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ACOUSTIC BEHAVIOUR OF TETRAALKYLAMMONIUM HALIDES IN WATER AT 313.15 K.

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ABSTRACT

Ultrasonic velocity (v) was measured in aqueous solutions of tetraalkylammonium halides i.e. tetramethylammonium chloride/ bromide/ iodide (TMAC/ TMAB/ TMAI) and tetraethylammonium chloride/ bromide/ iodide (TEAC/ TEAB/ TEAI) at 313.15 K. Parameters such as adiabatic compressibility, β, apparent molal compressibility, ϕ_k, intermolecular free length, L_f, specific acoustic impedance, Z, molar sound velocity, R, and all the significant salvation number, Sn, were derived using ultrasonic velocity, v, and density, ρ, for these solutions. An appreciable inflection in the vicinity of CMC (as established by conductance measurements etc.) is observed for plots of various acoustic parameters versus surfactant concentration. It is inferred from the results that a significant solute-solvent interaction is predominant and there is no remarkable aggregation of surfactant molecules in pre-micellar region i.e. dilute aqueous solutions of these surfactants.

Key words : Tetraalkylammonium halides, Acoustical studies, Ultrasonic velocity, Derived acoustical parameters.

It is an established fact that if an electrolyte is added to a polar liquid like water, the ions tend to form a new structure wherein the solvent dipoles are oriented about each ion. Consequently, a considerable electrostrictive effect is exerted on the surrounding solvent molecules by the electric field of the ions. As a matter of fact, both the volume and compressibility of the solvent molecules are reduced substantially. The structure of electrolytic solution may be successfully explained through acoustic measurements that take into account various consequences of ion salvation.

Research workers in the past[1-5] have shown that NMR[1,2], IR[3,4] and Raman spectra[5], have been used to study molecular interactions. The velocity measurement of the propagation of ultrasound waves[6-10] and their absorption[11,12] have already been found to be useful in the study of molecular interactions for inorganic, organic and organo-metallic binary systems. Likewise, research workers[13-18] have also employed ultrasonic measurements to look into the important consequences of ion-solvent interactions for the structure of electrolytic solutions. Recent references[19-35] suggest diverse uses of ultrasonic technique. References[19-29] adorn the field of medicine, whereas studies on emulsions/ micro emulsions[30-33], polymer-surfactants interactions[34] and ultrasonic-destruction of surfactants, i.e., application of industrial waste water[35] are only a few cases to suggest versatility of the technique.

A multi-frequency ultrasonic interferometer (M-83, Mittal Enterprises, New Delhi) operating at 4 MHz, was used to measure the ultrasonic velocity of the aqueous solutions at a constant temperature 313.15 (± 0.01)K. The maximum uncertainty of the velocity results was ± 0.2%. The density of solutions was measured by a 15 mL dilatometer calibrated with distilled water and benzene with buoyancy corrected. The accuracy of the density results was ± 0.0001.

Computation of acoustic parameters :

Ultrasonic velocity (v) and density (ρ) data (Tables 1-6) for aqueous tetraalkylammonium halides at 40°C were used to compute different acoustic parameters viz. adiabatic compressibility, β, molar sound velocity, *R*, average molecular weight $\overline{M}$, apparent molal compressibility $¤_K$, intermolecular free length, *Lf*, specific acoustic impedance, *Z*, and primary salvation number, Sn.

$$= \circ^{-1} v^{-2} \qquad \ldots(1)$$

$$R = (\overline{M}/\circ) v^{1/3} \qquad \ldots(2)$$

$$\overline{M} = (n_0 M_0 + nM)/(n_0 + n) \qquad \ldots(3)$$

$$¤_K = 10^3 / C \circ_0 (\circ_0 \; - \;_0 \circ) + \;_0 \frac{M}{\circ_0} \qquad \ldots(4)$$

$$Lf = [\;\; /K]^{1/2} \qquad \ldots(5)$$

$$Z = \circ v \qquad \ldots(6)$$

$$\text{and, } Sn = n_0/n(1 - \;\; / \;_0) \qquad \ldots(7)$$