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The Study of Ion- Solvent Interaction of Bleaching Powder (antiseptics) in Polar Solvent Butanol and excellent Solvent Water

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Abstract

Ion solvent interaction measurements of Bleaching Powder (antiseptics) and Butanol & Water carried out for the study of solute-solvent interaction. Various acoustic parameters (intermolecular free length, isentropic compressibility, specific acoustic impedence, molar sound velocity, apparent molal adiabatic compressibility, relative association and solvation number) have been evaluated using ultrasonic velocity data. The results were discussed in the light of solute-solvent interaction between the molecules.

Introduction

Several techniques such as IR, MNR, Roman spectroscopy and Ultrasonics have been used for the determination of molecular and ion-solvent interaction[1-6]. The present work deals with the study of solute-solvent interaction in the solution of Bleaching Powder in Butanol and Water using Ultrasonic velocity data. The values of ultrasonic velocity, specific acoustic impedence, apparent molal adiabatic compressibility, relative association and solvation number increases while the isentropic compressibility, intermolecular free length and molar sound velocity decrease with increasing Bleaching Powder.

Experimental

All the chemicals used in present study are of AR/BDH grade. A known amount of Bleaching Powder is dissolved in Butanol and Water so as to obtain various concentration solutions. The ultrasonic velocity in these solutions was measured using a multi frequency ultrasonic interferometer (F-81 Mittal Enterprises, New Delhi) at a fixed frequency of 2 MHz and a constant temperature (30°C ± 0.005°C). The desities of the solvent and solutions are measured using a specific gravity bottle.

The various acoustic parameters viz. isentropic compressibility (βs), apparent molal adiabatic compressibility (Φ_k), specific acoustic impedance (Z)[7], molar sound velocity (R)[8], relative association (R_A)[9] salvation number (S_n)[10], viscosity (η), intermolecular free length (L_f)[11], and shear's relaxation time (τ)[12] have been evaluated by using the following empirical formula:

1. $\beta s = \frac{1}{V^2 \rho}$

2. $L_f = K (\beta_s)^{\frac{1}{2}}$

3. $Z = v \times \rho \times 10^{-5}$

4. $R = \frac{M}{\rho} \times v^{\frac{1}{3}}$

   Where $[M = n_1 m_1 + n_2 m_2 / n_1 + n_2]$

5. $R_A = \left(\rho/\rho_0\right)\left(V_0/V\right)^{\frac{1}{3}}$

6. $S_n = \frac{n_1}{n_2}\left(1 - \frac{\beta_S}{\beta_{S_0}}\right)$ and

7. $\phi_K = \frac{1000}{C \times \rho_0}(\rho_0 \beta_S - \beta_{S0} \rho) + \beta_{S0} \times \frac{M}{\rho_0}$

8. $\tau = \frac{4}{3}\eta \times \beta_S$

Where v_0, v, ρ_0, ρ, β_{s0}, β_s are the ultrasonic velocity density and isentropic compressibility of the solvent and solution respectively, n_1, n_2 and m_1, m_2 are the number of moles and molecular weight of the solvent and solute respectively and K and C are the temperature dependent Jacobson's constant and concentration respectively.

Result and Discussion

Ultrasonic velocity (v) in the solution of Bleaching Powder, Butanol, Water increases with increasing concentration of Bleaching Powder. The variation of velocity with concentration (c) can be expressed by the following relationship.

$$\frac{dv}{dc} = -\frac{v}{2}\left[\frac{1}{\rho\left(d\rho/dc\right)} + \frac{1}{\beta_s\left(d\beta_s/dc\right)}\right]$$

In general results show that while the density increase, the isentropic compressibility decreases with increasing concentration of solute and the quantity $(d\beta s/dc)$ is positive while $(d\rho/dc)$ is negative. Since the values of $[1/\beta s(d\beta s/dc)]$ are larger than the values of $[1/\rho(d\rho/dc)]$ for Bleaching Powder, Butanol, Water, the concentration derivative of velocity, (dv/dc) is positive *i.e.* the ultrasonic velocity increases with increasing the concentration of solute.[13-15]

Ultrasound Velocity Vs Mole Concentration

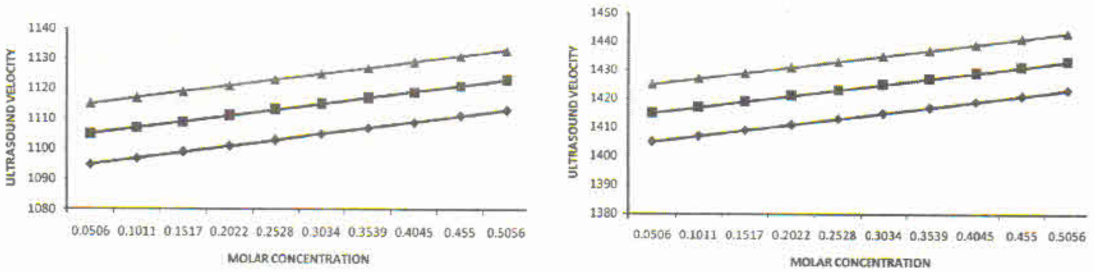

Table 1. Bleaching Powder + Butanol at Temp. 30°C

Isentropic Compressibility of Diethylether = 79.81 x 10^{12} dyne/cm^2

Molar Concentration Bleaching Powder (mole/litre)	density ρ (gm/ml.)	Ultrasound Velocity (m/sec.)	Isentropic Compressibility β_s (cm²/dyne.10^{12})	Lowering Compressibility β_{so}-β_s (cm²/dyne.10^{12})	Viscosity (C.P.)	Specific Viscosity η_{sp} (C.P.)	Reduce Viscosity η (C.P.)	Shear's Relaxation Time τ	Specific Acoustic Impedence $Z \times 10^{-5}$	Molar Sound Velocity R (m/sec.)	Relative Association R_A	Solvation Number S_n	Intermolecular Free Length L_f	Specific Lowering Compressibility $\beta_s - \beta_{so}/C$ (10^{12})	Apparent Molal Compressibility ϕ_K
0.0506	0.8102	1118	98.75	25.70	0.2407	0.0088	0.1741	31.6912	0.9058	388.53	1.0423	0.6034	0.6270	-508.3652	-36.8547
0.1011	0.8104	1120	98.37	26.08	0.2449	0.0264	0.2611	32.1212	0.9076	388.86	1.0432	0.6123	0.6258	-257.9072	-18.3354
0.1517	0.8106	1122	98.00	26.45	0.2512	0.0528	0.3482	32.8221	0.9095	389.19	1.0440	0.6211	0.6246	-174.4076	-12.1632
0.2022	0.8108	1124	97.62	26.83	0.2600	0.0897	0.4435	33.8428	0.9113	389.51	1.0449	0.6298	0.6235	-132.6477	-9.0778
0.2528	0.8110	1126	97.25	27.20	0.2720	0.1400	0.5537	35.2704	0.9132	389.84	1.0458	0.6385	0.6223	-107.5836	-7.2270
0.3034	0.8112	1128	96.88	27.57	0.2860	0.1987	0.6549	36.9453	0.9150	390.17	1.0467	0.6471	0.6211	-90.8676	-5.9936
0.3539	0.8114	1130	96.52	27.93	0.2974	0.2464	0.6963	38.2726	0.9169	390.49	1.0475	0.6558	0.6199	-78.9219	-5.1130
0.4045	0.8116	1132	96.15	28.30	0.3080	0.2909	0.7191	39.4870	0.9187	390.82	1.0484	0.6643	0.6187	-69.9577	-4.4528
0.4550	0.8118	1134	95.79	28.66	0.3200	0.3412	0.7497	40.8708	0.9206	391.15	1.0493	0.6728	0.6176	-62.9812	-3.9396
0.5056	0.8122	1136	95.41	29.04	0.3270	0.3705	0.7328	41.5975	0.9227	391.57	1.0504	0.6818	0.6163	-57.4426	-3.5361

Table 2. Bleaching Powder + Water at Temp. 30°C

Isentropic Compressibility of Diethylether = 49.84 x 10^{12} dyne/cm^2

Molar Concentration Bleaching Powder (mole/litre)	density ρ (gm/ml.)	Ultrasound Velocity (m/sec.)	Isentropic Compressibility β_s (cm²/dyne.10^{12})	Lowering Compressibility β_{so}-β_s (cm²/dyne 10^{12})	Viscosity (C.P.)	Specific Viscosity η_{sp} (C.P.)	Reduce Viscosity η (C.P.)	Shear's Relaxation Time τ	Specific Acoustic Impedence $Z \times 10^{-5}$	Molar Sound Velocity R (m/sec.)	Relative Association R_A	Solvation Number S_n	Intermolecular Free Length L_f	Specific Lowering Compressibility $\beta_s - \beta_{so}/C$ (10^{12})	Apparent Molal Compressibility ϕ_K
0.0506	1.0001	1426	49.17	0.67	0.8011	0.9064	17.9263	52.5216	1.4261	908.92	1.0065	0.0096	0.4425	-13.1700	-1.1771
0.1011	1.0051	1428	48.79	1.05	0.8061	0.9127	9.0259	52.4401	1.4353	913.94	1.0121	0.0152	0.4408	-10.3856	-0.9063
0.1517	1.0102	1430	48.41	1.43	0.8112	0.9191	6.0592	52.3581	1.4445	918.96	1.0176	0.0207	0.4390	-9.4283	-0.8163
0.2022	1.0152	1432	48.03	1.81	0.8162	0.9254	4.5758	52.2757	1.4538	923.99	1.0232	0.0261	0.4373	-8.9282	-0.7715
0.2528	1.0203	1434	47.66	2.18	0.8213	0.9318	3.6858	52.1930	1.4631	929.03	1.0288	0.0315	0.4356	-8.6111	-0.7449
0.3034	1.0253	1436	47.30	2.54	0.8263	0.9381	3.0924	52.1099	1.4724	934.06	1.0343	0.0368	0.4340	-8.3859	-0.7272
0.3539	1.0304	1438	46.93	2.91	0.8314	0.9445	2.6686	52.0265	1.4817	939.11	1.0399	0.0421	0.4323	-8.2133	-0.7147
0.4045	1.0354	1440	46.57	3.27	0.8364	0.9508	2.3507	51.9427	1.4910	944.15	1.0455	0.0473	0.4306	-8.0737	-0.7054
0.4550	1.0405	1442	46.22	3.62	0.8415	0.9572	2.1035	51.8586	1.5004	949.20	1.0511	0.0524	0.4290	-7.9563	-0.6983
0.5056	1.0456	1444	45.87	3.97	0.8466	0.9635	1.9057	51.7742	1.5098	954.25	1.0567	0.0575	0.4274	-7.8546	-0.6927

The isentropic compressibility (β_s) of chloramines-t solutions decreases with increase in the molar concentration of solute. The complimentary use of isentropic compressibility data can provide interesting information on solute solvent interaction. The results of isentropic compressibility have been explained in terms of Bachem's equation.[16]

$\beta_s = \beta_{s\,0} + AC + C^{3/2}$

The variation of intermolecular free length with molar concentration of Bleaching Powder in Butanol and Water is show in Fig. 1 at 30C. It decreases with increasing molar concentration and the slope of lines is found to be negative. Linear decreases of L_f has also been reported for oxalic acid dehydrate in tetra hydro furan by Ravi Chandran *et. al.*[17].

The variation of specific viscosity increases with increasing molar concentration of Bleaching Powder in Butanol and Water shown in Fig.2 at 30C it increase with increasing molar concentration and the slope of lines is found to be negative. The result of N_{sp} indicates that there is significant interaction between the solute and solvent molecules.[18-19]

It is found that molal adiabatic c\compressibility has been negative increase with increasing molar concentration while molal adiabatic compressibility negative on increasing molar concentration shown in table 1&2.

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