## 5. CONCLUSION

Comparison of the theoretically estimated ultrasonic velocities using NR, IMR, CFT and FLT with the experimental values shows that the CFT is preferable than the FLT and the IMR more satisfactorily proclaims for the observed values, than that of the NR.

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