International e-Conference on New Horizons And Multidisciplinary Applications In Science And Technology
In Association withInternational Journal of Scientific Research in Science and Technology
Volume 9 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Acoustically Study of Internal Pressure and Gibbs Free Energy on Binary Liquid Mixture of 7-Hydroxy-4-Phenyl-2H-Chromen-2-One in Acetone-Water, DMF-Water DMSO-Water at 308.15K

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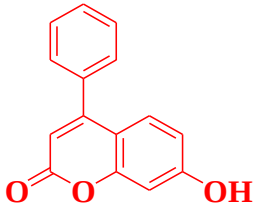
ABSTRACT

Due to the vast pharmacological activity of Coumarins derivatives the viscosity, ultrasonic velocity and density of 7-hydroxy-4-phenyl-2H-chromed-2-one has been measured in 70:30 (v/v) Acetone–water, 70:30 (v/v) NNDMF-water and 70:30 (v/v) DMSO-water with different concentration of 7-hydroxy-4-phenyl-2H-chromene-2-one at temperature 308.15K.To know the various interaction with the various Thermo acoustical parameters internal pressure, Gibb's free energy was calculated from experimental data of ultrasonic velocity, viscosity, and densities. The changes in values of this parameter with the change concentration of solute represent the different types of interaction like solute-solvent interaction, solvent-solvent, and dipole-dipole interactions present in the solutions.

Keyword:- 7-hydroxy-4-phenyl-2H-chromen-2-one, Acetone, DMF, DMSO, internal pressure, Gibb's free energy.

I. INTRODUCTION

Coumarins and chromones are ubiquitous and have relevant pharmacological activities such as anti-inflammatory, antioxidant, cardio protective, and antimicrobial properties[1,2]. The majority of the large numbers of drugs being introduced in pharmacopeias every year are heterocyclic compounds.



7-hydroxy-4-phenyl-2*H*-chromen-2-one

The knowledge of viscosities, densities, ultrasonic velocities, and various acoustical parameters are useful for the studies of thermo acoustical properties of a system. The study of molecular interaction in liquid shows valuable information regarding the internal structure, molecular association, complex formation, internal pressure. The studies of the solution properties of a liquid solution of polar and non-polar components have great applications in industrial and technological process[3]. The literature survey [4-7] reveals the many researchers who give attention to the study of ultrasonic velocity measurement and the study of acoustical properties. Due to these vast applications of 7-hydroxy-4-phenyl-2H-chromen-2-one make our interest in an investigation of its acoustical parameters. The measured values of ultrasonic velocity, internal pressure, Gibb's free energy gives idea regarding types of interaction present in the 7-hydroxy-4-phenyl-2H-chromen-2-one -70:30 (v/v) Acetone –water,7-hydroxy-4-phenyl-2H-chromen-2-one-70:30 (v/v) NNDMF-water and 7-hydroxy-4-phenyl-2H-chromen-2-one -70:30 (v/v) DMSO-water solutions.

II. MATERIALS AND METHODS

The compound 7-hydroxy-4-phenyl-2H-chromen-2-one synthesize by known method[8]. The densities of Ethanol, Acetone, DMF, and 8,10-dinitro-7H-benzo[c] carbazole solution were measured by using a specific gravity bottle, and the viscosity was measured using Ostwald's viscometer. The ultrasonic velocities of pure components and their mixture were measured by ultrasonic interferometer (Mittal enterprises, model F-81s) at 2 MHz having accuracy ±1 ms–1 in velocity.

Theory:-

Given acoustical parameters are calculated by using various equations.

Ultrasonic velocity (*u*)

$$(u) = v\lambda \quad \text{..... (1)}$$

Where, u-ultrasonic velocity, λ-wavelength.

Internal pressure (Πi)

$$(\Pi i) = bRT\,(k\eta/U)^{1/2}\,(\rho^{2/3}/M^{7/6}) \quad \text{..... (2)}$$

Where, b is the cubic packing factor which is assumed to be 2 in liquid systems. K = 4.28 x 109 and is independent to the nature of liquid. R is gas constant. η is the viscosity and ρ is the density of solution, M-molecular weight (M is the molar mass of the solute) of solute.

Gibb's free energy (ΔG)

$$(\Delta G) = R.T.Ln\,(KT\tau/h) \quad \text{..... (3)}$$

Where, k = 1.23×10^{-23} , h = 6.626×10^{-34} , R is the gas constant, T is the absolute temperature & (τ) is the Relaxation time.

III. RESULTS AND DISCUSSION

The experimentally determined values of density(ρ) and ultrasonic velocities (u) and viscosity (η) for 7-hydroxy-4-phenyl-2H-chromen-2-one- 70% Acetone, 7-hydroxy-4-phenyl-2H-chromen-2-one-70%NNDMF and 7-hydroxy-4-phenyl-2H-chromen-2-one-70% DMSO solutions measured at 318.5K are given in Table 1.At a constant temperature From fig.1 it is observed that increase in the concentration of 7-hydroxy-4-phenyl-2H-chromen-2-one with an increase ultrasonic velocity (u), also fig 2 and 3 indicates an increase of density and viscosity an increase in the concentration of solute at a constant temperature. An increase in concentration

allows for a closer approach of solvent and solute molecules and a stronger association between solute and solvent molecules. This leads to a decrease in the volume and an increase in the density of the solution[9]. The increased values of viscosity and ultrasonic velocity indicate molecular association in the experimental systems, which are possible due to the presence of hydroxyl group solute structure notably; velocities of lower value are less molecular interaction. It may be due to breaking of molecular clusters, presence of dipole-dipole interaction, solute-solvent interactions, solvent- solvent interactions, and presence of hydrogen bonding between the solute molecule and water molecule solvents.

The internal pressure (πi) is the cohesive force, which is a result of the strength of attraction and force of repulsion between solute and solvent molecules of the solution. It is evident from fig 4 and Table-which internal pressure values increase with the increase of solute concentration for all the experimental systems. Further πi with attentiveness indicates an increase in intermolecular interactions due to the forming of aggregates of solvent molecules around the solute, which affects the structural arrangement of the solution system. Indicated may also accredit to the presence of solute-solvent interactions and hydrogen bonding[10]. Gibb's free energy (ΔG) decreases with an increase in the concentration of solute and a decrease at high temperatures [fig-5].decline of Gibb's free energy indicates the need for a longer time for the co-operative process to take place or for the rearrangement of molecules in the mixture. Stipulate the restricted flow of the ternary mixture compared with the behavior of pure components.

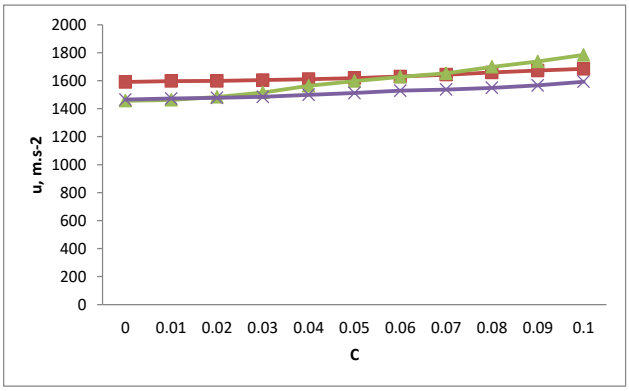


Figure1. Ultrasonic velocity (u) plotted against concentration of 7-hydroxy-4-phenyl-2H-chromen-2one -70% Acetone (■),7-hydroxy-4-phenyl-2H-chromen-2one – 70%NNDMF (▲) and 7-hydroxy-4-phenyl-2H-chromen-2one – DMSO (×), at 308.15K.

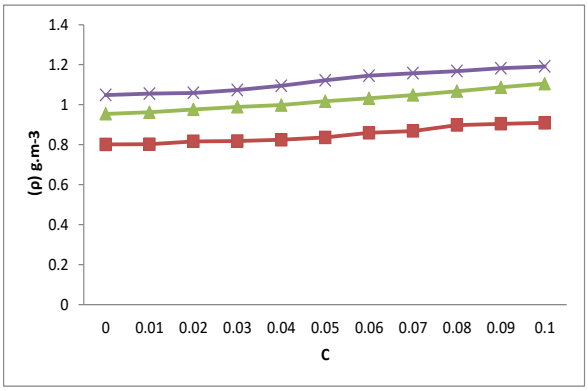


Figure 2. Density (ρ) plotted against concentration of 7-hydroxy-4-phenyl-2H-chromen-2one-70% Acetone (■),7-hydroxy-4-phenyl-2H-chromen-2one – 70%NNDMF (▲) and 7-hydroxy-4-phenyl-2H-chromen-2one – DMSO (×), at 308.15K.

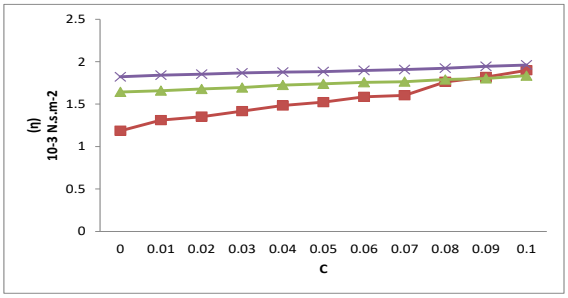


Figure 3. Viscosity (ŋ) plotted against concentration of 7-hydroxy-4-phenyl-2H-chromen-2one -70% Acetone (■),7-hydroxy-4-phenyl-2H-chromen-2one – 70% DMF (▲) and 7-hydroxy-4-phenyl-2H-chromen-2one –DMSO (×),at 308.15K.

Table 1. Experimental values of ultrasonic velocity, density and viscosity of 7-hydroxy-4-phenyl-2H-chromen-2one -70% Acetone, 7-hydroxy-4-phenyl-2H-chromen-2one – 70% DMF and 7-hydroxy-4-phenyl-2H-chromen-2one –DMSO solutions at temperatures 308.15K.

C	u, $m.s^{-2}$			(ρ) $kg.m^{-3}$			(η) 10^{-3} $N.s.m^{-2}$		
	7O% Ac+L	70% NNDMF+L	70% DMSO+L	7O% Ac+L	70% NNDMF+L	70% DMSO+L	7O% Ac+L	70% NNDMF+L	70% DMSO+L
0	1590.1	1456.2	1464.5	0.801	0.954	1.048	1.185	1.643	1.822
0.01	1596.9	1462.3	1472.2	0.802	0.962	1.055	1.311	1.658	1.841
0.02	1598.3	1483.7	1476.9	0.816	0.976	1.059	1.352	1.678	1.852
0.03	1604.4	1515.6	1484.3	0.818	0.989	1.073	1.417	1.695	1.867
0.04	1610.5	1563.1	1498.6	0.824	0.998	1.094	1.483	1.724	1.876
0.05	1618.6	1596.9	1512.1	0.836	1.017	1.122	1.523	1.738	1.882
0.06	1630.1	1627.2	1528.5	0.859	1.032	1.145	1.585	1.756	1.896
0.07	1642.7	1652.8	1536.7	0.868	1.048	1.157	1.603	1.764	1.907
0.08	1658.3	1698.4	1548.6	0.898	1.067	1.168	1.762	1.789	1.923
0.09	1672.1	1736.8	1566.4	0.904	1.087	1.182	1.819	1.802	1.945
0.1	1684.6	1784.3	1592.8	0.909	1.105	1.191	1.898	1.835	1.961

Table 2. Gibb's free energy(ΔG), internal pressure (πi) of 7-hydroxy-4-phenyl-2H-chromen-2one -70% Acetone ,7-hydroxy-4-phenyl-2H-chromen-2one – 70%NNDMF and 7-hydroxy-4-phenyl-2H-chromen-2one –DMSO solutions at different concentration(c) and at temperature 308.15K.

C	(πi)10-6 Pa			(ΔG)(x 10-20 k.J.mol-1)		
	7O% Ac+L	70%NNDMF+L	70%DMSO+L	7O% Ac+L	70%NNDMF+L	70%DMSO+L
0	133.075	183.979	205.683	0.125	0.1258	0.1258
0.01	139.789	185.461	207.128	0.1249	0.1257	0.1257
0.02	143.542	187.018	207.939	0.1248	0.1256	0.1257
0.03	146.912	187.622	210.09	0.1247	0.1254	0.1256
0.04	150.742	187.452	212.314	0.1244	0.1252	0.1255
0.05	153.855	188.565	215.299	0.1243	0.1249	0.1253
0.06	159.256	189.608	217.863	0.1243	0.1248	0.1252
0.07	160.655	190.506	219.431	0.1241	0.1246	0.1251
0.08	171.481	191.538	220.89	0.1239	0.1243	0.125
0.09	174.284	192.464	222.646	0.1238	0.1241	0.1249
0.1	178.02	193.725	222.823	0.1234	0.1239	0.1248

(Uncertainties in isnotropic internal pressure 1×10^{-6} Pa, Gibb's free energy 0.01 x 10^{-20} $k.J.mol^{-1}$).

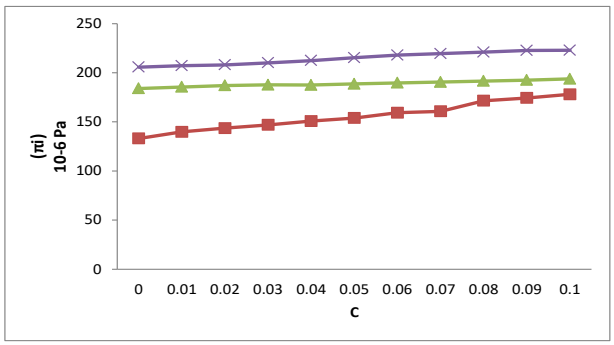


Figure 4 Internal pressure (Jli) plotted against concentration of 7-hydroxy-4-phenyl-2H-chromen-2one -70% Acetone (■),7-hydroxy-4-phenyl-2H-chromen-2one – 70%NNDMF (▲) and 7-hydroxy-4-phenyl-2H-chromen-2one – DMSO (×), at 308.15K

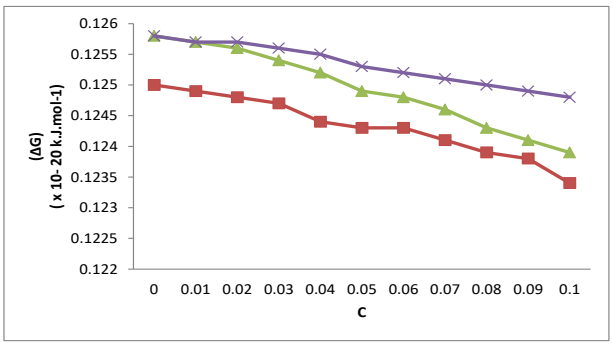


Figure 5 Gibb's free energy (ΔG) plotted against concentration of 7-hydroxy-4-phenyl-2H-chromen-2one -70% Acetone (■),7-hydroxy-4-phenyl-2H-chromen-2one – 70%NNDMF (▲) and 7-hydroxy-4-phenyl-2H-chromen-2one –70%DMSO (×), at

IV. CONCLUSION

In the present article, the densities, ultrasonic velocities, viscosity, and thermodynamical parameters at temperatures, 308.15K over the entire range of composition of 7-hydroxy-4-phenyl-2H-chromen-2one in 70% Acetone, 70%NNDMF and 70% DMSO has been scope. From these measured physical property data, internal pressure, Gibb's free energy intend and used to found the solute-solvent, solvent-solvent interaction, and hydrogen bonding. From the above investigation, it is the effect that 7-hydroxy 4-phenyl-2H-chromen-2one shows absorbing interactive behavior with solvents like Acetone, DMF, and DMSO.

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