Studies in Acoustic Parameters of Promethazine Drug in Dioxane-Water Solvent at Different Temperatures

U.S. WASNIK[1], R.M.JUMLE[2] AND P.R. RAJPUT[3]

1-Department of Chemistry, Arts Science and Commerce College, Chikhaldara Dist : Amravati (M.S.)
2-Department of Chemistry , Shivaji College, AkotDist : Akola (M.S.) India
3-Department of Chemistry, VBMV, Amravati (M.S.) India
Corresponding author: us.wasnik@gmail.com

Abstract

Measurements of ultrasonic velocity have been carried out for Promethazine hudrochloride (PM) at three different temperatures. Viscosities and densities of present system have been measured at 303K, 308K & 313K. From this data various acoustic parameters such as apparent molar compressibility (ϕ_k), apparent molar volume (ϕ_v), adiabatic compressibility (β_s), specific acoustic impendence (Z), intermolecular free length (L_f), molar compressibility (W) & relative association (R_A) have been determined. From these derived parameters limiting apparent molal volume (ϕ^0_v), limiting apparent molal compressibility (ϕ^0_k) and Experimental slopes (S^0_V & S^0_K) have calculated by using Massons equation. The viscosity data are analysed using Jones – Dole equation. The results are interpreted on the basis of solute-solvent and solute-solute interactions.

Keywords: Promethazine hydrochloride, acoustic parameters.

Introduction

The studies on volumetric, ultrasonic and viscometric properties of liquid mixtures and their dependence on composition and temperature are of importance in many fields of applied research and find applications in many important chemical, textile, leather, industrial and biological process. Ultrasonic waves provide valuable information about the molecular interaction in pure liquids, aqueous solutions, liquid mixtures and also provide valuable information about the structure of solids[1-4].

Ultrasonic velocity measurements have been successfully employed to detect and assess weak and strong molecular interactions, present in binary liquid mixtures [5, 6]. Ultrasonic studies have found wide applications owing to their ability to characterize the physico-chemical behaviour of solutions. The excess properties have been claimed to be an aid in the characterization of the molecular interactions that are present in solutions and liquid mixtures. This is achieved through elevation of ideal quantities. In recent years, considerable efforts have been given for the elevation of ideal and excess thermodynamic quantities of binary and ternary liquid mixtures [7, 8].The study of molecular interaction in the liquid mixtures is of considerable in the elucidation of the structural properties of the molecules.

The nature and degree of molecular interactions in different solutions depend upon the nature of the medium, the structure of the solute molecule and also the extent of solvation taking place in solution.For

International Journal of Chemical and Physical Sciences, ISSN:2319-6602
IJCPS Vol. 4 Special Issue – NCSC Jan-2015
www.ijcps.org

the present study drug *[Dimethy1 (1-(10-H phenothiazin-10-y1) propan-2-y1] amine)* is selected. This drug is used as antihistaminic, sedative. Acoustic parameters provide a better insight into molecular environment to liquid mixtures, it seemed important to study molecular interactions, which motivated theauthors to carry out the present investigation in the binary liquid mixtures of Promethazine hydrochloride (PM) with dioxane-water solvent at different temperatures using ultrasonic technique.

Materials and Methods

Solventdioxane used in the present work was of AR grade, purified and dried by the usual procedure. Densities, viscosities and ultrasonic velocities were measured at different temperatures over a wide range of composition. Densities were determined by using bicapillarypyknometer. The Viscosities (η) of pure compounds and their mixtures were determined using Oswald's Viscometer calibrated with double distilled water [8,9]. Ultrasonic velocity measurements were made by using an ultrasonic interferometer (Mittal Enterprises, New Delhi) at a frequency of 2MHz with a tolerance of $\pm$ 0.005%. All the measurements were carried out at different temperatures.

Acoustic parameters such as apparent molar compressibility (ϕ_k), apparent molar volume (ϕ_v), adiabatic compressibility (β_s), specific acoustic impendence (Z), intermolecular free length (L_f),molar compressibility (W) & relative association (R_A)were determined using following relationsLimiting apparent molar volume (ϕ^0_v), limiting apparent molar compressibility(ϕ^0_k)and Experimental slopes (S^0_V&S^0_K) have calculated by using Massons equation.

Ultrasonic velocity	$u = \lambda \upsilon$	1
Adiabatic compressibility	$\beta_s = 1/ u^2_s \rho_s$	2
Apparent molar compressibility	$\phi_k = 10^3(\rho_0\beta_s-\rho_s\beta_0)/m-\rho_s \rho_0 + \beta_s M/\rho_s$	3
Apparent molar volume	$\phi_v = 10^3(\rho_0-\rho_s)/m-\rho_0 \rho_s + M/\rho_0$	4
Specific acoustic impendence	$Z = \rho.u$	5
Intermolecular free length	$L_f = K (\beta_s)^{1/2}$	6
Molar compressibility	$W = M \times (\beta_s)^{-1/7}\rho_s$	7
Relative association	$R_A = (\rho/\rho_0) \times (u_0/u)^{1/3}$	8
Limiting apparent molar volume	$\phi_v = \phi^0_v + S_v C^{1/2}$	9
Limiting apparent molar compressibility	$\phi_k = \phi^0_k + S_k^{1/2}$	10

In the present paper, we report densities (ρ) and Ultrasonic velocities of binary mixtures of Promethazine hydrochloride (PM) withdioxane-water solvent at different temperatures, over the entire composition range.

Table 1: The Experimental values Density, Ultrasonic Velocity and related Parameters at different temperatures System- PM in 20% Dioxane-Water medium
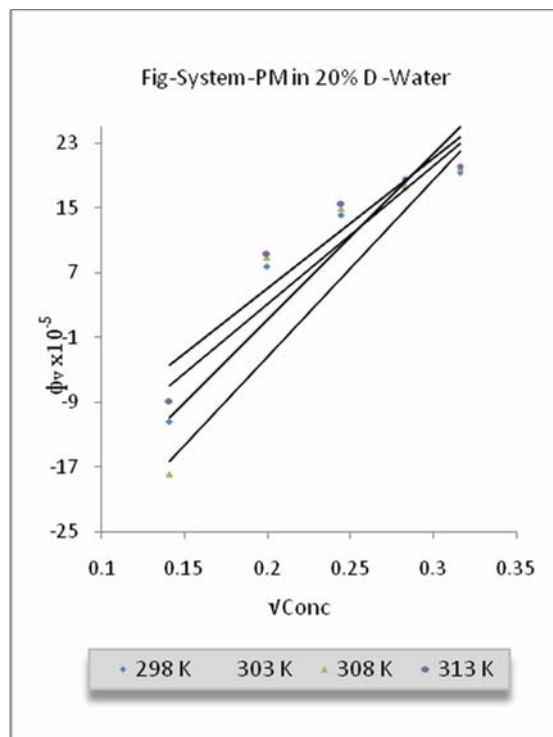
Temp T(K)	Conc. mol. dm^{-3}	Density $\rho s Kgm^{-3}$	Ultrasonic Velocity (u) m/s	β_s x10^{-10} Pa^{-1}	Φv x10^{-5} m^3mol^{-1}	Φk x10^{-14} m^3mol^{-1} Pa^{-1}	L_f x10^{-11} (m)	Z x 10^5 Kg m^{-2} sec^{-1}	Relative association R_A X10^{-3}
298K	0.02	1025.45	1621.1	3.7108	-11.454	-152.81	3.9723	16.6235	996.42
	0.04	1025.74	1622.8	3.7020	7.7182	-73.593	3.9675	16.6457	996.36
	0.06	1026.06	1625.4	3.6890	14.506	-47.909	3.9606	16.6775	996.13
	0.08	1026.19	1628.5	3.6745	17.451	-35.190	3.9528	16.7115	995.63
	0.1	1026.41	1631.5	3.6602	19.399	-27.586	3.9451	16.7458	995.23
303K	0.02	1024.45	1625.3	3.6952	-21.937	-176.235	3.9972	16.6503	997.24
	0.04	1024.77	1627.6	3.6836	2.4168	-86.030	3.9909	16.6791	997.08
	0.06	1024.91	1629.9	3.6728	10.820	-55.763	3.9850	16.7050	996.75
	0.08	1025.12	1632.1	3.6621	14.937	-40.646	3.9792	16.7309	996.65
	0.1	1025.31	1634.6	3.6502	17.420	-31.704	3.9728	16.7597	996.18
308K	0.02	1020.96	1629.2	3.6901	-7.9301	-179.43	4.0273	16.6334	993.22
	0.04	1021.12	1631.1	3.6810	9.8516	-86.888	4.0223	16.6554	992.99
	0.06	1021.84	1633.3	3.6685	14.866	-56.945	4.0154	16.6897	993.24
	0.08	1022.06	1635.1	3.6596	17.976	-41.313	4.0106	16.7117	993.09
	0.1	1022.21	1637.5	3.6484	19.909	-32.160	4.0044	16.7386	992.75

Table 2.   Limiting values of ϕ_v and ϕ_k along with slope (S_V&S_K) for PM indioxane-water medium at different temperatures

Temp.T (K)	Medium	Parameters			
		ϕ_v^0 x10^{-5} m^3mol^{-1}	ϕ_k^0 x10^{-14} $m^3mol^{-1}pa^{-1}$	S_v x10^{-5} $m^3mol^{-3/2}dm^{3/2}$	S_k x10^{-14} $m^3mol^{-3/2}dm^{3/2}pa^{-1}$
298K	20%D-W	-31.28	-232.3	171.7	695.7
303K	20%D-W	-40.29	-273.3	194.1	820.8
308K	20%D-W	-40.09	-274.3	205.9	818.5

Results and Discussion

Table 1 shows that density (ρ), ultrasonic velocity (u) and viscosity (η) increases with increase in concentration for all three systems. The increase in ultrasonic velocity is due to decrease in intermolecular free length (L_f) as shown in Table. This suggests that there is a strong interaction between promethazine hydrochloride and solvent molecule. Adiabatic compressibility (β_s) is a measure of intermolecular association or repulsion calculated from the measured ultrasonic velocity (u) and density (ρ). Adiabatic compressibility is found to decrease with increase in concentration[10]. Since adiabatic compressibility is inversely related to the product of density and ultrasonic velocity based on this the compressibility is expected to decrease which has observed in the present case.

International Journal of Chemical and Physical Sciences, ISSN:2319-6602
IJCPS Vol. 4 Special Issue – NCSC Jan-2015
www.ijcps.org

Fig-System-PM in 20% D -Water

When the sound waves travels through the solution, certain part of it travels through the medium and rest gets reflected by the ion[11] i.e. restriction for flow of sound velocity by the ions. The character that determines the restriction movement of sound waves is known as acoustic impendence (Z). It has been found that acoustic impendence increases with increase in concentration. The apparent molar compressibility (ϕ_k) explains the solute-solvent and solute- solute interactions in solution and was calculated by using the equation 3. The apparent molar volume (ϕ_v) is defined as the change in volume of solution for the added one mole of a particular component at constant temperature and pressure. It is thermodynamic property which helps in elucidating solvation behavior of electrolyte in solution. Apparent molar volume was evaluated from the density of solution and solvent. It is evident from the Table 2 that ϕ^0_k values are negative for 20% Dioxane-water. The negative ϕ^0_k values are suggest solute-solvent interaction whereas positive values are due to solute- solute interaction. S_v is a measure of solute - solvent interaction. It is observed from the Table 2 that The decreasing values of ϕ^0_v and increasing values of S_v clearly indicates the decrease in solute-solvent and increase in solute-solute interactions with the rise of temperature which indicates the solute-solute interactions are stronger than solute-solvent interactions.

References

[1]. R P Verma and S Kumar, Ind J Pure and apply Phy 2000; 312:59.

[2]. S Kamila, S jena and B Bihari. J ChemThermodyn 2005; 37:820.

[3]. R Abraham, M Abdulkhadar and CV Asokan. J ChemThermodyn 2001; 32:1.

International Journal of Chemical and Physical Sciences, ISSN:2319-6602
IJCPS Vol. 4 Special Issue – NCSC Jan-2015
www.ijcps.org

[4]. S Mukharjee, C Basu and US Ghosh. J Non-Cryst Solids.1992; 144:159.

[5]. Kannappan V and Jaya SanthiR Indian J pure &applPhy 2005;43, 750.

[6]. Kannappan V, Xavier Jesu Raja and JayasanthiR Indian J pure &apply 2003;41,690.

[7]. Jayakumar S, Karunanithi N, Kannappan V andGunasekaran S Asian Chem Lett1999;3, 224.

[8]. YonzhanLuo and Robert L Bldwin J MolBiology 1998; 49, 279.

[9]. Kannappan V and Jaya Santhi R Indian J pure & apply 2005; 43,167.

[10]. Owen B.B and Kronick P K, J Phys Chem,1961; 65:81.

[11]. Sumathi T & Uma Maheshwari, Indian J Pure and Applied phys., 2009; 47:782