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Density and Ultrasonic Study of Benzothiazole and Chlorobenzothiazole at 298.15K

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Abstract

Ultrasonic refers to study of sound waves, which are higher frequency than the human audible range. It is widely used in many applications viz. medical, underwater, food and oil technology etc. The Intermolecular interaction plays an important role in the development of molecular science. Substituted benzothiazole plays a vital role in the biological field such as anti-allergic, anti-inflammatory analgesic, and fungicidal activity. Therefore, present work is carried out to study the substituted benzothiazole with different concentrations at 298.15K with 2 MHz. The acoustical parameters; adiabatic compressibility, linear free length, acoustic impedance, relative association etc evaluated with experimental values of density and ultrasonic velocity. It is observed that the density and ultrasonic velocity increases with increase the concentration of solute while adiabatic compressibility and linear free length deceases. The intermolecular interactions have been observed at molar concentrations, which suggest the solute-solvent interaction.

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Keywords: Benzothiazole; ultrasonic velocity, density, acoustic parameters.

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1. Introduction

Heterocyclic compounds provide a synthetic and structural ability due to the number of substitution [1]. They are broadly available in nature and essential to life in various modes [2, 3]. Benzothiazoles and their derivatives are very important intermediate for biological and pharmaceutical activities of antioxidants drugs [4].

Ultrasonic and density studies have found wide application owing to their ability to characterize the physico-chemical behavior of solutions [5]. The measurements of ultrasonic velocity provide useful information regarding the internal structure, complex formation and molecular interaction in liquids because of their accuracy. 1,4-Dioxane (Dx) has been widely used as a solvent, greasing agents, pharmaceuticals and dispersion agents in the textile industry. The Dx is a heterocyclic diethyl ether with each of its two oxygen atoms forming an ether functional group. The molecular structure of Dx may be related to ethanediol and methoxy ethanol, but is an almost apolar, aprotic and protophilic solvent [6]. Thermodynamical and acoustical properties of multi-component liquid mixtures have attracted much attention of researcher in the past decade, as they are required for design of several types of industrial equipments [7].The measurement of various parameters; density, viscosity, refractive indices and ultrasonic velocity of materials are important for process control in most of industrial processes [8]. The substantial work also has been reported by many researchers [9, 10].

The present work deals with some acoustical parameters of substituted Benzothiazole and in mixed organic-aqueous solvent media. The measurements of densities and ultrasonic velocity with acoustical properties have been studied in a different concentration of Benzothiazoles in 70% Dx-water mixtures at 298.15K at atmosphere pressure.

2. Materials and Method

2.1. Materials

The Benzothiazole and Chlorobenzothiazole (Hi-media) and Dx used in the present study was Anal R grade (Qualigens) and purified according to literature method [11]. The water used was doubly distilled and its specific conductivity was found to be 0.74 μS at 298.15 K.

2.2. Method

The purity of the compounds was confirmed by comparing the experimental values of density and speed of sound with literature values at 298.15K at atmosphere pressure (Table 1). The sample solutions were prepared by mixing appropriate volumes of the Dx-water components in standard flasks with airtight caps and the mass measurements were performed on precision digital balance (SHIMADZU AUY-220 of accuracy ± 0.1 mg). The sound velocity of pure components and their mixtures were measured by ultrasonic interferometer (Mittal enterprises, model F-81s at variable frequency) at 2 MHz with frequency tolerance was ± 0.03%. It consists of high frequency generator and a measuring cell. The densities were measured by Densitometer (DMA-35, Anton Paar, Austria, accuracy ± 0.001gm.cc^{-3}). The accuracy of instrument was examined with pure distilled water and Dx, values are agreed closely with literature values (Table 1). The various acoustical parameters were calculated using Microsoft Excel programme.

2.3. Theory

The expression used to determine ultrasonic velocity is;

$$u = \nu\lambda \text{ -------(1)}$$

Where ‘u’ ultrasonic velocity and ‘λ’ wavelength.

The compressibility and ultrasonic velocities have been closely studied by a large number of investigators [12, 13]. The adiabatic compressibility was calculated from Newton-Laplace equation;

$$\beta = \frac{1}{\rho \times u^2} \text{ -------(2)}$$

Where ρ = density