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Physical Characterization of Triethylamine Hydrochloride Aqueous Solution in Relation to Acoustic and Viscometric Parameters at 298.15K and 300.15K

K. C.Patil[1]* and P. S.Jogi[2]

1. Department of Physics, Janata Mahavidyalaya, Chandrapur-442401, Maharashtra, **INDIA**
2. Department of Chemistry, Janata Mahavidyalaya, Chandrapur-442401, Maharashtra, **INDIA**

Email: kc.physics.chd@gmail.com

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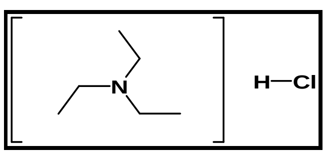
ABSTRACT

In the present paper, ultrasonic velocity and related acoustic physical parameters of aqueous solutions of triethylamine hydrochloride at temperatures (298.15K and 300.15K) have been determined. The study of this solution has covered its concentration range (0.1 to 0.9) mol kg^{-1}. The ultrasonic velocity shows a maximum value when the presence of triethylamine hydrochloride increases in double distilled water.

Graphical Abstract



Molecular structure of triethylamine hydrochloride

Keywords: Triethylamine hydrochloride, Molecular interactions, Ultrasonic velocity.

INTRODUCTION

Different chemical engineering operations for designing the processes to reduce environmental pollution by removing sour gases from natural gases needs the physical properties of pure amines and their aqueous solutions [1]. In recent years, ultrasonic technique is an important tool for examining the physicochemical properties of liquids; liquid mixtures [2]. In previous study, the physical properties of an amino-glycoside antibiotic in water [3-5] and also methylamine hydrochloride in water [6] with the influence in several industrial applications have been studied. Triethylamine is used as a computing base for the separation of acidic, basic and neutral drugs by reverse-phased high-performance liquid chromatography. It is used in industry as a quenching agent in the ozonolysis of alkenes, in the purification of chemical drugs [7] and as an intermediate in the production of various chemicals, including pharmaceuticals. It is also widely used as catalyst for polymerization reactions (in urethane and epoxy resin systems) and as solvent and corrosion inhibitor [8]. Exposure to triethylamine may cause adverse health effects such as visual disturbances and asthma [9]. In the present study, we have carried out physical characterization of aqueous solutions of triethylamine hydrochloride of different concentration (0.1 to 0.9) mol kg^{-1} in relation to ultrasonic velocity and various thermo-acoustic parameters at temperatures 298.15K and 300.15K found in industrial applications.

MATERIALS AND METHODS

Materials: Triethylamine hydrochloride (Purity>98%),chemical formula $(CH_2CH_3)_3N.HCl$, molecular weight 137.65 g mol^{-1}, a white crystalline powder, strongly soluble in water having strong fishy odor, was used in the present investigation (Figure 1).

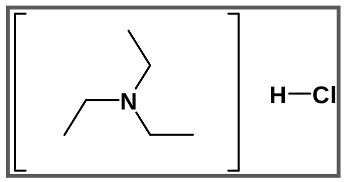


Figure 1. Molecular structure of triethylamine hydrochloride.

The double distilled water was used to prepare the fresh solution of triethylamine hydrochloride. All the solutions of different concentrations were freshly prepared on molality basis.

Methods: The ultrasonic velocity of solvent water and mixture were measured by using digital ultrasonic pulse echo velocity meter (VCT–70A) at 2MHz. Digital ultrasonic pulse echo velocity meter is a simple and unique, direct reading digital system to determine the velocity of ultrasonic waves as well as to observe echoes for attenuation measurements with excellent accuracy. The temperature around the cell was controlled by circulating the water from thermostat manufactured by Acculab scales company (Model – i-therm, AI – 7982). The density of the pure water and mixture was measured by using highly accurate specific gravity bottle method. To determine the viscosity of the solutions, an Ostwald's viscometer was used.

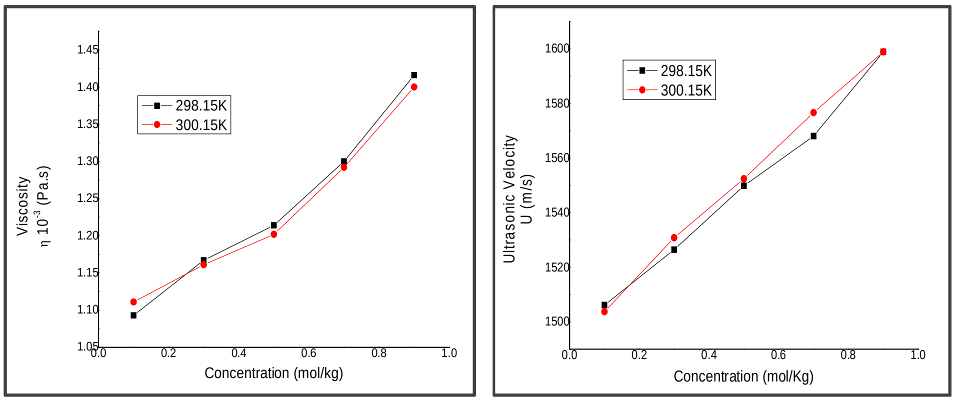
RESULTS AND DISCUSSION

The experimentally measured and evaluated values of system (Water+ triethylamine hydrochloride) at different concentrations and temperatures (298.15K and 300.15K) are listed in tables 1 and 2 respectively.

Table 1. Basic Parameters of aqueous solution of triethylamine hydrochloride at 298.15K and 300.15K

(mol kg^{-1})	T(K)	Experimentally measured parameters		
		ρ (10^3) (kg m^{-3})	η(10^{-3}) (Pa-s)	U (m s^{-1})
0.1	298.15K	0.996	1.0930	1503.171
	300.15K	0.993	1.1110	1506.748
0.3	298.15K	0.997	1.1670	1526.457
	300.15K	0.994	1.1610	1530.830
0.5	298.15K	0.999	1.2140	1549.862
	300.15K	0.996	1.2020	1552.453
0.7	298.15K	1.000	1.3000	1568.056
	300.15K	0.997	1.2920	1576.650
0.9	298.15K	1.001	1.4160	1598.893
	300.15K	0.999	1.4000	1598.893

The different behaviour of measured and evaluated physical properties at different composition and temperature has been observed in the present investigation. The ultrasonic velocity of aqueous solution of triethylamine hydrochloride increases with increase in composition as well as temperature. It has been reported that, maximum value of ultrasonic velocity indicates the maximum molecular interactions in the liquid mixtures [**10**]. The increase in ultrasonic velocity sharply may be due to stronger dipole-dipole molecular interactions [**11**]. The adiabatic compressibility and free length shows reverse trend to that of ultrasonic velocity in the present investigation. This type of trend shows that system becomes less compressible and compactness exists in the solution (Fig 1 and 2). The compactness may be due to some specific interactions. The enhanced compactness results in decrease in free length [**12**]. The internal pressure is a measure of cohesive force between the constituent molecules in all the mixtures [**13**].



(a) (b)

Figure 1. (a and b)Effect of concentration and temperature viscosity and ultrasonic velocity of aqueous solutions of triethylamine hydrochloride at temperatures(298.15K and 300.15K).

Table 2. Evaluated Physical Parameters of aqueous solution of triethylamine hydrochloride at 298.15K and 300.15K

(mol kg^{-1})	T(K)	Evaluated physical parameters							
		β_{ad} 10^{-10} ($N^{-1}m^2$)	L_f 10^{-11} (m)	V_f 10^{-8} (m^3 mol^{-1})	π_i 10^9 (Pa-s)	Z 10^6 (kg $m^{-2}s^{-1}$)	τ 10^{-13} (s)	R 10^{-4} (m^5N^{-1})	$\Delta G10^{-21}$ ($Jmol^{-1}$)
0.1	298.15K	4.4239	4.3265	1.4203	2.950	1.5007	6.447	2.0955	4.6691
	300.15K	4.4528	4.3554	1.3826	2.970	1.4934	6.5961	2.1013	4.8095
0.3	298.15K	4.3009	4.2659	1.3601	2.950	1.5231	6.692	2.1514	4.8060
	300.15K	4.2905	4.2753	1.3767	2.931	1.5225	6.6417	2.1606	4.8350
0.5	298.15K	4.1656	4.1983	1.3567	2.911	1.5489	6.743	2.2083	4.8336
	300.15K	4.1655	4.2125	1.3806	2.888	1.5463	6.6759	2.2169	4.8539
0.7	298.15K	4.0641	4.1469	1.2876	2.922	1.5691	7.045	2.2631	4.9941
	300.15K	4.0324	4.0324	1.3104	2.899	1.5791	6.9464	2.2744	5.0006
0.9	298.15K	3.9045	4.0646	1.2041	2.948	1.6018	7.372	2.3243	5.1607
	300.15K	3.915	3.954	1.2250	2.925	1.5973	7.3087	2.3309	5.1883

The most useful information regarding the intermolecular interactions in binary solutions can be obtained from very important physical parameters such as internal pressure and free volume. The internal pressure is only a parameter which varies due to all type of solute-solute, solvent-solute and solvent-solvent interactions. The resultant of attractive and repulsive forces between the components of mixture is known as internal pressure. The measure of dipolar, ionic interactions and internal structure is provided by internal pressure. Many researchers [**14-19**] theoretically calculated the internal pressure of mixtures. It has been observed in the present investigation that internal pressure decreases with increase of temperature. This may be due to the weakening of cohesive forces and it leads to structure breaking tendency of the solute. The free volume of solution increases in a non linear manner as the temperature increases in the present study. Increase in temperature causes weakening of cohesive forces which results in enhanced free volume. Acoustic impedance (Z) of

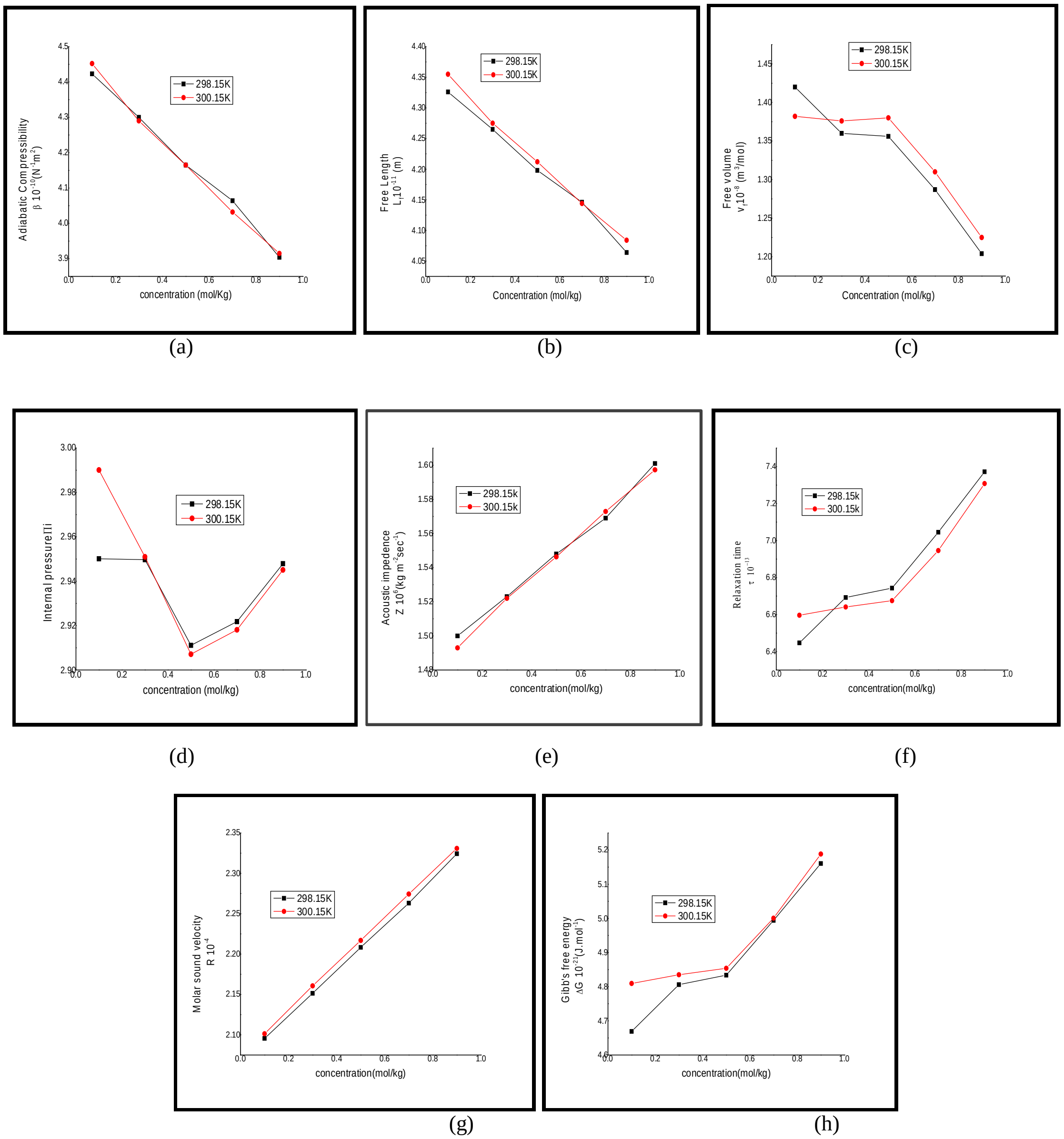


Figure 2. (a-h) Effect of concentration and temperature on adiabatic compressibility, free length, free volume, internal pressure, acoustic impedance, relaxation time, Rao's constant and Gibb's free energy respectively of aqueous solution of triethylamine hydrochloride at temperatures(298.15K and 300.15K).

aqueous solution of triethylamine hydrochloride at temperatures (298.15K and 300.15K) has been measured. The ratio of the instantaneous pressure excess at any particle of the medium to the instantaneous velocity of that particle is known as acoustic impedance of the medium [20]. Acoustic impedance depends upon the inertial and elastic properties of the solution. The formation of hydrogen bonding between solute and solvent increases an internal pressure with rise in composition of triethylamine hydrochloride in water. Hence, with the propagation of ultrasonic wave through the solution in present investigation, instantaneous pressure excess at any molecule in aqueous solution increases which results in increased acoustic impedance.

APPLICATION

The present investigation provides better understanding of physicochemical properties of triethylamine hydrochloride in aqueous environment as well as several biochemical and physiological processes. The measured and derived physical parameters with respect to temperature and concentration plays key role in the development of molecular model, process design and operation in chemical engineering.

CONCLUSION

Density, viscosity, ultrasonic velocity and related acoustic physical parameters of aqueous triethylamine hydrochloride of different concentration (0.1, 0.3, 0.5, 0.7 and 0.9) mol kg^{-1} at 298.15K and 300.15K were studied. The nature, strength and order of molecular interactions of aqueous triethylamine hydrochloride in terms of these parameters are investigated. It is found that there is no color change when solute is dissolved in water as well ultrasonic velocity varies linearly with respect to concentration and temperature range under the study. This indicates that there is no complex formation present in understudied solution.

REFERENCES

[1]. D. Go´mez-Dı´az, Jose´ M. Navaza, Speed of Sound and Isentropic Compressibility of Aqueous Solutions of Pyrrolidine and Piperidine, J. Chem. Eng. Data., **2006**, 51, 722-724.

[2]. Sangeeta, Amit K. Agarawal, Ultrasonic Velocity and Other Allied Properties of Some Alkali Earth Metal Carboxylates in Mixed Organic Solvents, *J. Applicable Chem.*, **2017**, 6 (5), 890-895.

[3]. K. C. Patil, C.M.Dudhe, Studies on thermodynamic properties of streptomycin aqueous solutions from T= (298.15 to 308.15) K, *Der Pharma Chem.*, **2015**, 7(9), 239-249.

[4]. K. C. Patil, C .M. Dudhe, Molecular interaction study of aqueous solution of an Amino-glycoside antibiotic Neomycin at 298.15 to 308.15 K, *Der Pharma Chem.,* **2015**,7(12), 219-226.

[5]. K. C. Patil, C. M. Dudhe, Acoustical and Viscometric studies on Gentamicin sulphate in aqueous medium, Der Pharma Chem., **2016**, 8(20), 227-233.

[6]. K. C. Patil,V. Singh, Thermodynamic Properties of Methylamine Hydrochloride in aqueous medium at 298.15K and 300.15K, *Int. J. Research in Advent Technology*, **2018,** 6,1451-1455.

[7]. Claudius Matasă, Eugenia Tonca, Basic nitrogen compounds: chemistry, technology and applications, Chemical Publishing Co., **1973**.

[8]. B. Åkesson, S. Skerfving, MattiassonL, Experimental study on the metabolism of triethylamine in man, *Br. J. Ind. Med*., **1988**, 45 (4), 262-268.

[9]. B. Åkesson, I. Florén, S. Skerfving, Visual disturbances after experimental human exposure to triethylamine, *Br. J. Ind. Med*.,**1985**, 42, 848-850.

[10]. I. Vibhu, A. K. Singh, M. Gupta, J. P. Shukla, Ultrasonic and IR investigation of N–H–N complexes in ternary mixtures, *J. Mol. Liq*., **2004**, 115,1–3.

[11]. R. Kumar, S. Jayakumar, V. Kannappan, Thermodynamic properties of donor–acceptor complexes of tertiary amine with aryl ketones in hexane medium, *Thermochim. Acta*., **2012**, 536,15– 23.

[12]. L. Palaniappan, Ultrasonic analysis in the ternary system of pyridine + benzene + 2-butanol, *Physica B.*, **2008**, 403, 3887–3891.

[13]. V. Kannappan, S. J. Askaralli, and P. A. Abdul Mahaboob, Determination of stability constants of charge transfer complexes of iodine monochloride and certain ethers in solution at 303 K by ultrasonic method, *Indian J. Pure Appl. Phys*., **2009**, 47,97.

[14]. C. V. Suryanarayana, J. Kuppusamy, Free volume and internal pressure of liquid from ultrasonic velocity, *J.Acoust. Soc. India.*, **1976**, 4, 75.

[15]. J. D. Pandey, Evaluation of the van der waals constant, internal pressure and sound velocity in binary liquid mixtures from flory's theory, *J. Chem. Soc., Faraday Trans.*, **1980**, 76, 12-15.
[16]. J. D. Pandey, S. K. Shukla, J. Chhabra, R. Dey, Excess thermodynamic parameters for the Pb - Sn alloy at various composition, *J. Indian Chem. Soc.*, **2004**, 81, 962-964.
[17]. N. Santhi, P. Sabarathinam, G. Alamelumangai, J. Madhumitha, M. Emayavaramban, Estimation of internal pressure of liquids and liquid mixtures, *Int. lett. chem. phys. astron.*, **2013**, 5, 1-7.
[18]. A. F. M. Barton, Internal pressure, A fundamental liquid property, *J. Chem. Edu.*, **1971**, 48(3), 156.
[19]. S. C. Srivastava, N. Berkowitz, On the relationship between internal pressure and Ultrasonic velocity, *Can. J. Chem.*, **1963**, 41(7), 1787-1793.
[20]. A. Awasthi, J. P. Shukla, Ultrasonic and IR study of intermolecular association through hydrogen bonding in ternary liquid mixtures, *J. Mol. Liq.*, **2003**, 41(6), 477-486.