IJPSR (2014), Volume 5, Issue 9 **(Research Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 07 March 2014; received in revised form, 16 May 2014; accepted, 26 June 2014; published 01 September 2014

COMPARATIVE STUDY OF SPECIFIC ACOUSTIC IMPEDANCE AND TRANSPORT PROPERTIES OF SULFA COMPOUNDS USING ULTRASONIC VELOCITY

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Keywords:

Specific Acoustic impedance, Transport properties, Ion-ion interaction, Ion-solvent interactions

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ABSTRACT: Measurement of ultrasonic velocity in non-aqueous solution gives information about the behavior of solution such as molecular association and disassociation. The attraction and repulsion between the molecules of the components involved show considerable effect upon the physical and chemical properties of a solution such as density, viscosity, and ultrasonic velocity. The ultrasonic velocity data combined with density and viscosity provides the standard means for determining the acoustical parameters and internal pressure, free volume. The Specific acoustic impendence in solutions can be used as a tool to estimate the strength of intermolecular attraction. Internal pressure (πi) and free volume (Vf) are the transport properties, which are useful in understanding the intra and intermolecular interactions. Internal pressure gives an idea of the solubility characteristics. Sulphanilamide is a parent compound and also the potent antibiotic which is important in urinary tract infections and meningococcal meningitis profilaxes [1]. Another sample Sulphadiazine is the Sulphonamide potent antibiotic, and it is a competitive inhibitor of the bacterial enzyme dihydropteroate synthesis.

INTRODUCTION: The passage of ultrasonic waves through solutions and liquids disturb the equilibrium between solute and solvent molecules. The velocity of such a wave is the thermodynamic quantity and is related to physio-chemical properties of the medium [2]. Ultrasonic velocities have been adequately employed in understanding the nature of molecular interaction in pure solutions [3]. The behavior of Specific Acoustic impedance of the solution emphasizes the strong solute-solvent interactions occurring in the Solution.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.5(9).3775-78

This article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.5(9).3775-78

Internal pressure, the free volume is reliable and easily measurable parameters, which are fundamentally responsible for the structure of liquids/solutions. Internal pressure depends on the nature of the solvent, and solute interactions may lead to contraction or expansion at a constant temperature [4].

EXPERIMENTAL ANALYSIS: The density of the solution is measured with 25ml of specific gravity bottle with an accuracy of 0.0001gm/cc. Cannon Fenske viscometer is used for the viscosity measurements, with an accuracy of ± 0.5%. Mittal's interferometer of frequency $2MH_Z$, with an accuracy of ±0.5m/s, is used for the measurement of ultrasonic velocity.

Specific Acoustic impedance (z), internal pressure (π_i) and free volume (v_f) of both the salts are evaluated by using the formulae

Specific acoustic impedance (Z) = ρu (Rayl)

Internal pressure (π_i) = bRT $[k\eta/u]^{1/2}\rho^{2/3}/M^{7/6}$ atms

Free volume (v_f) = $[M_{eff}\ u/k\eta]^{3/2}$cc

RESULTS AND DISCUSSION: In the present Work, the specific acoustic impedance of Sulphadiazine, a dip is observed at 0.01 molality at all temperatures. These may be due to the weak solute-solvent interaction taking place in the solution, and in (another sample) sulphanilamide, the linear increase in *Z with the molality at a given temperature is observed in the solution. This linear increasing due to the effect of strong solute-solvent interaction existing in the solutions [5]. This may be due to the effect of solute-solvent interaction occurring in the solution [6] as shown in **Fig. 1** & **2** and **Table 1** & **2**.

TABLE 1: SPECIFIC ACOUSTIC IMPEDANCE (RAYL) SULPHANILAMIDE

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	18.85	18.65	18.22	17.87	17.55	17.34
0.005	18.96	18.66	18.45	18.02	17.63	17.40
0.01	19.05	18.74	18.54	18.21	17.74	17.53
0.015	19.13	18.85	18.60	18.27	17.84	17.61
0.02	19.15	18.90	18.68	18.36	18.01	17.71

TABLE 2: SPECIFIC ACOUSTIC IMPEDANCE (RAYL) SULPHADIAZINE

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
.001	18.59	18.34	18.02	17.76	17.55	17.34
.005	18.78	18.44	18.13	17.91	17.70	17.27
.01	18.71	18.44	18.09	17.88	17.49	17.18
.025	18.74	18.50	18.19	17.98	17.62	17.40
0.05	18.85	18.56	18.37	18.20	17.80	17.53

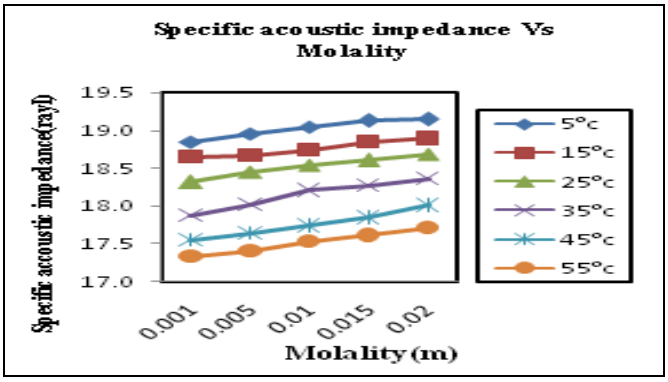

FIG. 1: SULPHANILAMIDE

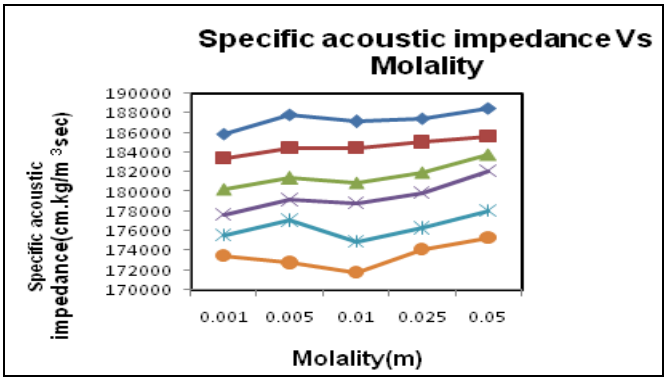

FIG. 2: SULPHADIAZINE

The internal pressure is a single factor, which varies due to all internal interactions. There is a non-linear variation with respect molalities and temperatures are observed in Sulphadiazine and Sulphanilamide. At 0.01 molality there is an abrupt change noticed in both systems as shown in **Fig. 3** & **4** and **Table 3** & **4.**

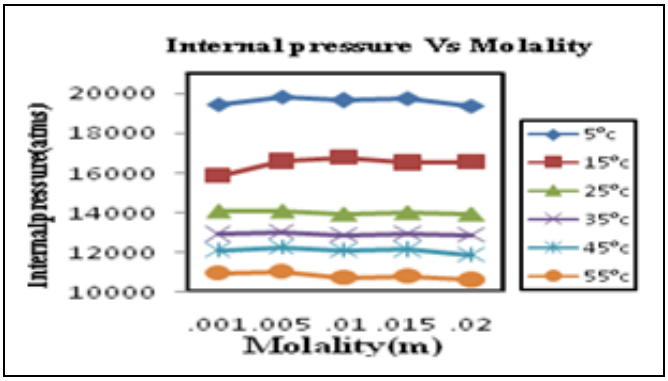

FIG. 3: SULPHANILAMIDE

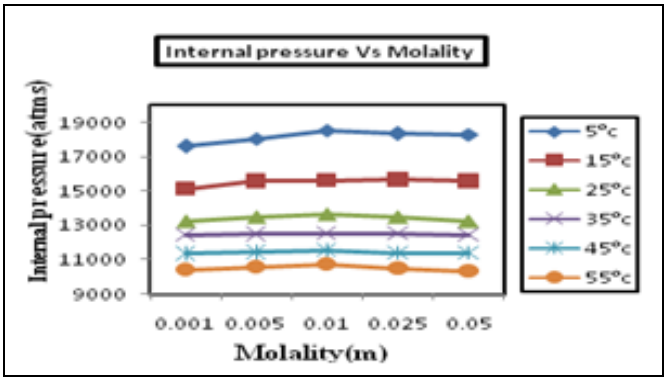

FIG. 4: SULPHADIAZINE

TABLE 3: INTERNAL PRESSURE (ATMS) SULPHANILAMIDE

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	19448	15828	14076	12895	12087	10933
0.005	19843	16591	14080	12983	12239	10992
0.01	19658	16774	13943	12867	12090	10703
0.015	19779	16493	14002	12934	12117	10786
0.02	19376	16535	13916	12842	11875	10582

TABLE 4: INTERNAL PRESSURE (ATMS) SULPHADIAZINE

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	17581	15102	13266	12415	11337	10387
0.005	18029	15557	13508	12480	11412	10566
0.01	18510	15617	13671	12530	11518	10706
0.025	18312	15641	13495	12491	11401	10468
0.05	18280	15571	13266	12447	11400	10323

Hence, there is a weak solute-solvent interaction taking place in the solutions. The reduction in internal pressure may be due to the breaking up of the structure of the solvent medium due to the addition of solute in the solvent [7]. The Internal pressure decreases with rising in temperature because when the temperature is increased, there is a tendency for the ions to move away from each other, reducing the possibility for interaction, which may further reduce the cohesive forces and ultimately leads to a decrease in the internal pressure [8, 9]. Free Volume is the free space available for the molecule to move [10]. The structure making and breaking effects of these samples are confirmed by decreasing and increasing values of free volume concerning molalities and temperatures [11, 12] as shown in **Fig. 5** & **6** and **Table 5** & **6.**

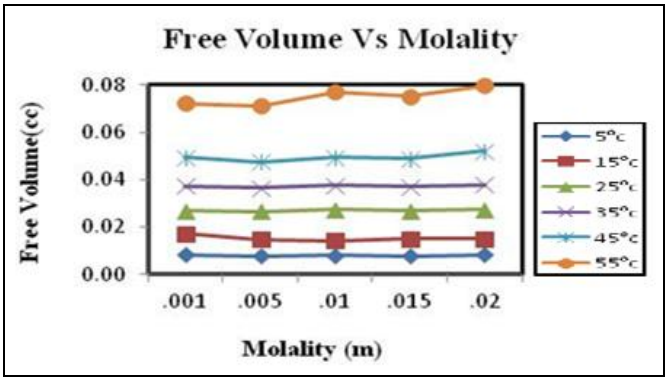

FIG. 5: SULPHANILAMIDE

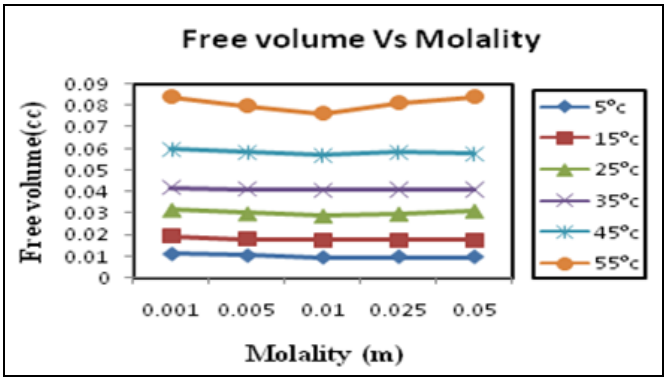

FIG. 6: SULPHADIAZINE

TABLE 5: FREE VOLUME (cc) SULPHANILAMIDE

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	0.008	0.017	0.027	0.037	0.049	0.072
0.005	0.008	0.015	0.026	0.037	0.048	0.071
0.01	0.008	0.014	0.027	0.038	0.049	0.077
0.015	0.008	0.015	0.027	0.037	0.049	0.075
0.02	0.008	0.015	0.027	0.038	0.052	0.080

TABLE 6: FREE VOLUME (CC) SULPHADIAZINE

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	0.011239	0.019478	0.031506	0.041865	0.059698	0.083960
0.005	0.010463	0.017897	0.029864	0.041198	0.058524	0.079810
0.01	0.009652	0.017679	0.028742	0.040663	0.056828	0.076477
0.025	0.009903	0.017479	0.029724	0.040842	0.058209	0.081304
0.05	0.009869	0.017528	0.031078	0.040987	0.057831	0.084148

From the analysis of Sulphadiazine and Sulphanilamide, it is observed that the systems seem to be conditioned by repulsive forces; hence, the solute-solvent interaction is weak.

CONCLUSION: Sulfonamide compounds identified as chemotherapeutic agents, possess a broad spectrum of biological properties [13]. Sulfanilamide is a potent antibiotic because this drug undergoes metabolic alterations in tissues [14].

Sulphadiazine is essential for folic acid synthesis used in the treatment of rheumatic fever and meningococcal meningitis.

The Weak solute-solvent interactions observed in the non-aqueous sulfa drug solution is based on the thermodynamical and acoustic impedance analysis which reveal the entry of these salts into the formamide introduce a structure breaking tendency in these samples.

ACKNOWLEDGEMENT: Nil

CONFLICT OF INTEREST: Nil

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How to cite this article:
Padmavathy R, Vasantharani EJ and Santhakumari S: Comparative study of specific acoustic impedance and transport properties of sulfa compounds using ultrasonic velocity. Int J Pharm Sci & Res 2014; 5(9): 3775-78. doi: 10.13040/IJPSR.0975-8232.5(9).3775-78.