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Interaction Study of Tetra Ethyl lead in Different Alkaline Media

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ABSTRACT

Density, Viscosity and Ultrasound velocity of Tetra ethyl lead in aqueous NaOH and aqueous KOH have been measured at varying concentrations at 30°C. The derived acoustic parameters like specific acoustic impedance (Z), intermolecular free length (L_f), relative association (Ra), isentropic compressibility (β_s) etc. have been calculated using density, viscosity and ultrasound velocity data. These parameters are used to discuss the nature and extent of intermolecular interactions in the mixture.

Introduction

The study of intermolecular interaction is of considerable importance in the elucidation of the formation of complexes and plays important role in the liquid mixtures[1-3]. The estimation of the speed of ultrasound is the fundamental requirement for investigating the transport properties of liquid and solid systems[4].tetra ethyl lead is used as an anti knocking agent in the fuels. In this paper the speed of ultrasound waves in tetra ethyl lead in aqueous NaOH and aqueous KOH has been estimated for different concentrations at 30°C and we will try to compute solute- solvent interaction, which may occur when tetra ethyl lead is dissolve in different alkaline solutions. The results are interpreted on the basis of solute-solvent interactions[5], where the addition of solute and its varying concentration has a major influence on the interactions[6-14].

Experimental

Density, viscosity and ultrasound speed have been measured by using precalibrated bicapillary pycknometer[15-16] Ostwald's viscometer[17] and single frequency ultrasonic interferometer at 2 MHz respectively with an accuracy of ±0.05%[18-19.] All chemicals used in the research work are of analytical reagent (AR) Grade obtained from E. Merk. The purity of the used chemicals was checked by density determination at 30°C. The values of density obtained tally with the literature values. Weights of the samples were measured using electronic balance with an accuracy of ± 0.01 mg. all measurements were made in a thermostatically controlled water bath with temperature accuracy of ±1°C. Detailed of experimental techniques are give else where[20].

Theory and Calculations - Different acoustic parameters such as isentropic compressibility (β_s), Intermolecular free length (L_f), Specific acoustic impedance (Z), apparent molal compressibility (φ_k), Solvation number (Sn) and relative association (Ra) have been calculated at 30°C, using ultrasonic velocity(U), density(ρ) and viscosity (η) of these solutions with the help of the following equtions[21].

1. Isentropic Compressibility (β_s) = $U^2 . \rho^{-1}$ (1)
2. Inter molecular Free length (L_f) = $K . \beta^{-1/2}$ (2)
3. Specific acoustic impedance (Z) = $U . \rho$ (3)
4. Apparent molal compressibility (φ_K) = $1000(\rho^o\beta - \beta^o\rho)/Cp + (\beta^o .M)/\rho^o$ (4)
5. Solvation Number (S_n) = $n_1 / n_2 \ (1-\beta/\beta^o)$ (5)
6. Relative association (R_a) = $(\rho/\rho^o) \ (U^o/U)^{1/3}$ (6)

Where p, p_o and U, Uo are the densities and ultrasonic velocities of solution and solvent respectively. K is Jacobson Constant, M molecular weight of solute, β^o and β is the isentropic compressibility of solvent and solution, C is concentration in mole/litre. n_1 and n_2 are the number of moles of solvent and solute respectively.

Results and Discussion

We have measured ultrasonic velocity, density and viscosity of tetra ethyl lead in aqueous NaOH and KOH solutions in Table 1 and 2. These tables show that these three parameters increases with increase in concentration of tetra ethyl lead in solution. This indicates that strong interaction observed at higher concentration of tetra ethyl lead and suggests more association between solute solvent molecules in the system.

Density is a measure of solvent-solvent and ion-solvent interactions. Increase in density with concentration indicates the increase of solvent-solvent and solute-solvent interactions. The increase in density is due to structure breaking properties of the solvent due to added solute.

The isentropic compressibility for the solution of tetra ethyl lead decreases with increase in solute concentration (Table 1, 2). This is attributed to the fact that the solute molecules in dilute solution ionize in simple metal ions and anions. These ionic particles are surrounded by a layer of solvent ions, firmly bound and oriented towards the ions.

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Table 1. Experimental values of Tetra ethyl lead in aqueous NaOH at30°C.

Conc.	U	ρ	η	βs	L_f	Z	Φ_K	Sn	Ra
0.0275	1472	1.1922	0.7988	38.71	0.3926	0.1755	-32.9581	11.0654	0.0231
0.0550	1476	1.1949	0.8015	38.41	0.3911	0.1764	-21.9279	15.6021	0.0461
0.0826	1481	1.1977	0.8043	38.09	0.3895	0.1773	-18.6399	20.4840	0.0691
0.1101	1485	1.2004	0.8070	37.79	0.3879	0.1782	-16.8191	25.1566	0.0920
0.1376	1490	1.2032	0.8098	37.46	0.3862	0.1792	-15.8996	30.0852	0.1149
0.1651	1493	1.2059	0.8125	37.20	0.3849	0.1800	-14.7431	34.0486	0.1378
0.1926	1497	1.2087	0.8153	36.90	0.3833	0.1810	-14.1891	38.5758	0.1606
0.2202	1501	1.2114	0.8180	36.65	0.3820	0.1818	-13.5024	42.4608	0.1834
0.2477	1505	1.2142	0.8208	36.36	0.3805	0.1827	-13.1758	46.8985	0.2061
0.2752	1510	1.2169	0.8235	36.04	0.3788	0.1838	-13.0459	51.7250	0.2288

Table 2. Experimental values of Tetra ethyl lead in aqueous KOH at 30°C.

Conc.	U	ρ	η	βs	L_f	Z	Φ_K	Sn	Ra
0.0275	1455	1.1752	0.7857	40.20	0.4001	0.1710	-108.3854	7.3801	0.0234
0.0550	1459	1.1779	0.7884	39.88	0.3985	0.1719	-59.2712	13.5620	0.0468
0.0826	1463	1.1807	0.7912	39.57	0.3969	0.1727	-42.8482	19.6796	0.0702
0.1101	1467	1.1834	0.7939	39.26	0.3954	0.1736	-34.5984	25.7339	0.0935
0.1376	1471	1.1862	0.7967	38.96	0.3939	0.1745	-29.6184	31.7256	0.1168
0.1651	1475	1.1889	0.7994	38.66	0.3923	0.1754	-26.2735	37.6556	0.1400
0.1926	1479	1.1917	0.8022	38.36	0.3908	0.1762	-23.8633	43.5246	0.1632
0.2202	1483	1.1944	0.8049	38.07	0.3893	0.1771	-22.0375	49.3334	0.1864
0.2477	1487	1.1972	0.8077	37.78	0.3878	0.1780	-20.6015	55.0829	0.2095
0.2752	1491	1.1999	0.8104	37.49	0.3863	0.1789	-19.4385	60.7737	0.2326

The orientation of solvent ions around the ions of solutes is attributed to the influence of electrostatic field of ions and thus the internal pressure increases, which lowers the compressibility of solution.

Intermolecular free length is the distance between the surfaces of the neighboring molecules and variation in free length with concentration and temperature is similar to that of isentropic compressibility[22].

The specific acoustic impedance is a product of density of solution and velocity has shown the reverse trends to that of intermolecular free lentgh[23].Thus the fact that increase of specific acoustic impedance with increase in intermolecular forces with the addition of solute ions and supports the strong solute- solvent interaction due to structural arrangement affected. The values of apparent molal compressibility increases with increase in concentration at 30°C temperature studied which indicates occurrence of solute-solvent interaction and solvent effect is more dominating than the electrolyte. The values of solvation numbers are listed in table 1 and 2. The result shows that the solvation number is found to increase in solute which shows close association between solute and solvent.

The relative association[24] depends on either the breaking up of solvent molecules on the addition of solute to it or solvation of ions that are present. In the present case relative association increases with increase in concentration of tetra ethyl lead which is due to the breaking up of molecules in the solution which also indicates prominent solute- solvent interaction.

Conclusion

It is concluded from the data available at present that the solute-solvent interaction is possible and increases with the increase in concentration.

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