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Thermodynamical Parameters, Adiabatic Compressibility Analysis of Amides Using Ultrasonic Velocity

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Abstract: Measurement of ultrasonic velocity in non-aqueous solutions 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.Sulphanilamide is the parent compound of all the sulfa-drugs which is important in urinary tract infections and meningococcal meningitis profilaxes. Benzenesulphonamide is one of the sulfa drug used in the treatment of gastrointestinal, duodenyl ulcer, neurological disorder.. The passage of ultrasonic waves through solutions and liquids disturb the equilibrium between solute and solvent molecules. In the present work, non-aqueous solutions of both the samples have been prepared with different concentrations and the experiments were carried out from a low temperature of 5^0C to a high temperature of 55^0C.The various interactions occurring in the solutions are interpreted in terms of ion-ion and ion-solvent interactions.Internal pressure, free volume are the thermodynamical parameters to explain about the wealth of information about the state of liquids. The structural changes of molecules in the solution takes place due to the existence of electrostatic field between the interacting molecules. The arrangement of the molecules results in the effect of adiabatic compressibility. The analysis of the study reveals the structural changes occurring in the solution.

Keywords: Amides, Internal pressure, Free volume, Adiabatic compressibility,Ion-solvent interactions

1. Introduction

Ultrasonic technique is the vital probe in evaluating the thermo-dynamical parameters such as internal pressure and free volume. In the recent years, ultrasonic technique has become a more powerful tool in providing information regarding the behavior of liquids and solids owing to its ability of characterizing physiochemical behavior of the medium [1-3].The velocity of ultrasonic waves in a medium and several other acoustic parameters which are dependent on it, helps to determine the overall response of the medium and about the nature of interactions between the molecules of the medium[4,5].Ultrasonic velocity of a liquid/solution is fundamentally related to the binding forces and it is the adequately employed in understanding the nature of molecular interaction in pure liquids/solutions.[6-8]. Internal pressure, free volume and acoustical parameter such as adiabatic compressibility (β) are computed from the basic parameters. The present work deals with the ultrasonic investigations and acoustical study of amides in formamide .

2. Experimental Technique

Density of the solutions is measured using 25ml specific gravity bottle with 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 2 MH_Z with an accuracy ±0.5m/s is used for the measurement of ultrasonic velocity.

(i) Internal pressure (π_i) = $bRT\,[k\eta/u]^{1/2}\rho^{2/3}/M^{7/6}$ atms
(ii) Free volume (v_f) = $[\,Meff\,u/k\eta]^{3/2}cc$
(iii) Adiabatic compressibility (β) = $[1/u^2\rho]$ cm^2/dynes.

3. Tables & Figures

SULPHANILAMIDE-TABLE (1)

INTERNAL PRESSURE (Atms)

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

BENZENE SULPHONAMIDE –TABLE(2)

Molality(m)	5°C	15°C	25°C	35°C	45°C	55°C
.001	20066	16519	14522	12962	11640	10624
.005	20164	16888	14682	13099	11931	10731

.01	20373	16953	14867	13246	12148	10850
.015	20607	17192	14985	13299	12221	10937
.02	20655	17294	15257	13425	12269	11023

INTERNAL PRESSURE (Atms)

SULPHANILAMIDE-TABLE (3)
FREE VOLUME (cc)

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

BENZENE SULPHONAMIDE- TABLE (4)
FREE VOLUME (cc)

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
.001	0.0076	0.0150	0.0241	0.0368	0.0556	0.0791
.005	0.0075	0.0140	0.0233	0.0356	0.0516	0.0766
.01	0.0072	0.0138	0.0224	0.0345	0.0488	0.0742
.015	0.0070	0.0133	0.0219	0.0340	0.0480	0.0723
.02	0.0069	0.0130	0.0207	0.0331	0.0473	0.0706

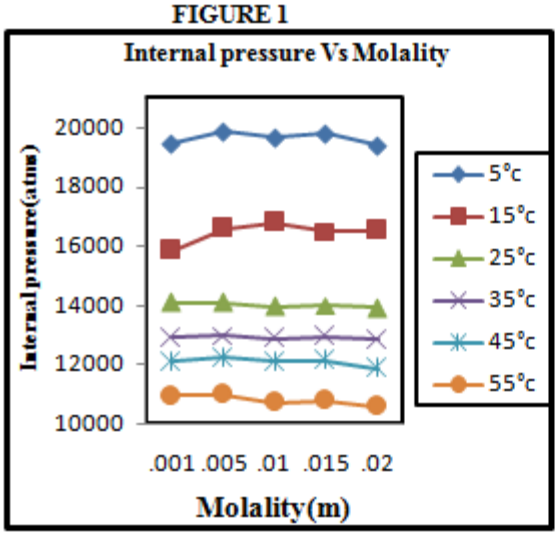
SULPHANILAMIDE TABLE(5)
Adiabatic compressibilityx10^{-11} (cm^2/dynes)

Molality(m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	3.23	3.28	3.41	3.52	3.62	3.69
0.005	3.19	3.27	3.35	3.45	3.59	3.66
0.01	3.16	3.24	3.32	3.39	3.55	3.61
0.015	3.14	3.22	3.28	3.36	3.51	3.58
0.02	3.13	3.20	3.28	3.33	3.44	3.54

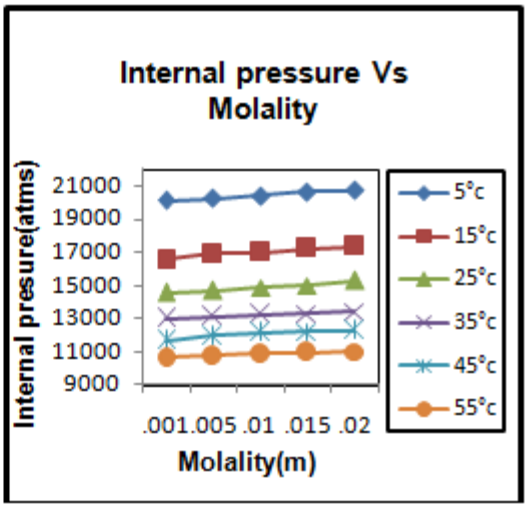
BENZENE SULPHONAMIDE-TABLE(6)
(Adiabatic compressibilityx10^{-11} (cm^2/dynes))

Molality (m)	5°C	15°C	25°C	35°C	45°C	55°C
0.001	3.23	3.29	3.35	3.41	3.46	3.54
0.005	3.26	3.33	3.38	3.44	3.50	3.57
0.01	3.28	3.37	3.43	3.48	3.54	3.60
0.015	3.32	3.40	3.47	3.53	3.57	3.62
0.02	3.36	3.44	3.50	3.56	3.62	3.66

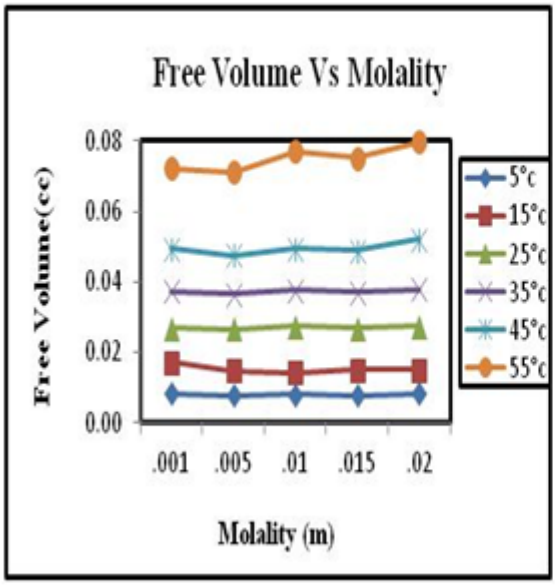
SULPHANILAMIDE
FIGURE 1



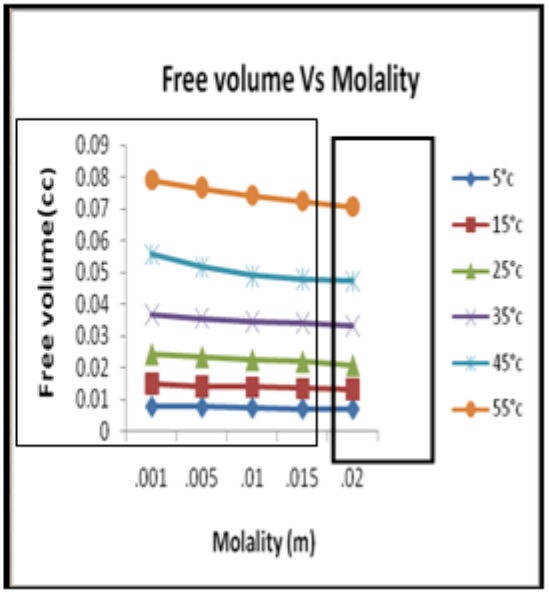
BENZENE SULPHONAMIDE
FIGURE 4



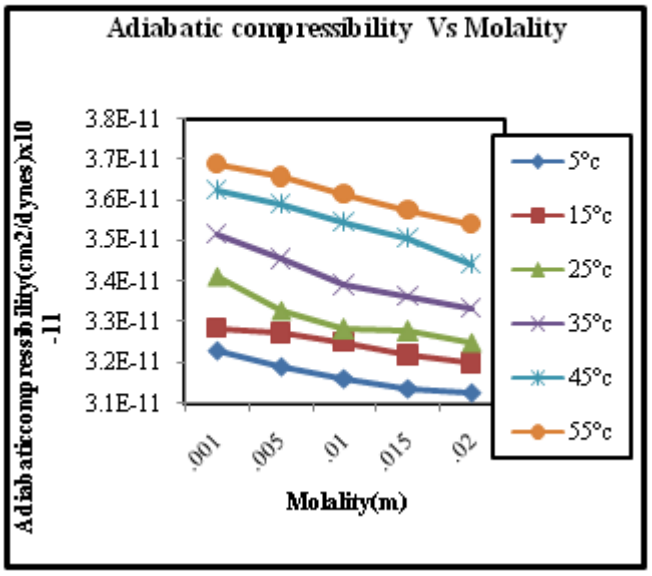
SULPHANILAMIDE
FIGURE 2



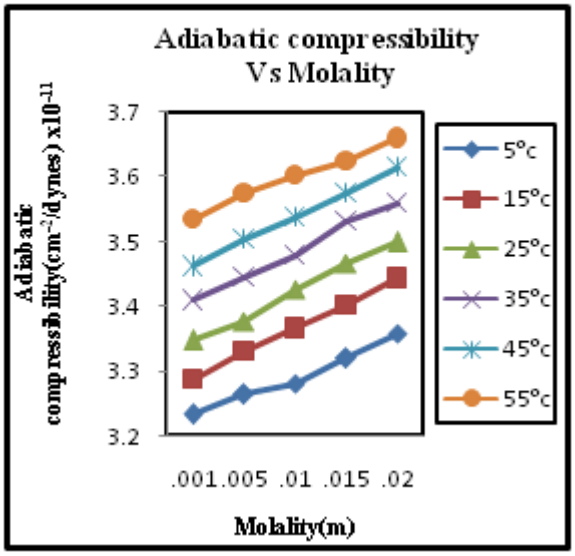
BENZENE SULPHONAMIDE
FIGURE 5



Sulphanilamide
Figure 3



Benzene Sulphonamide
Figure 6



4. Results and Discussion

Internal pressure and free volume are easily measurable and fundamentally responsible for various interactions occurring in the solution. In the present study ,internal pressure found to show a peak at 0.005 molality, for all temperature in the cases. Sulfanilamide, through there is a decrease 0.002 molality as shown in table (1) &fig(1)which indicates weak solute-solvent interactions, the solution stabilities through strong solute – solvent interactions.

Another solute,internal pressure exhibits an increasing trend with respect to increasing molalities as shown in table (2), fig(2).In benzene sulphonamide the internal pressure is found to be increasing with increase in concentration for all temperatures which indicates strong solute-solvent interactions, taking place in the solution. Internal pressure is a measure of cohesive energy of the system hence these variations may be due to the structure making nature of the solute in the solvent . It implies that there is a strong solute-solvent interaction taking place in the solution[9].The dependence of parameter on temperature has also been used to explain the strength of interactions with change in temperatures[10,11].The internal pressure decreases with rise in temperature of the solution. Since when the temperature is increased, there is a tendency for the ions to move for away from other ,reducing the possibility of interaction, which may further reduce the cohesive forces and ultimately leads to a decrease in internal pressure[12].

The variations in the free volume (V_f) with respect to molalities and temperature of Benzene Sulphonamide and sulfanilamide behave in an opposite manner to internal pressure as expected.The variations of V_f with molalities as shown inTable(3&4), fig (3&4) also confirm the structure making nature of the solutes in the solvent. The structure

making/ breaking property is confirmed by the decreasing/ increasing trend of the free volume with respect to concentrations and temperatures [13,14].The results obtained from the present study suggest that there is a strong solute-solvent interactions occurring in both the solutions. This may be due to intermolecular H- bonding presents in this system[15,16]. The adiabatic compressibility increases with decrease in molality and rise in temperature [17]as shown in Table(5&6),fig (5&6). When the salt is added to the solvent ,the compressibility is lowered. This lowering is attributed to the influence of the electrostatic field of the ions on the surrounding solvent molecules. such a decrease may be due to (i) an increase in the number of incompressiblemolecule[18,19,20] .(ii) structural changes occurring in the solution .This may be due to the association taking place between the molecules. When the temperature increases, the associated groups of molecules breakdown increasingly and the forces of attraction between the molecules decrease. This leads to an increase in the adiabatic compressibility of the system[21].

5. Conclusion

Sulphanilamide compounds identified as chemotherapeutic agents, possess broad spectrum of biological properties[22]. Sulfanilamide is a potent antibiotic because this drug undergoes metabolic alterations in tissues[23] .Both acoustical and thermodynamical analysis reveals that the addition of amides in formamide enhances the structure of solution. The detailed study of Thermodynamical parameters and acoustic parameter suggests that there is a molecular association existing in the solution. The addition of solute into the solvent brings about a strong solute-solvent interaction in the solution.

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