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Comparitive Study Of Theoretical Ultrasonic Velocities In Binary Liquid Mixture Containing 1-butanol And Hexane At Temperatures (=303.15, 308.15, 313.15, 318.15 & 323.15) K

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Abstract: Ultrasonic velocity is measured experimentally at 3MHz frequency in the binary liquid mixture containing 1-butanol and hexane at temperatures 303.15K, 308.15K, 313.15K, 318.15K & 323.15K over the entire composition range and theoretical values of ultrasonic velocity have been evaluated by using Nomoto's relation, Impedance relation, Van Dael ideal mixture relation. These theoretical values are compared with the experimental values. A good agreement has been found between experimental and theoretical ultrasonic velocities.

Keyword: Ultrasonic velocity, 1-butanol, hexane, binary liquid mixture.

INTRODUCTION:

Investigating the physicochemical behavior of liquid and liquid mixtures ultrasonic study has been gained much importance for the past several years. Many researcherscholars1-6 carried out ultrasonic velocity and their investigations in liquid mixtures. The experimental results of ultrasonic velocity and theoretical results of ultrasonic velocities using Nomoto7, impedence8 ,Van dael9 relations are interpreted in terms of molecular interactions. In the present study ultrasonic velocities in the binary liquid mixture containing 1-butanol and hexane are experimentally measured at temperatures 303.15K, 308.15K, 313.15K, 318.15K & 323.15K are compared with theoretical values.

THEORETICAL

The different theoretical ultrasonic velocicy relations used in the present study are expressed as follows

Nomoto's relation $U_N = [(x_1R_1+x_2R_2) /(x_1V_1+x_2V_2)]^3$ (1)

Impedance dependent relation $U_{Im} = x_iZ_i / x_i$ (2)

Van Dael ideal mixing relation $U_{imx} = [(x_1/M_1U^2_1 + x_2/M_2U^2_2)(x_1M_1+x_2M_2)]^{-1/2}$ (3)

EXPERIMENTAL

The chemicals used in the present study were purified by standard procedure10. The purity of samples was checked by comparing experimental values of density and ultrasonic velocity with the available literature11-14 compiled in Table 1. Job's method of continuous variation was used to prepare the mixtures of required proportions. The prepared mixtures were preserved in well-Stoppard conical flasks. After mixing the liquids thoroughly, the flasks were left undisturbed to allow them to attain thermal equilibrium. The ultrasonic velocities were measured by using single crystal ultrasonic pulse echo interferometer (Mittal enterprises, India; Model: F-80X). It consists of a high frequency generator and a measuring cell. The measurements of ultrasonic velocities were made at a fixed frequency of 3MHz. The ultrasonic velocity has an accuracy of ± 0.5 ms-1. The temperature was controlled by circulating water around the liquid cell from thermostatically controlled constant temperature water bath. The densities of pure liquids and liquid mixtures were measured by using a specific gravity bottle with an accuracy of ± 0.5%. Weights were measured with an electronic balance (Shimadzu AUY220, Japan) capable of measuring up to 0.1mg. An average of 4-5 measurements was taken for each sample.

Table-1: Experimental and literature values of density and ultrasonic velocity of pure liquids at 303.15K.

Liquids	U/ (m.s^{-1})		/ (kg.m^{-3})	
	Expt.	Lit.	Expt.	Lit.
1-butanol	1227.4	1228.8[11]	801.7	801.8[12]
hexane	1058.2	1057.0[13]	650.1	649.3[14]

RESULTS AND DISCUSSION

The theoretical evaluation of ultrasonic velocity based on different models in liquid mixture has been used to

correlate with the experimental findings. The theoretical values of ultrasonic velocities calculated by using the equations (1-3) along with the experimental values for the liquid mixture at temperatures

(303.15K, 308.15K, 313.15K, 318.15K & 323.15K) are given in Tables 2. From Table 2 it is observed that the theoretical values of ultrasonic velocity calculated by using various theories show deviation from experimental values. The limitations and approximation incorporated in these theories are responsible for the deviations of theoretical values from experimental values. In Nomoto's theory, it is supposed that the volume does not change on mixing. But on mixing two liquids, the interaction between the molecules of the two liquids takes place because of the presence of various types of forces such as hydrogen bonding, dipole-dipole, dispersive forces, charge transfer and dipole-induced dipole interactions. The deviations of experimental values from theoretical values calculated using Van Dael Ideal mixture relation might be due to the compressibility of the component liquids in the present mixtures. The deviations of experimental values and values calculated from impedance relation imply non-additivity of acoustic impedance in the liquid mixtures.

Table 2 : Experimental and theoretical values of velocities (m.s-1) in binary liquid system 1-butanol and hexane at temperatures 303.15K ,308.15K, 313.15K 318.15K & 323.15K.

X	U_{exp}	U_N	U_{Imp}	U_{vdv}
303.15K				
0.0000	1058.2	1058.2	1058.2	1007.4
0.1364	1068.5	1074.1	1085.1	1032.3
0.2623	1089.0	1090.1	1108.5	1056.3
0.3791	1112.0	1106.3	1129.1	1079.7
0.4871	1136.8	1122.7	1147.3	1102.2
0.5875	1162.0	1139.2	1163.6	1124.1
0.6812	1181.0	1155.8	1178.1	1145.3
0.7688	1192.0	1172.6	1191.3	1165.9
0.8507	1207.0	1189.6	1203.2	1185.8
0.9277	1221.0	1206.7	1214.1	1205.3
1.0000	1224.0	1224.0	1224.0	1224.0
308.15K				
0.0000	1038.5	1038.5	1038.5	988.7
0.1364	1050.2	1054.3	1066.1	1013.6
0.2623	1071.7	1070.3	1090.0	1037.6
0.3791	1097.2	1086.6	1111.0	1061.1
0.4871	1118.9	1103.0	1129.4	1083.7
0.5875	1143.4	1119.7	1145.8	1105.7
0.6812	1160.0	1136.6	1160.5	1127.0
0.7688	1176.0	1153.7	1173.7	1147.8
0.8507	1192.0	1171.1	1185.7	1167.9
0.9277	1205.0	1188.6	1196.5	1187.5
1.0000	1206.4	1206.4	1206.4	1206.4
313.15K				
0.0000	1020.7	1020.7	1020.7	971.7
0.1364	1033.0	1036.8	1049.4	997.0
0.2623	1051.9	1053.2	1074.3	1021.4
0.3791	1078.3	1070.0	1096.1	1045.3
0.4871	1098.8	1086.9	1115.1	1068.3
0.5875	1127.4	1104.1	1132.0	1090.8
0.6812	1146.5	1121.5	1147.1	1112.6
0.7688	1158.7	1139.3	1160.7	1133.9
0.8507	1176.5	1157.3	1173.0	1154.5
0.9277	1187.7	1175.6	1184.1	1174.7
1.0000	1194.2	1194.2	1194.2	1194.2
318.15K				
0.0000	1002.0	1002.0	1002.0	953.9
0.1364	1013.2	1018.8	1032.5	979.8
0.2623	1033.0	1036.0	1058.9	1005.0
0.3791	1060.0	1053.5	1081.8	1029.6
0.4871	1082.1	1071.3	1102.0	1053.5
0.5875	1110.0	1089.4	1119.8	1076.8
0.6812	1129.2	1107.8	1135.7	1099.6
0.7688	1141.0	1126.6	1149.9	1121.7
0.8507	1158.0	1145.7	1162.8	1143.3
0.9277	1172.0	1165.2	1174.4	1164.5
1.0000	1185.0	1185.0	1185.0	1185.0
323.15K				
0.0000	0978.4	0978.4	0978.4	0931.5
0.1364	0994.0	0996.2	1011.5	0958.3
0.2623	1014.0	1014.4	1040.0	984.5
0.3791	1040.0	1033.1	1064.8	1010.2
0.4871	1062.5	1052.1	1086.4	1035.3
0.5875	1090.6	1071.5	1105.5	1059.8
0.6812	1112.3	1091.3	1122.5	1083.8
0.7688	1126.0	1111.6	1137.7	1107.4
0.8507	1140.0	1132.3	1151.4	1130.4
0.9277	1156.0	1153.4	1163.8	1153.0
1.0000	1175.0	1175.0	1175.0	1175.0

CONCLUSION

Ultrasonic velocities in the binary liquid mixture containing 1-butanol and hexane at temperatures (303.15K, 308.15K, 313.15K, 318.15K & 323.15K) are determined and the validity of different theories is checked. Over all the observations it is cleared that in all the theories Nomoto's relation gives best results followed by Impedance theory.

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