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Research Article

INTERMOLECULAR INTERACTION OF MALTOSE THROUGH ULTRASONIC STUDIES

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ABSTRACT
Molecular Interaction studies in liquids provide vivid information about the structural details of the molecules in solution phenomena. The Cohesive Energy of the Inter& Intra molecular interaction is the best revealed through ultrasonic studies. In the current paper by passing ultrasonic waves through aqueous solution of Maltose the Acoustical and related Thermodynamical parameters are estimated. The study is carried out at different temperatures in order to understand the effect of temperature with the association of molecular phenomena of structure breaking or breaking. The Scientist A. Passyanski gave the Signal Acquisition in Ultrasonic systems. Compressibility is explained by assuming that the molecules are fully compressed. The compressibility of the solution is mainly due to free solvent molecules. This was given by S. Barnartt. The Scientists Tunetaka Sasaki and Yasunaga Bull extended the idea of finding the hydration number and other parameters. B. Jacobson gave a Broad-band Spectroscopy of Liquids. W. Schaff has been engaged on the study of importance of Molecular interaction between the acceptor and the Donor molecules.
In India V.A. Tabhane worked on the Acoustical study of organic materials. The internal pressure and free volume analysis for Aqueous solution of Pinacol was given by S. Sekar and A. Dhanalakshmi. The Molecular interaction studies on liquids by Viscometric / Ultrasonic techniques was given by J.B. Thakare, D.T. Dongre & Deogankar.

INTRODUCTION
There are many approaches to determine the structure function relationship of molecules. Ultrasonic methods along with spectroscopic techniques are found to be powerful tools in the investigation of molecular interactions occurring in solutions. The Maltose samples are more prominently used in Bio-medical & Pharmaceutical fields. The relative associations of the molecules from their pure to dilated forms are investigated through the variation of Ultrasonicvelocity, density, viscosity, compressibility studies. The formation of Hydrogen bonding as expressed in spectroscopic studies can be easily ascertained by the Thermodynamical studies through Ultrasonic & acoustical measurements. The Interactions confirm the structure making and breaking properties of solution phenomena.

Experimental Studies
The aqueous solution of Maltose (AR Grade) is dissolved in double distilled water for making up different concentrations under study. A Mittal type fixed frequency Interferometer (2 MHz) is used for the determination of Ultrasonic velocity. A 10 ml specific gravity bottle& cannon Fenske Viscometer was used for determining both density & viscosity of the solutions respectively. A circulating thermostat to maintain the temperature of the system constant for temperature variation studies.

Mathematical Formulas
Ultrasonic Velocity (U) =λ x f λ = wavelength f=frequency Where λ=2d/n

Adiabatic Compressibility: $\beta = (1/u^2\rho)$

Intermolecular free length (L_f): $L_f = \left(\frac{K}{U_P^{1/2}}\right) = K\left(\beta_{ad}\right)^{1/2}$

Specific Acoustic Impedance(z)= ρ*U

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Rao's Constant(R)= $$R = \frac{M}{\rho} \bullet u^{1/3}$$

Wada's Constant(W)= $$\left[\frac{M}{\rho}\right](\beta_{ad})^{-1/7}$$

Tabular columns

Table 1:

Mol/Temp	**Ultrasonic Velocity (U)(m/sec)** 308K	313K	318K	323K	328K	**Adiabatic Compressibility(βx10^{-11})** 308K	313K	318K	323K	328K
0.1	1509	1534	1560	1579	1616	44.11	43.08	41.26	41.72	38.33
0.4	1517	1547	1567	1580	1632	43.58	40.52	39.39	38.86	36.48
0.6	1527	1556	1607	1613	1656	41.51	38.96	36.72	36.46	34.28
1	1546	1610	1617	1620	1680	40.1	36.63	36.24	35.25	32.85
1.2	1578	1618	1661	1657	1696	37.41	35.59	32.63	33.03	31.25
1.6	1612	1637	1702	1698	1705	34.97	33.27	30.46	32.33	30.33
2	1640	1652	1702	1760	1740	32.61	31.94	29.77	27.92	28.39

Table 2:

Mol/Temp	**Intermolecular Free Length (L_fx10^{-11})** 308K	313K	318K	323K	328K	**Specific Acoustical impedance(Z)(Rayl)** 308K	313K	318K	323K	328K
0.1	0.1335	0.1332	0.131	0.133	0.1285	150244	151284	155349	151826	161448
0.4	0.1327	0.1292	0.128	0.1284	0.1253	151272	159533	161984	162895	167978
0.6	0.1296	0.1268	0.1236	0.1244	0.1215	157728	164979	169483	170084	176166
1	0.1273	0.1229	0.1229	0.1223	0.119	161293	169637	170597	175149	181223
1.2	0.123	0.1211	0.0165	0.1184	0.116	169406	173727	184454	182723	188679
1.6	0.1189	0.1171	0.1127	0.1171	0.1143	177417	183637	192852	182208	193418
2	0.1148	0.1147	0.1113	0.1099	0.1106	186960	189495	197374	203517	202470

Table 3: Molar Sound Velocity

Mol/Temp	308K	313K	318K	323K	328K
0.1	996.14	1011.56	1007.06	1047.11	1015.67
0.4	1093.89	1064.87	1067.12	1072.33	1086.09
0.6	1121.19	1098.95	1116.66	1118.03	1118.29
1	1114.44	1241.29	1119.1	1212.37	1230.32
1.2	1270.18	1280.21	1249.55	1256.93	1255.54
1.6	1363.45	1344.26	1348.65	1422.65	1347.56
2	1434.65	1429.78	1427.68	1448.06	1433.53

Table 4: Molar Compressibility

Mol/Temp	308K	313K	318K	323K	328K
0.1	564.22	571.69	569.51	588.87	573.6
0.4	619.58	605.46	606.56	609.1	615.8
0.6	638.01	627.15	635.8	636.48	636.59
1	634.72	706.64	637	692.5	701.29
1.2	725.68	730.58	715.56	719.18	718.49
1.6	780.94	771.56	773.67	809.91	773.13
2	825.19	822.78	821.4	831.79	824.63

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RESULTS AND DISCUSSION

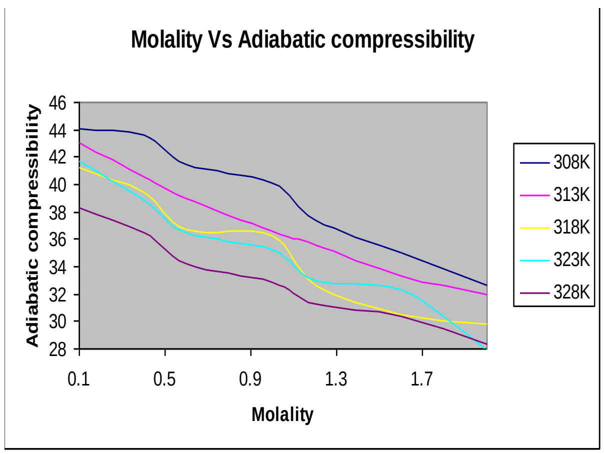
The experimentally determined values of ultrasonic velocity for Maltose at temperatures at 303K,308K, 313K, 318K and 323K are summarized in the table.

The measurement of ultrasonic velocity is an important tool to study the physical & chemical properties of the liquid. Ultrasonic velocity and allied parameters of Maltose for various concentrations, at different temperatures are presented in tables and represented graphically in figures.

The parameters derived from ultrasonic measurements such as adiabatic compressibility, acoustical relaxation time, intermolecular free length, specific acoustic impedance, molar sound velocity and molar compressibility prove a better insight into molecular environment in liquid mixtures and solutions.

In this the ultrasonic velocity increases with increase in both temperature and concentration.

The plots between the ultrasonic velocity and concentration potential shows that the ultrasonic velocity is found to linearly increase with concentrations and temperatures. This linear increase suggests that there are strong solute-solvent interactions in the liquid solution. These interactions are both concentration and temperature dependent. The effects of temperature on the interactions are more than that of concentration. At low concentrations, the number of hydrogen bonds formed may be less and at higher concentrations, it may be more due to solute-solute interactions [graph1].



Graph 1

The compressibility is a macroscopic observable, which is sensitive to solute-solvent interactions. Any modifications induced by the solute on the local structure of the solvent generate changes in the adiabatic compressibility of the solutions and therefore compressibility can be used to characterize solvated properties of solute in dilute solutions. The decrease of adiabatic compressibility with concentration and temperature of the solution studied here indicates the formation of a more number of tightly bound systems. This implies, since the density should increase with concentration, the β is also decreasing with concentration (Bingham, 1922). This is seen from the fact that the velocity is equal to the square root of the reciprocal of the β with density [Graph 2].

The intermolecular free length of the liquid systems decreases with increase in velocity. The free length is the distance between the surfaces of the neighboring molecules. It indicates significant interactions between the solute and solvent molecules, due to which the structural arrangement in the neighborhood of constituent solute particles is considerably affected. At lower concentrations, the molecules are not closer and then the intermolecular free length will be high (Suryanarayana and Kuppusamy, 1976). As the concentration increases, the molecules come closer, thereby decreasing the intermolecular free length [Graph 3].

The usual behavior of the linear increase of specific acoustic impedance with concentration at a given temperature is observed in all the systems studied here. The specific acoustic impedance in liquids can also be used to assess the strength of inter-molecular attraction (Wood and Brussi, 1943). As the strength

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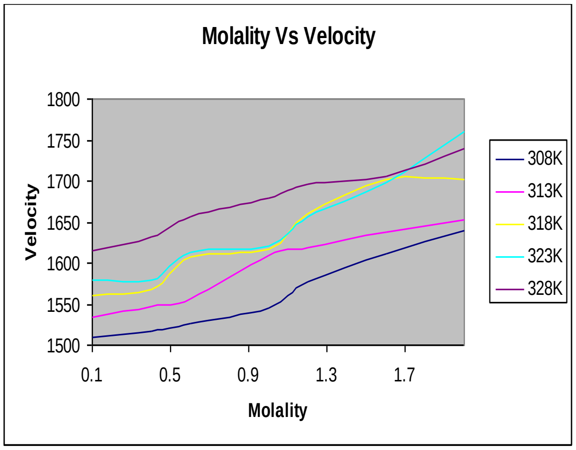
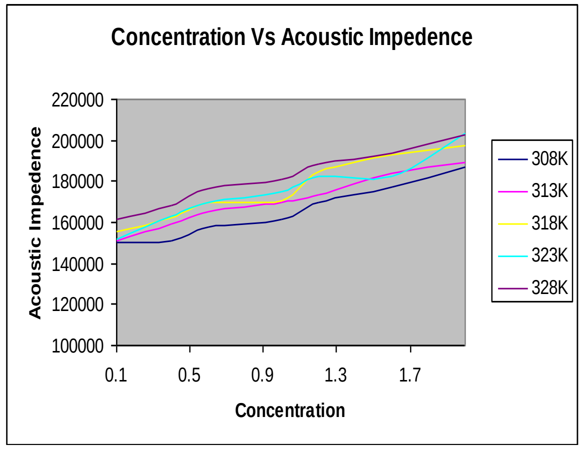
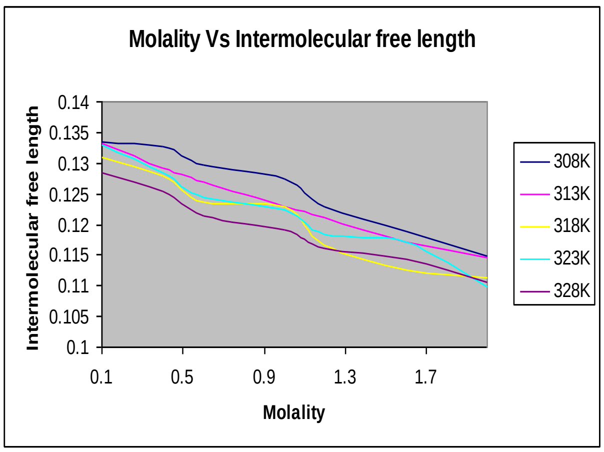
of the intermolecular attraction increases, the ultrasonic velocity also increases consequently, the acoustic impedance value also increases. Acoustic impedance is a characteristic property of the medium [Graph 4].



Graph 2

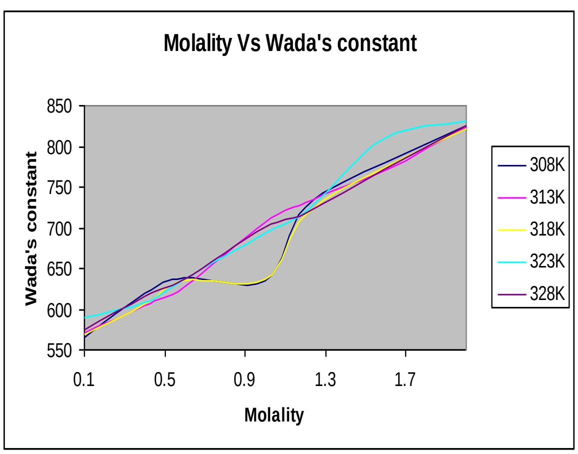


Graph 3

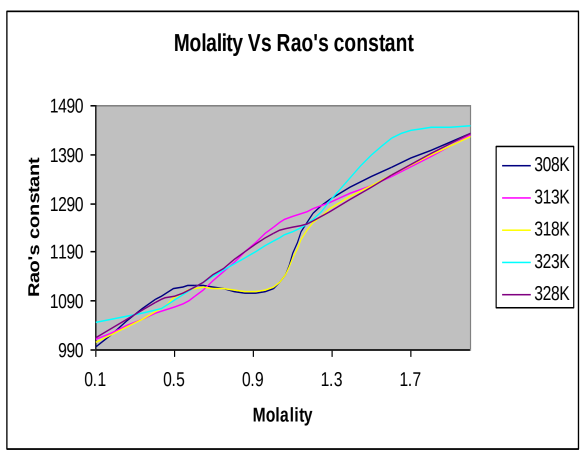


Graph 4

The variations of molar sound velocity (Rao's constant) and molar compressibility (Wada's constant) show increasing trend with the variation of concentrations and temperatures as expected [Graphs 5,6].



Graph 5



Graph 6

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