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Theoretical evaluation of ultrasonic Velocity and Excess Parameters in Binary Liquid Mixtures of Bromobenzene with alkanols

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ABSTRACT

Basic physical properties governing behavior of dielectric liquids and its mixtures has to be given before developing the new compounds. These physical properties, their dependence on the compositions, the structure of the substance and other external factors which affect the dielectric liquid can be extensively studied using the theoretical evaluation of ultrasonic parameters. In this paper the theoretical evaluation is done by using the binary system of bromo-benzene in propanol, butanol, and pentanol at different temperatures at 298.15k, 303.15k and 308a.15k. Suitable interpretations are given based on the results obtained. The results observed that Nomoto method was best suited followed by CF Theory and ideal mixing relation for all the combination studies and the molecular interaction of liquid mixture due to the strong interaction between unlike molecules.

Keywords: Binary, Molecular interaction, Nomoto method, van-deal's method, CFT method.

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INTRODUCTION

The study of the noble and complex form of organic liquids has now gained considerable interest particularly due to the possibility of developing new organic liquids. The organic liquid will offer many fruitful applications in the field of science and technology.

The quest for the development of new organic liquids is growing day by day and new organic liquids can be obtained by the suitable combinations of available mixtures. The maximum contribution towards the discovery of new organic compounds comes from the field of technology. During recent years considerable interest has been developed In the ultrasonic studies in binary and ternary liquid mixtures [1-4]. Kannappan and V. Rajendran [5, 6] measured the ultrasonic velocity in 3 ternary liquid mixtures of Benzene, Toluene and 1 – 4 dioxane with cyclohexane in choloform of different proportions also compared the relative merits of Flory's statistical theory and Junjie's thermodynamical approach for theoretical evaluation of sound velocity in a mixtures and found that Junjie's is better suited than Flory's for the ultrasonic velocities. Further the work is carried out by the researchers using (i) P-Cholotoluene + N-Heptane + 1- Pentanol, 1-Hexanol, 1- Heptanol. (ii) Phenetole with 1-Pentanol, 1-Hexanol, 1- Heptanol, 1-+Optanol, 1- Nananol and 1- Decanol. (iii) Benzene + Acetone + Toluene and found Nomoto's relation is best suited for the prediction of ultrasonic Velocity [7,8]. These studies created and an interest to the author to continue this work in this field using Nomoto's method, VanDeal's ideal mixing relation and schaff's collision factor and the results are compared with expiremental values. Thermodynamic parameters such as U_{exp}^2 / U_{idl}^2, Alpha, excess sound velocity are evaluated in binary mixtures.

Theoretical consideration

Nomoto [9] suggested an empherical formula for sound velocity in binary liquid mixture as follows

$$U_m = [(X1\ R1+X2\ R2)/(X1\ V1+X2\ V2)]^3$$

Van Deal and Vangeal [10] suggested the following relation for sound velocity U_{im} as

$$\frac{1}{X_1M_1 + X_2M_2} \quad \frac{1}{U(im)^2} = \frac{X_1}{M_1U_1^2} + \frac{X_2}{M_2U_2^2}$$

Schaff's [11] developed and expansion for sound velocity in Binary mixtures as

$$U_{mix} = \frac{U\infty\ (X_1S_1 + X_2S_2)\ (X_1B_1 + X_2B_2)}{Vm}$$

The symbol's used in all three relations have their usual meaning.
The values of excess thermodynamic parameters, G^E were evaluated from the relations

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$G^E = G - G_{idl}$ here G_{idl} is the ideal value given by

$G_{idl} = X_1 G_1 + X_2 G_2$

The degree of intermolecular attraction ($\propto$) is given by $\propto = (U_{xp}^2 / U_{im}^2) - 1$

RESULTS AND DISCUSSION

The values of sound velocity have been evaluated theoretically using three different methods. The binary system chosen for this study is Bromobenzene with propanol, butanol and pentanol at different temperatures 298.15k, 303.15k and 308.15k are discussed. The experimental value of ultrasonic velocity and density of binary mixture are taken from the work of capital P.S. Nikam et al [12]. The experimental value of density and ultrasonic velocity for the pure components are given in the table 1. The experimental and The theoretical value of ultrasonic velocity and the percentage deviation of the theoretical velocity from the experimental value in the above mixtures of different mole fractions of bromobenzene at 298.15k ,303.15k and 308.15k has been investigated and reported in table 2-10. The variation of ultrasonic velocity with concentration of Bromobenzene for various temparature is reported graphically from figure 1- 15. The calculated values of U_{exp}^2 / U_{idl}^2, Alpha, excess sound velocity, excess impedance and excess volume are given in tables 11- 19. The variation of alpha and excess velocity with the mole fraction of bromobenzene are given in figure 10-15.

Components	298.15K		303.15K		308.15K	
	Density $\rho\ 10^3$ kgm^{-3}	Velocity U ms^{-1}	Density ρ 10^3 kgm^{-3}	Velocity U ms^{-1}	Density ρ 10^3 kgm^{-3}	Velocity U ms^{-1}
Bromobenzene	1488.8	1153.4	1481.7	1138.5	1475.1	1124.1
Propan-1-ol	798.9	1212.2	794.8	1194.4	790.8	1175.4
Butan-1-ol	806.5	1249.6	802.6	1228.8	798.8	1217.7
Pentanol	812.4	1282.6	808.6	1264.2	804.8	1246.0

Table 1 : Ultrasonic Velocity and Density of Pure Components

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Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-Deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.0733	886.5	1199.3	1205.4	1171.4	1224.9	-0.5044	2.3263	-2.1337
0.1512	935.6	1191.1	1199.4	1137.5	1235.9	-0.6945	4.5001	-3.7612
0.2339	989.4	1180.2	1193.5	1110.5	1243.7	-1.1152	5.9057	-5.3804
0.322	1048.0	1172.0	1187.6	1089.8	1248.5	-1.3144	7.0136	-6.5230
0.4161	1114.0	1165.8	1181.7	1075.7	1249.2	-1.3471	7.7285	-7.1513
0.5166	1217.8	1157.2	1175.8	1068.6	1244.9	-1.5869	7.6564	-7.5855
0.6244	1272.0	1150.1	1170.0	1070.1	1234.3	-1.7008	6.9559	-7.3184
0.7402	1365.5	1147.0	1164.1	1084.0	1211.6	-1.4689	5.4925	-5.6320
0.8651	2287.7	1159.2	1158.3	1106.8	1190.9	0.07078	4.5561	-2.7398
					AVERAGE	-1.0735	5.7928	-5.3584

Table 2 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Propanol -298.15

Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	U Nomoto ms^{-1}	U van-deal ms^{-1}	U cft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.0733	874.7	1239.9	1238.9	1216.5	1251.9	0.087098	1.8935789	-0.96131
0.1512	942.9	1230.36	1229.1	1188.9	1252.8	0.102409	3.3697454	-1.82386
0.2339	1011.2	1220.74	1219.3	1167.2	1250.6	0.117961	4.3858643	-2.44606
0.322	1079.4	1211.12	1209.7	1150.5	1245.8	0.117247	5.0052844	-2.86347
0.4161	1147.7	1201.5	1200.1	1138.4	1238.6	0.116521	5.2517686	-3.08781
0.5166	1215.9	1191.88	1190.4	1130.9	1228.5	0.124174	5.1162869	-3.07246
0.6244	1284.1	1182.26	1180.9	1128.2	1215.4	0.115034	4.5725982	-2.80311
0.7402	1352.3	1172.64	1171.4	1130.7	1198.3	0.105744	3.5765452	-2.18822
0.8651	1420.6	1163	1161.9	1138.8	1177.8	0.094583	2.0808255	-1.27257
					AVERAGE	.1089	3.916	-2.279

Table3 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Butanol -298.15K

Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.1024	880.04	1269.6	1268.37	1253.9	1275.4	0.09688	1.23661	-0.4568
0.2044	947.68	1256.7	1255.13	1230.1	1266.6	0.12493	2.11665	-0.7878
0.3057	1015.3	1243.8	1242	1210.3	1256.77	0.14472	2.69336	-1.0428
0.4065	1082.96	1230.9	1228.96	1193.9	1245.66	0.15761	3.00593	-1.1991
0.5068	1150.6	1218	1215.9	1180.9	1233.26	0.17241	3.04598	-1.2529
0.6065	1218.24	1205.08	1203.13	1170.6	1219.64	0.16181	2.86122	-1.2082
0.7057	1285.9	1192.1	1190.35	1162.9	1204.7	0.1468	2.44946	-1.057
0.8043	1353.5	1199.2	1177.6	1157.6	1188.75	0.13	1.8	0.809
0.9024	1421.2	1166.3	1154.4	1154.4	1171.53	0.1046	1.02032	-0.4484
					AVERAGE	0.133	2.22	-0.780

Table 4 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Pentanol-298.15K

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Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		Uexpt ms^{-1}	Unomoto ms^{-1}	Uvan-deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.0733	833.7	1188.8	1187.89	1154.3	1207.1	0.07661	2.90209	-1.5436
0.1512	881.6	1183.7	1182.24	1121.0	1218.2	0.12349	5.29695	-2.9180
0.2339	930.6	1172.2	1176.62	1094.4	1226.1	-0.3757	6.63709	-4.6030
0.322	984.1	1163.9	1171.01	1074.1	1231.0	-0.6072	7.71544	-5.7720
0.4161	1042.4	1155.5	1165.41	1060.3	1232.0	-0.8503	8.23886	-6.6222
0.5166	1108.1	1148.3	1159.83	1053.5	1228.1	-0.9941	8.25568	-6.9494
0.6244	1211.5	1142.2	1154.27	1055.1	1217.7	-1.0457	7.62563	-6.6144
0.7402	1265.1	1134.0	1148.66	1069.0	1195.5	-1.2763	5.73192	-5.4303
0.8651	1358.7	1131.0	1143.21	1091.9	1175.4	-1.068	3.45712	-3.9257
Average						-0.66857	6.20675	-4.9310

Table 5 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Propanol at 303.15K

Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.0733	832.8	1176.3	1169.38	1136	1188.39	0.59177	3.426	-1.0278
0.1512	877	1165.4	1164.2	1103.4	1199.7	0.1003	5.3200	-2.9432
0.2339	925.8	1159.2	1159.04	1080.7	1207.9	0.0138	6.7719	-4.2012
0.322	978.8	1146.9	1153.9	1057.6	1213.2	-0.6066	7.7862	-5.7808
0.4161	1037.2	1135.7	1148.76	1044.3	1214.5	-1.1369	8.0479	-6.9385
0.5166	1102	1132.1	1143.64	1037.8	1211.1	-1.0091	8.3296	-6.9782
0.6244	1205.3	1124.8	1138.53	1039.8	1201.2	-1.2059	7.5569	-6.79232
0.7402	1259	1121.4	1133.3	1054.1	1179.7	-1.05003	6.0014	-5.19886
0.8651	1352	1115.2	1128.3	1077.2	1160.2	-1.16104	3.4074	-4.03515
AVERAGE						-0.60677	6.2941	-4.87733

Table 6 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Propanol -308.15K

Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.0881	870	1219.77	1217.9	1196.5	1231.8	0.1533	1.9077367	-0.98871
0.1787	938	1210.74	1208.0	1170.3	1232.7	0.2254	3.3401061	-1.81377
0.2717	1006	1201.71	1198.1	1148.5	1231.0	0.2970	4.427857	-2.44235
0.3672	1074	1192.68	1188.3	1132.3	1227.2	0.3672	5.0625482	-2.89432
0.4653	1142	1183.65	1178.6	1120.8	1220.5	0.4266	5.3098467	-3.11427
0.5663	1210	1174.62	1168.8	1113.7	1211.0	0.4954	5.1863581	-3.09717
0.6701	1278	1165.59	1159.1	1111.6	1198.3	0.5568	4.6319889	-2.8063
0.7769	1345	1156.56	1149.6	1114.5	1182.1	0.6017	3.6366466	-2.20827
0.8867	1413	1147.53	1140.0	1123.3	1162.0	0.6553	2.1114916	-1.26097
AVERAGE						0.4199	3.957	-2.291

Table 7 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Butanol -303.15K

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Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.0881	866.4	1208.3	1215.7	1185.4	1220.2	-0.6091	1.898472	-0.98871
0.1787	934.0	1198.9	1214.3	1162.2	1220.6	-1.2777	3.067607	-1.81377
0.2717	1001.7	1189.6	1212.6	1137.5	1217.9	-1.9317	4.381231	-2.44235
0.3672	1069.3	1180.2	1210.4	1121.2	1213.9	-2.5536	5.003982	-2.89432
0.4653	1136	1170.9	1207.5	1109.3	1207.1	-3.1258	5.260910	-3.11427
0.5663	1204	1161.5	1203.5	1102.2	1196.8	-3.6122	5.108735	-3.09717
0.6701	1272.1	1152.1	1197.5	1199.6	1183.8	-3.9334	4.563523	-2.8063
0.7769	1339.8	1142.8	1187.7	1102	1167.4	-3.9271	3.571866	-2.20827
0.8867	1407.4	1133.4	1168.7	1109.8	1147.9	-3.1090	2.087413	-1.26097
Average						-2.675	3.882	2.256

Table 8 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Butanol -308.15K

Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.1024	875.9	1251.63	1250.17	1236.1	1257.32	0.11665	1.2407	-0.4546
0.2044	943.2	1239.06	1237.32	1212.7	1248.86	0.14043	2.12742	-0.7909
0.3057	1010.5	1226.49	1224.56	1193.4	1239.36	0.15736	2.69794	-1.0493
0.4065	1077.8	1213.92	1211.8	1177.5	1228.59	0.17464	3.0002	-1.2085
0.5068	1145.2	1201.35	1199.3	1164.6	1216.55	0.17064	3.05906	-1.2652
0.6065	1212.5	1188.78	1186.81	1154.7	1203.28	0.16572	2.8668	-1.2197
0.7057	1279.8	1176.21	1174.4	1147.3	1188.79	0.15388	2.45789	-1.0695
0.8043	1347.1	1163.64	1162.08	1142.8	1173.12	0.13406	1.79093	-0.8147
0.9024	1414.4	1151.07	1149.84	1139.3	1156.26	0.10686	1.02253	-0.4509
						0.14669	2.25150	-0.92483

Table 9 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Pentanol-303.15k

Mole Fraction "X_1"	Density ρ_{mix} kgm^{-3}	Ultrasonic Velocity				Percentage Deviation		
		U expt ms^{-1}	Unomoto ms^{-1}	Uvan-Deal ms^{-1}	Ucft ms^{-1}	(ΔU/U)% Nomoto	(ΔU/U)% Van-deal	(ΔU/U)% CFT
0.1024	872.5	1233.81	1232.57	1218.5	1239.4	0.1005	1.24087	-0.4604
0.2044	938.9	1221.62	1220.09	1195.6	1231.4	0.12524	2.12996	-0.8006
0.3057	1005.9	1209.43	1207.7	1176.4	1222.3	0.14304	2.73104	-1.0641
0.4065	1072.9	1197.24	1195.4	1161.2	1211.9	0.15369	3.01026	-1.2245
0.5068	1139.9	1185.05	1183.17	1148.8	1200.2	0.15864	3.05894	-1.2784
0.6065	1206.9	1172.86	1171.04	1139.1	1187.3	0.15518	2.87843	-1.2312
0.7057	1274.2	1160.6	1158.98	1131.9	1173.2	0.13958	2.47286	-1.0882
0.8043	1341.1	1148.5	1147	1127.2	1157.9	0.13061	1.85459	-0.8185
0.9024	1408.1	1136.3	1135.11	1124.6	1141.5	0.10473	1.02966	-0.4576
						0.134579	2.267401	-0.93594

Table 10 Ultrasonic Velocity and percentage Deviation of the Binary Mixture Bromobenzene + Pentanol -308.15K

From the observed results the average percentage deviation can computed ultrasonic velocity using various theories Nomoto's method, Van Deal's ideal mixing relation and collision factor theory for the mixture bromobenzene with propanol are -1.07, 5.79 and -5.3 at the temperature 298.15k and -0.66, 6.20, -4.93 at 303.15k at 303.15k and -.60, 6.29 and -4.8 at

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308.15k respectively. For the mixture Bromobenzene with Butanol the deviations are -108, 3.91, -2.27 at the temperature 298.15k and .41, 3.9, -2.3 at 303.15k and -2.6, 3.8 and -2.25 at 308.15k.For the mixture Bromobenzene with pentanol the deviations are 0.13,2.22,-0.78 at the temperature 298.15k and 0.14,2.25,-0.92 at the temperature 303.15k and 0.13,2.26,-0.93 at the temperature 308.15k. These values are for Nomoto's method, Van Deal's ideal mixing relation and collision factor theory respectively.

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.0733	1207.76	0.986025	-0.01397	-8.46874	-22.2234	-0.3413
0.1512	1203.30	0.97981	-0.02019	-12.2094	-19.2822	-0.2093
0.2339	1198.32	0.96997	-0.03002	-18.1255	-15.4598	-0.1064
0.322	1193.14	0.96487	-0.03513	-21.1452	-10.9465	-0.0355
0.4161	1187.61	0.96360	-0.03640	-21.8121	-5.47208	-0.0026
0.5166	1181.70	0.95896	-0.04104	-24.5027	1.214512	-0.0033
0.6244	1175.12	0.95786	-0.04213	-25.0216	9.639699	-0.0497
0.7402	1165.88	0.96786	-0.03214	-18.8882	22.95654	-0.1437
0.8651	1161.33	0.99633	-0.00367	-2.13212	48.8833	-0.2921

Table 11 Excess parameters in the Binary Mixture Bromobenzene+Propanol- 298.15K

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.0733	1190.183	0.997677	-.00232	-1..38309	-19.8717	-0.34127
0.1512	1185.948	0.996213	-.00379	-2.24792	-17.1894	-0.20928
0.2339	1181.206	0.98481	-.01519	-9.00555	-13.7315	-0.10637
0.322	1176.281	0.97906	-.02094	-12.3808	-9.67445	-0.03554
0.4161	1171.021	0.973668	-.02633	-15.5206	-4.76436	-0.0020
0.5166	1165.403	0.970865	-.02914	-17.1026	1.160602	-0.00328
0.6244	1159.138	0.970989	-.02901	-16.9377	8.858827	-0.04967
0.7402	1150.276	0.971901	-0.0281	-16.2757	20.46211	-0.14366
0.8651	1146.041	0.973924	-.02608	-15.0409	27.72983	-0.29208

Table 12 Excess parameters in the Binary Mixture Bromobenzene+Propanol-303.15K

Analysing the average percentage deviation of the calculated ultrasonic velocity of the different theories used , it is observed that Nomoto's method was best suited followed by collision factor theory and ideal mixing relation for all the combination studied.

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Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.0733	1171.522	1.008173	0.008173	4.77783	-18.13191	-0.34127
0.1512	1167.643	0.996161	-0.00384	-2.24344	-15.6925	-0.20928
0.2339	1163.283	0.992992	-0.00701	-4.08339	-12.5292	-0.10637
0.3220	1158.764	0.979628	-0.02037	-11.8639	-8.82277	-0.03554
0.4161	1153.937	0.968642	-0.03136	-18.2365	-4.34227	-0.00214
0.5166	1148.781	0.97117	-0.02883	-16.6809	1.06797	-0.00328
0.6244	1143.016	0.968381	-0.03162	-18.2157	8.1169	-0.04967
0.7402	1134.724	0.976653	-0.02335	-13.3243	18.91733	-0.14366
0.8651	1131.02	0.97222	-0.02778	-15.8204	25.32246	-0.29208

Table 13 Excess parameters in the Binary Mixture Bromobenzene+Propanol- 308.15K

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.0881	1241	0.998357	-0.0016	-1.01982	-34.5517	-0.34127
0.1787	1232.53	0.996475	-0.0035	-2.17402	-54.8204	-0.20928
0.2717	1223.46	0.995555	-0.0044	-2.72246	-46.5115	-0.10637
0.3672	1214.15	0.995014	-0.0049	-3.0304	-36.1917	-0.03554
0.4653	1204.71	0.994673	-0.0043	-3.21318	-23.9353	-0.002
0.5663	1194.99	0.994790	-0.0052	-3.11698	-9.49105	-0.00328
0.6701	1185.01	0.995362	-0.0046	-2.75142	7.197612	-0.04967
0.7769	1174.73	0.996433	-0.0035	-2.09726	26.23968	-0.14366
0.8867	1164.17	0.998018	-0.0019	-1.1545	47.71781	-0.29208

Table 14 Excess parameters in the Binary Mixture Bromobenzene+Butanol- 298.15K

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Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.0881	1220.72	0.99844	-0.00156	-0.95169	-32.2278	-0.34127
0.1787	1212.78	0.99662	-0.00337	-2.04627	-27.2946	-0.20928
0.2717	1204.26	0.99576	-0.00424	-2.55549	-20.6957	-0.10637
0.3672	1195.51	0.99525	-0.00474	-2.83896	-12.6936	-0.03554
0.4653	1186.66	0.99493	-0.00507	-3.01053	-3.38093	-0.0030
0.5663	1177.54	0.99504	-0.00495	-2.92023	7.453691	-0.00328
0.6701	1168.16	0.99559	-0.00441	-2.57709	32.7621	-0.04967
0.7769	1158.52	0.99661	-0.00339	-1.96305	33.88566	-0.14366
0.8867	1148.60	0.99812	-0.00188	-1.07811	49.61291	-0.29208

Table 15 Excess parameters in the Binary Mixture Bromobenzene+Butanol- 303.15K

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.0881	1209.33	0.99836	-0.00164	-0.99207	-33.2987	-0.34127
0.1787	1201.09	0.996481	-0.00352	-2.11545	-28.2038	-0.20928
0.2717	1192.26	0.995562	-0.00444	-2.64888	-21.4052	-0.10637
0.3672	1183.20	0.995023	-0.00498	-2.94831	-13.1613	-0.03554
0.4653	1174.02	0.994682	-0.00532	-3.12615	-3.55131	-0.00321
0.5663	1164.57	0.994799	-0.0052	-3.03255	7.61825	-0.00328
0.6701	1154.85	0.99537	-0.00463	-2.67687	20.40847	-0.04967
0.7769	1144.86	0.996439	-0.00356	-2.04039	34.88787	-0.14366
0.8867	1134.58	0.998021	-0.00198	-1.12311	51.11239	-0.29208

Table 16 Excess parameters in the Binary Mixture Bromobenzene+Butanol- 308.15K

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.1024	1269.37	1.0003	0.0003	0.2	-45.22	-0.34127
0.2044	1255.93	1.0010	0.0010	0.6	-36.07	-0.02092
0.3057	1242.97	1.0014	0.0014	0.9	-25.35	-0.10637
0.4065	1229.9	1.0016	0.0016	1.0	-12.93	-0.03554
0.5068	1216.9	1.0018	0.002	1.1	1.157	-0.0310
0.6065	1204.1	1.0016	0.0016	0.9	16.915	-0.00328
0.7057	1191.2	1.0015	0.0015	0.9	34.315	-0.04967
0.8043	1178.5	1.0011	0.0011	0.7	53.367	-0.14366
0.9024	1165.8	1.0008	0.0008	0.5	74.060	-0.29208

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Table 17 Excess parameters in the Binary Mixture Bromobenzene+pentanol- 298.15K

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.1024	1251.33	1.00048	0.00048	0.30168	-43.73	-0.34127
0.2044	1238.25	1.0013	0.0013	0.80592	-34.91	-0.20928
0.3057	1175.08	1.08942	0.08942	0.51410	-24.54	-0.10637
0.4065	1212.98	1.00156	0.00156	0.94347	-12.52	-0.03554
0.5068	1200.37	1.00164	0.00164	0.98118	1.12	-0.00314
0.6065	1187.84	1.00159	0.00159	0.94347	16.37	-0.00328
0.7057	1175.37	1.00143	0.00143	0.84291	33.23	-0.04967
0.8043	1162.97	1.00115	0.00115	0.66693	51.69	-0.14366
0.9024	1150.64	1.00074	0.00074	0.42810	71.70	-0.29208

Table 18 Excess parameters in the Binary Mixture Bromobenzene+pentanol- 303.15k

Mole Fraction "X_1"	Ultrasonic velocity U_{idl} ms^{-1}	U_{exp}^2/U_{idl}^2	Alpha	Excess Velocity(U^E) ms^{-1}	Excess Impedance $(Z^E)10^3$ Kg $m^{-2}S^{-1}$	Excess Volume $(V^E)10^{-3}$ m^3 mol^{-1}
0.1024	1233.5	1.000474	0.00047	0.29256	-42.263	-0.34127
0.2044	1220.8	1.00128	0.00129	0.78556	-33.682	-0.20928
0.3057	1159.5	1.08787	0.08787	0.87256	-23.678	-0.10637
0.4065	1196.3	1.00153	0.00153	0.91695	-12.084	-0.3554
0.5068	1184.0	1.00161	0.00161	0.95352	1.0860593	-0.0241
0.6065	1171.9	1.00156	0.00157	0.91695	15.806982	-0.00328
0.7057	1159.8	1.00129	0.00129	0.74943	32.104074	-0.04967
0.8043	1147.8	1.00116	0.00117	0.66877	49.910371	-0.14366
0.9024	1135.8	1.00075	0.00075	0.42716	69.241441	-0.29208

Table 19 Excess parameters in the Binary Mixture Bromobenzene+pentanol- 308.15k

The average percentage deviation due to ideal mixing relation was very high. This may be due to the assumption in the theory V1 = V2 = V_{idl} . Therefore the vast deviation may be due to the strong interaction between the unlike molecules of the liquid mixture.

The interaction effect can be explained from the calculated excess thermodynamic parameters. Both bromobenzene and alkanols are polar in nature which can interact by forming hydrogen bonding through Dipole – Dipole interaction (O-H - Br^-). Alkanols are liquids associated through hydrogen bonding and in the pure state exhibit an equilibrium between monomers and multimers species[13]. In the pure state, halogenated compounds present weak Dipole-Dipole interaction. When bromobenzene is mixed with alkanols the halogenated solvents can interact with OH groups[14]. The Aromatic derivatives set up an interaction between the electron cloud and the hydroxyl group[15]. Of course this interaction is of minor intensity

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compared with hydrogen bonding, but they can lead to formation of intermolecular complexes[16]. The excess impedance value found to be increased with increase of mole fraction,In the present study the Alpha is found to be negative for the mixture of Bromobenzene with propanol and butanol. But Aplha value is found to be positive for the mixture of bromobenzene with pentanol. The excess velocity is found to be negative for the mixture of bromobenze with propanol and butanol but it is found to be positive for pentanol. Here all the binary mixture the excess volume are found to be negative.

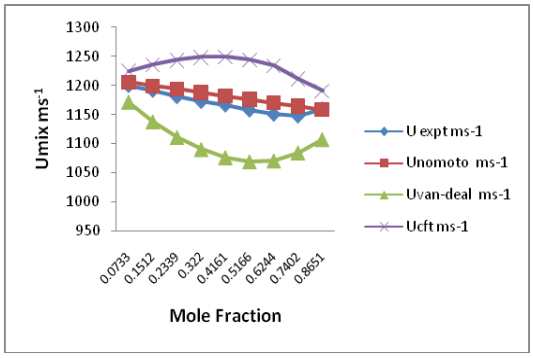

Fig 1: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+propanol at 298.15k

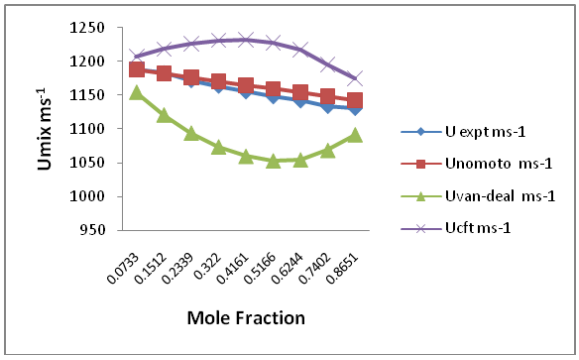

Fig 2: Comparison of Experimental value of Umix with theoretical Bromobenzene+propanol at 303.15k

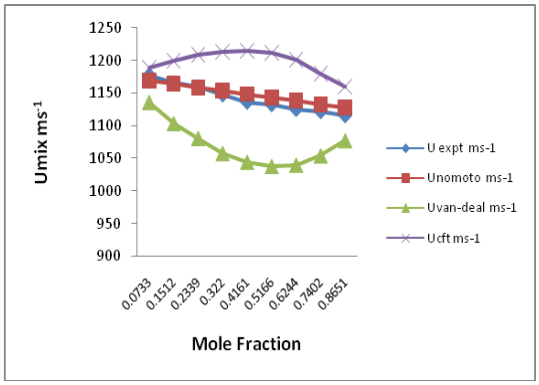

Fig3: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+propanol at 308.15k

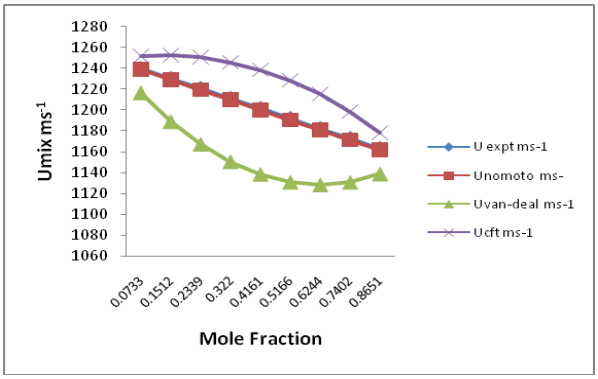

Fig 4: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+Butanol at 298.15k

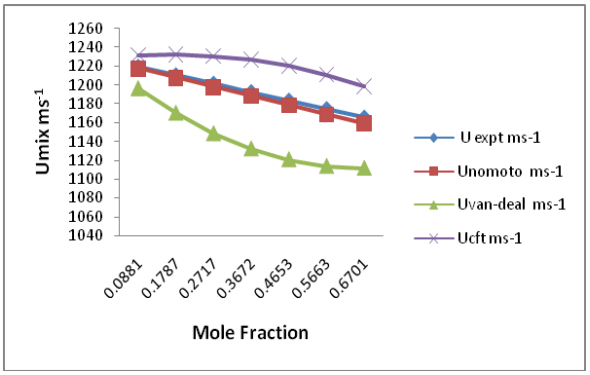

Fig5: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+Butanol at 303.15k

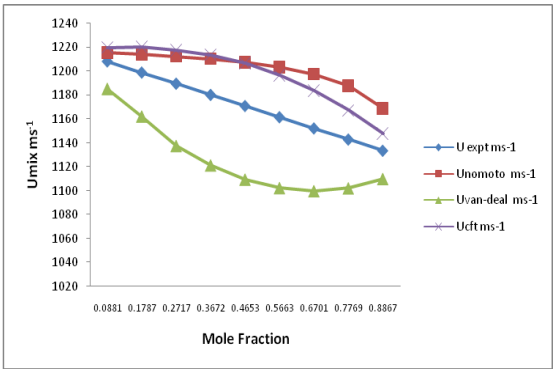

Fig 6: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+Butanol at 308.15k

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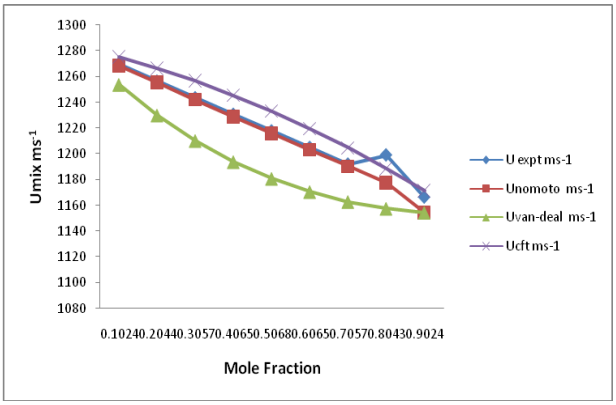

Fig7 : Comparison of Experimental value of Umix with theoretical value for Bromobenzene+Pentanoll at 298.15k

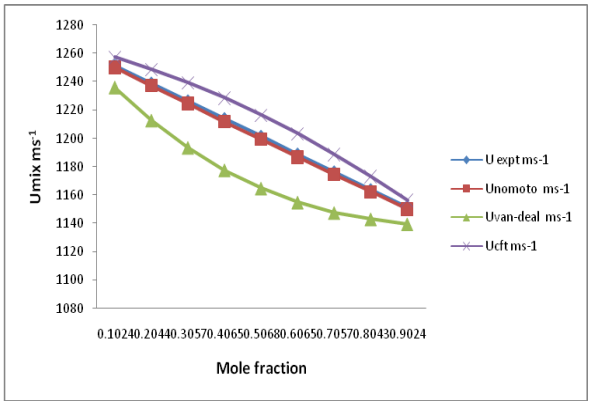

Fig 8: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+Pentanol at 303.15k

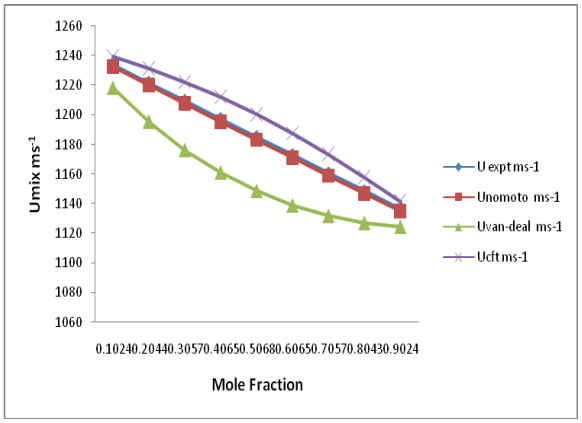

Fig 9: Comparison of Experimental value of Umix with theoretical value for Bromobenzene+Pentanol at 308.15k

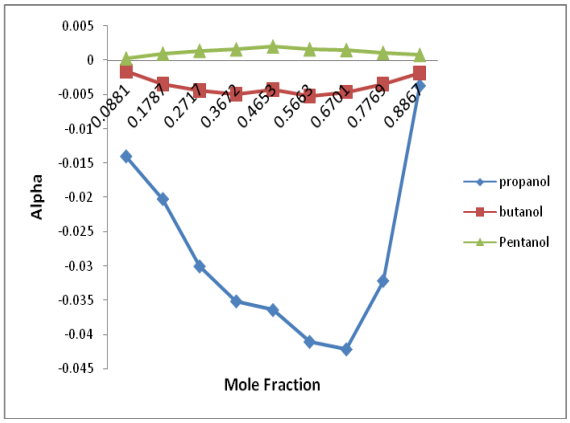

Fig 10: Variation of Alpha in the mixture Bromobenzene+Alcohols at 298.15k

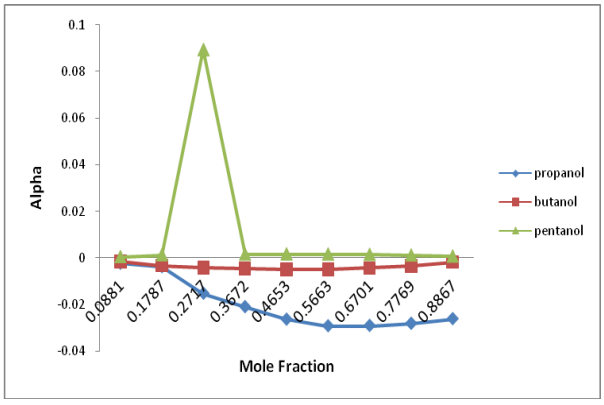

Fig 11: Variation of Alpha in the mixture Bromobenzene+Alcohols at 303.15k

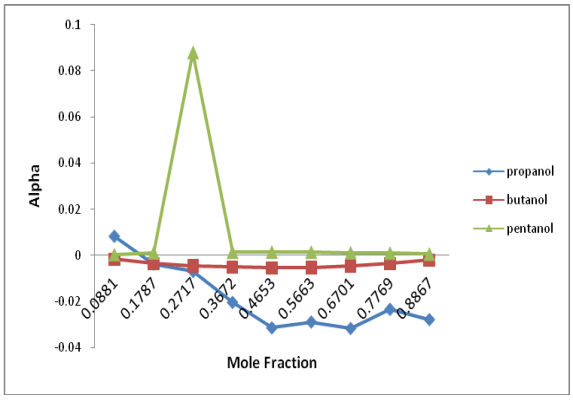

Fig 12: Variation of Alpha in the mixture Bromobenzene+Alcohols at 308.15k

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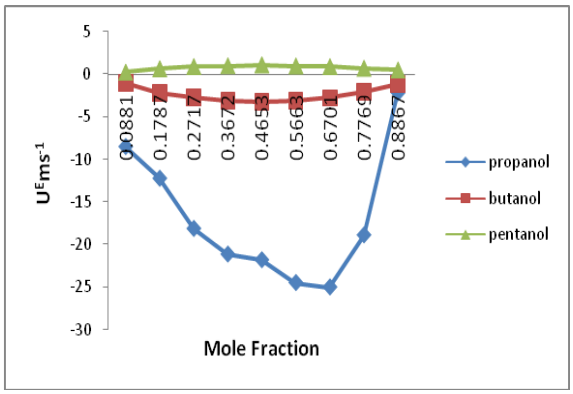

Fig 13: Variation of Excess velocity in the mixture Bromobenzene+Alcohols at 298.15k

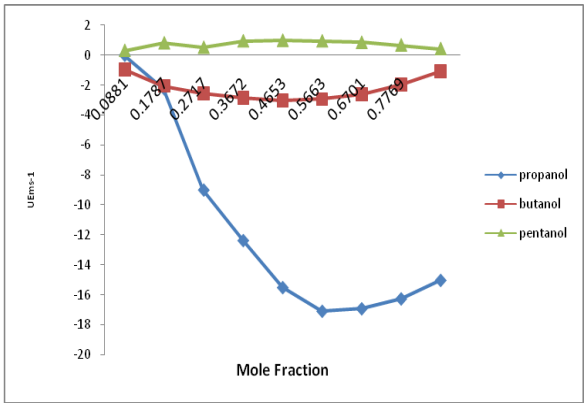

Fig 14: Variation of Excess velocity in the mixture Bromobenzene+Alcohols at at 303.15k

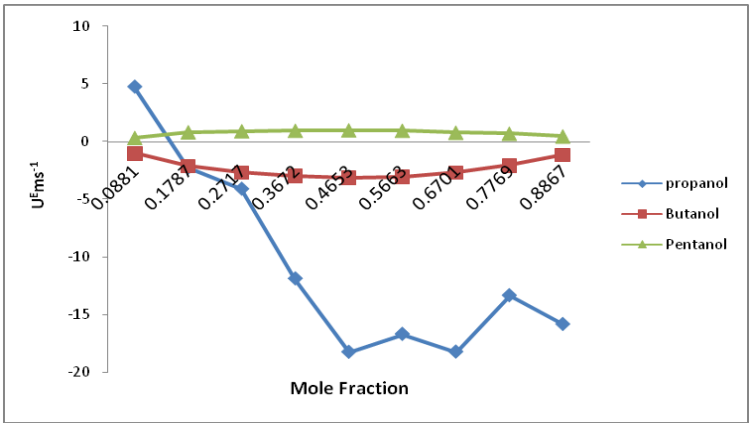

Fig 15: Variation of Excess velocity in the mixture Bromobenzene+Alcohols at 308.15k

The negative excess parameters indicate that the strong interaction in the liquid mixtures as well as interstitial accommodation of bromobenzene molecules in aggregates alcohols. Negative excess volume indicates the formation of molecular clusters and complexes and may involve charge transfer complexes[16]. The negative excess velocity found vary with mole fraction may be attributed to the breaking both the hydrogen bond and Bipolar interaction on mixtures[16]. The average percentage deviation of ultrasonic velocity ideal mixing relation decreases in the order propanol>Butanol> Pentanol . This trend suggest that hetro associationand homo association of molecules decreases with increasing chain length of carbon atoms ,Probably due to less proton donating tendency of higher alkanols. The decrease of average percentage deviation in the ideal mixing relation with the increasing chain length of carbon atoms in alkanols,suggests that ideal mixing can give good results with higher alkanols.

CONCLUSION

The investigation mixtures were chosen in order to obtain information about the molecular interactions between their components.In the present Study , the ultrasonic velocity has been evaluated in the binary mixture of Bromobenzene with propanol,Butanol and Pentanol

at three different temparatures 298.15k,303.15k and 308.15k. Using three different theoretical methods namely Nomoto's method,van Dael's mixing relation and Schaff's collision factor theory are evaluated. The results are compared with experimental values. Thermodynamic parameters such as U_{exp}^2 / U_{idl}^2, Alpha, excess sound velocity are evaluated and are used to explain the suitable method to compute the ultrasonic velocity theoretically.

In all binary system Bromobenzene with alcohols,both bromobenzene and alcohols are polar liquids and can interact through dipole – dipole interaction. The decrease in the negative excess parameters suggests that the hetro association and homo association of molecules decreases with increasing chain length of carbon atoms in alkanols. This may be due to the less proton donating tendancy of carbon atoms in alkanols. The average percentage deviation in the ideal mixing relation also decreases with increasing chain length of alkanols. This suggests the ideal mixing relation can good for alkanols with more number of carbon atoms in the chain. It may be concluded that Nomoto's relation and collision factor theory are better suited to evaluate ultrasonic velocity.

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