International Journal of Basic and Applied Chemical Sciences ISSN: 2277-2073 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jcs.htm
2016 Vol. 6(2) April-June, pp. 55-67/Baluja and Kasundra
Research Article

SOUND VELOCITY STUDIES OF SOME SCHIFF BASES OF 5-AMINO ISOPHTHALIC ACID IN N, N-DIMETHYLFORMAMIDE AND DIMETHYL SULPHOXIDE SOLUTIONS

***Shipra Baluja and Pravin Kasundra**
Physical Chemistry Laboratory, Department of Chemistry, Saurashtra University, Rajkot-360005 (India)
**Author for Correspondence*

ABSTRACT
This work reports densities, speeds of sound, and isentropic compressibility of the solutions of some Schiff bases synthesized using 5-amino isophthalic acid in N,N-dimethylformamide and dimethyl sulphoxide solutions of various concentrations at 308.15 K with a view to understand molecular interactions in these solutions.

Keywords: *Schiff Bases, 5-Amino Isophthalic Acid, Sound Velocity, Acoustical Properties*

INTRODUCTION
Recently, there has been an increased interest in the physico-chemical properties of solutions of organic and inorganic compounds (Kim *et al.,* 1998; José *et al.,* 2006; Laux *et al.,* 2009; Sandarve *et al.,* 2014), polymers (Hassun *et al.,* 1989; Yaseen *et al.,* 2005), drugs (Sarvazyan, 1991; Friedrich *et al.,* 2006) etc. The acoustical properties of solution have been found to be important parameters in the study of several chemical reactions and in the investigation of molecular interactions.
Literature survey shows that because of its non destructive nature, ultrasonic waves have been used in various industries for various processes like dyeing (Vankar *et al.,* 2007; McNeil and McCall, 2011), food processing (Mason *et al.,* 1996; Dolatowski *et al.,* 2007), extraction (Banjoo DR and Nelson, 2005; Pan *et al.,* 2008; Juan *et al.,* 2010), bleaching (Mistik and Müge Yükseloglu, 2005; Abou-Okeil *et al.,* 2010; Hong-xia *et al.,* 2010), cleaning (Foguel *et al.,* 2009), deacidification (Li *et al.,* 2010), waste water treatment effluents (Petrier and Francony, 1997; Saha *et al.,* 2011), organic synthesis (Li *et al.,* 2009; Nasir Baig and Varma, 2012) etc. Further, it is also used in medical fields (Lovett *et al.,* 1988; Boucaud *et al.,* 2001).
The ultrasonic measurements have also been used to study molecular interactions in various pure liquids (José *et al.,* 2006; Inoue *et al.,* 1991), liquid mixtures (Takagi, 1978; Nath and Dixit, 1984; Douhéret *et al.,* 2001; Bhatia *et al.,* 2010) and solutions of different compounds (Magazù *et al.,* 1997; Avivi *et al.,* 2000; Hagen *et al.,* 2004) etc.
The thermodynamic parameters calculated through ultrasonic velocity measurements can give idea about intermolecular attraction (solute-solute or solute-solvent) between molecules (Sasaki and Arakawa, 1973). In our laboratory, the ultrasonic and physicochemical studies of some drugs (Baluja and Kulshshtra, 2014), organic compounds (Baluja and Kulshshtra, 2014; Baluja *et al.,* 2008; Baluja *et al.,* 2010; Bhesaniya and Baluja, 2014) etc. have been studied in different solvents.
This paper is continuation of our previous work. In the present paper, ultrasonic studies of some Schiff base derived from 5-amino isophthalic acid have been studied in N, N dimethylformamide and dimethylsulphoxide solutions at 303.15 K of various concentrations with a view to understand molecular interactions in these solutions.

MATERIALS AND METHODS
The solvents N, N-dimethylformamide and dimethylsulphoxide were of analytical grade and were distilled by the reported procedure (Riddick *et al.,* 1986).
Their mole fraction purities were as follows: N, N dimethylformamide (>0.995) and dimethylsulphoxide (>0.996).

These values were checked by a gas-liquid chromatographic test. The solvents were degassed and dried over molecular sieves (Union Carbide, type 0.4 nm).
Ten Schiff bases (NPK-1 to NPK-10) were synthesized and the reaction scheme is given in Figure 1. The physical constants of all the synthesized compounds are reported in Table 1. All these compounds were recrystalized before use. The densities, viscosities and ultrasonic velocities of pure solvents and solutions of Schiff bases of different concentrations were measured at 303.15 K by using pyknometer, an Ubbelohde suspended level viscometer and single frequency ultrasonic interferometer (Mittal Enterprises, Model No F81) operating at 2 MHz, with the uncertainties of 0.0001 g/cm^3, ± 0.06 % and 0.01% respectively.
The temperature was maintained by an electronically controlled thermostatic water bath (NOVA NV-8550 E). The uncertainty of temperature was ±0.1° C.
All the solutions were prepared by using a Mettler Toledo AB204-S balance with a precision of (1 x 10^{-4}) g.

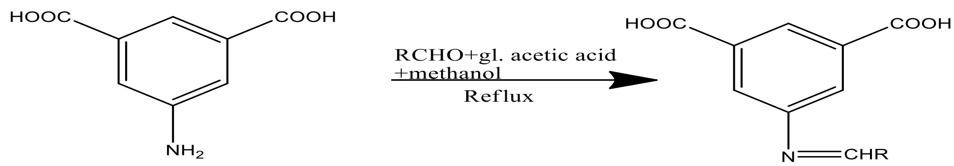

Figure 1: Reaction Scheme for Schiff Bases

Table 1: Physical Constants of Synthesized Schiff Bases

Comp. Code	**R**	**Yield (%)**	**R_f Value***
NPK-1	4-OCH_3,C_6H_4-	62	0.50
NPK -2	3-NO_2,C_6H_4-	82	0.48
NPK -3	3-OCH_3,4-OHC_6H_4-	68	0.52
NPK -4	2-OH-C_6H_4-	71	0.50
NPK -5	4-Cl,C_6H_4-	55	0.46
NPK -6	4-N$(CH_3)_2$-C_6H_4-	79	0.56
NPK -7	4-F,C_6H_4-	63	0.60
NPK -8	2-Cl,C_6H_4-	75	0.46
NPK -9	3-Cl,C_6H_4-	78	0.58
NPK -10	4-OH-C_6H_4-	66	0.52

*Hexane:Ethyl acetate-6.5:3.5

RESULTS AND DISCUSSION

Table 2 shows the experimental data of density (ρ), viscosity (η) and sound velocity (U) of pure solvents and solutions of Schiff bases in DMF and DMSO solutions at 303.15 K.
From these experimental data, various acoustical parameters like inter molecular free length (L_f), isentropic compressibility (κ_s), Rao's molar sound function (R_m), Vander Waals constant (b), relaxation strength (r), apparent molar compressibility (ϕ_k), apparent molar volume (ϕ_v) etc., were evaluated using the following equations:
Intermolecular free path length: $L_f = K_j \kappa_s^{1/2}$
Where, K_J is Jacobson constant (=2.0965 X 10^{-6}) Isentropic compressibility: $\kappa_s = 1/U^2\rho$
Rao's molar sound function: $R_m = (\frac{M}{\rho})U^{1/3}$

Where, M is the apparent molecular weight of the solution.
Van der Waals Constant:

$$b = \frac{M}{\rho}\{1 - (\frac{RT}{MU^2})[\sqrt{1 + (\frac{MU^2}{3RT})}-1]\}$$

Where, R is the gas constant (8.3143 $JK^{-1}mol^{-1}$) and T is the absolute temperature.
Relaxation Strength: $r = 1 - [\frac{U}{U_\infty}]^2$

Where, $U_\infty = 1.6 \times 10^5$ cm sec^{-1}.
Apparent molar compressibility:

$$\emptyset_k = \frac{(\rho_0\kappa_S - \rho\kappa_S^0)1000}{c\rho_0} + \frac{\kappa_S^0 M_2}{\rho_0}$$

Where, ρ_0 and κ_s^0 are density and isentropic compressibility of pure solvent respectively, c is the concentration of the solution and M_2 is the molecular weight of the compound.
Apparent molar volume:

$$\emptyset_V = \frac{(\rho_0 - \rho)1000}{c\rho_0\rho} + \frac{M_2}{\rho_0}$$

Table 2: The Density (ρ), Ultrasonic Velocity (U) and Viscosity (η) of Schiff Bases in DMF and DMSO

Conc M	ρ $g.cm^{-3}$	U. 10^{-5} $cm.s^{-1}$	η .10^3poise
DMF			
NPK-1			
0.00	0.9304	1.4416	7.8072
0.01	0.9316	1.4448	7.9519
0.02	0.9338	1.4476	8.0492
0.04	0.9356	1.4516	8.1727
0.06	0.9367	1.4560	8.2948
0.08	0.9374	1.4616	8.3970
0.10	0.9377	1.4684	8.5466
NPK-2			
0.01	0.9311	1.4436	7.4584
0.02	0.9328	1.4444	7.5422
0.04	0.9341	1.4476	7.6328
0.06	0.9349	1.4532	7.7331
0.08	0.9355	1.4564	7.8456
0.10	0.9358	1.4632	7.9753
NPK-3			
0.01	0.9313	1.4432	7.4608
0.02	0.9332	1.4440	7.5522
0.04	0.9347	1.4460	7.6498
0.06	0.9358	1.4516	7.7497
0.08	0.9364	1.4552	7.8524
0.10	0.9367	1.4604	7.9693
NPK-4			
0.01	0.9317	1.4456	7.4670
0.02	0.9339	1.4484	7.5587
0.04	0.9356	1.4516	7.6527
0.06	0.9367	1.4552	7.7511
0.08	0.9373	1.4604	7.8485

0.10	0.9376	1.4668	7.9542
NPK-5			
0.01	0.9316	1.4436	7.4602
0.02	0.9338	1.4456	7.5443
0.04	0.9356	1.4484	7.6474
0.06	0.9370	1.4612	7.7498
0.08	0.9380	1.4568	7.8529
0.10	0.9385	1.4620	7.9725
NPK-6			
0.01	0.9314	1.4444	7.4601
0.02	0.9334	1.4468	7.5463
0.04	0.9350	1.4508	7.6372
0.06	0.9361	1.4556	7.7325
0.08	0.9367	1.4604	7.8314
0.10	0.9370	1.4676	7.9567
NPK-7			
0.01	0.9311	1.4436	7.4742
0.02	0.9329	1.4452	7.5725
0.04	0.9344	1.4500	7.6723
0.06	0.9355	1.4516	7.7706
0.08	0.9363	1.4544	7.8697
0.10	0.9365	1.4604	7.9714
NPK-8			
0.01	0.9314	1.4440	7.4616
0.02	0.9332	1.4460	7.5432
0.04	0.9348	1.4488	7.6401
0.06	0.9360	1.4524	7.7415
0.08	0.9367	1.4572	7.8458
0.10	0.9371	1.4632	7.9765
NPK-9			
0.01	0.9309	1.4452	7.4553
0.02	0.9324	1.4484	7.5345
0.04	0.9336	1.4512	7.6272
0.06	0.9344	1.4536	7.7199
0.08	0.9349	1.4556	7.8239
0.10	0.9351	1.4580	7.9443
NPK-10			
0.01	0.9312	1.4432	7.4539
0.02	0.9329	1.4452	7.5317
0.04	0.9343	1.4480	7.6246
0.06	0.9353	1.4516	7.7206
0.08	0.9358	1.4552	7.8163
0.10	0.9361	1.4604	7.9263
DMSO			
NPK-1			
0.00	1.0621	1.4676	10.4384
0.01	1.0646	1.4688	10.5293
0.02	1.0668	1.4716	10.6304
0.04	1.0687	1.4736	10.7548

0.06	1.0702	1.4756	10.9059
0.08	1.0711	1.4772	11.0875
0.10	1.0715	1.4796	11.3118
NPK-2			
0.01	1.0643	1.4684	10.5220
0.02	1.0663	1.4696	10.6203
0.04	1.0680	1.4720	10.7400
0.06	1.0693	1.4756	10.8846
0.08	1.0701	1.4788	11.0563
0.10	1.0703	1.4804	11.2653
NPK-3			
0.01	1.0642	1.4700	10.5245
0.02	1.0660	1.4736	10.6225
0.04	1.0675	1.4756	10.7410
0.06	1.0685	1.4784	10.8825
0.08	1.0691	1.4820	11.0572
0.10	1.0693	1.4900	11.2732
NPK-4			
0.01	1.0644	1.4696	10.5239
0.02	1.0664	1.4724	10.6230
0.04	1.0681	1.4756	10.7419
0.06	1.0693	1.4788	10.8811
0.08	1.0702	1.4836	11.0522
0.10	1.0706	1.4892	11.2616
NPK-5			
0.01	1.0647	1.4684	10.5251
0.02	1.0668	1.4700	10.6218
0.04	1.0685	1.4716	10.7381
0.06	1.0698	1.4744	10.8628
0.08	1.0707	1.4792	11.0175
0.10	1.0712	1.4848	11.2124
NPK-6			
0.01	1.0641	1.4696	10.5226
0.02	1.0659	1.4716	10.6189
0.04	1.0674	1.4752	10.7348
0.06	1.0685	1.4788	10.8712
0.08	1.0690	1.4832	11.0363
0.10	1.0692	1.4876	11.2451
NPK-7			
0.01	1.0643	1.4692	10.5237
0.02	1.0663	1.4716	10.6203
0.04	1.0680	1.4752	10.7383
0.06	1.0693	1.4796	10.8820
0.08	1.0701	1.4844	11.0503
0.10	1.0704	1.4888	11.2517
NPK-8			
0.01	1.0644	1.4696	10.5264
0.02	1.0665	1.4712	10.6240
0.04	1.0682	1.4724	10.7446
0.06	1.0694	1.4756	10.8908

0.08	1.0702	1.4804	11.0669
0.10	1.0706	1.4860	11.2858
NPK-9			
0.01	1.0648	1.4680	10.5330
0.02	1.0670	1.4692	10.6359
0.04	1.0688	1.4708	10.7584
0.06	1.0703	1.4740	10.9077
0.08	1.0713	1.4788	11.0887
0.10	1.0718	1.4852	11.3115
NPK-10			
0.01	1.0642	1.4696	10.5227
0.02	1.0660	1.4728	10.6190
0.04	1.0674	1.4760	10.7348
0.06	1.0684	1.4796	10.8737
0.08	1.0689	1.4848	11.0413
0.10	1.0692	1.4908	11.2598

Some of the calculated acoustical parameters are given in Tables 3 and 4 for all the compounds in DMF and DMSO solutions respectively.
It is evident from Table 2 that ultrasonic velocity *(U)* increases with concentration for all the compounds in both the solvents. The velocity depends on intermolecular free length *(L_f)*. Comparison of ultrasonic velocity and intermolecular free length (Tables 3 and 4) shows these two parameters are inversely related. The decrease in the free length causes velocity to increase or vice versa. In a solution, when there is strong interaction between solvents and compound molecules, L_f decreases which causes velocity to increase.

Table 3: Some Acoustical Parameters of Schiff Bases in DMF

	L_f A^o	**$\kappa_s.10^{-11}$ cm^{2}dyn^{-1}**	**$R_m.10^{-3}$ cm^3.mol^{-1}**	**b**	**r**
DMF					
NPK-1					
0.00	0.4373	5.1718	4.1260	78.6657	0.1868
0.01	0.4361	5.1423	4.1577	78.2329	0.1846
0.02	0.4348	5.1103	4.1911	79.8190	0.1814
0.04	0.4331	5.0724	4.2679	81.2058	0.1769
0.06	0.4316	5.036	4.3480	82.6465	0.1719
0.08	0.4298	4.9936	4.4311	84.1187	0.1655
0.10	0.4277	4.9459	4.5175	85.6262	0.1577
NPK-2					
0.01	0.4366	5.1536	4.1637	79.3692	0.1859
0.02	0.4359	5.1385	4.2024	80.0924	0.1850
0.04	0.4347	5.1087	4.2906	81.7124	0.1814
0.06	0.4328	5.0651	4.3833	83.3704	0.1751
0.08	0.4318	5.0396	4.4744	85.0423	0.1714
0.10	0.4297	4.9913	4.5709	86.7405	0.1637
NPK-3					
0.01	0.4367	5.1553	4.1624	79.3520	0.1864
0.02	0.4360	5.1392	4.2002	80.0573	0.1855

0.04	0.4350	5.1167	4.2861	81.6577	0.1832
0.06	0.4331	5.0713	4.3772	83.2853	0.1769
0.08	0.4319	5.0431	4.4686	84.9540	0.1728
0.10	0.4303	5.0060	4.5631	86.6488	0.1669
NPK-4					
0.01	0.4358	5.1360	4.1537	79.1419	0.1837
0.02	0.4345	5.1041	4.1828	79.6463	0.1855
0.04	0.4331	5.0724	4.2507	80.8789	0.1832
0.06	0.4318	5.0414	4.3215	82.1573	0.1769
0.08	0.4301	5.0024	4.3961	83.4770	0.1728
0.10	0.4282	4.9573	4.4735	84.8225	0.1669
NPK-5					
0.01	0.4365	5.1508	4.1581	79.2634	0.1859
0.02	0.4354	5.1245	4.1924	79.8798	0.1837
0.04	0.4341	5.0948	4.2711	81.3268	0.1805
0.06	0.4300	5.0622	4.3612	82.7996	0.1660
0.08	0.4310	5.0234	4.4359	84.3019	0.1710
0.10	0.4294	4.9851	4.5226	85.8475	0.1651
NPK-6					
0.01	0.4363	5.1462	4.1624	79.3306	0.1850
0.02	0.4351	5.1182	4.2006	80.0144	0.1823
0.04	0.4335	5.0813	4.2868	81.5798	0.1778
0.06	0.4318	5.0419	4.3757	83.1812	0.1724
0.08	0.4303	5.0060	4.4670	84.8237	0.1669
0.10	0.4281	4.9550	4.5624	86.4924	0.1587
NPK-7					
0.01	0.4366	5.1536	4.1551	79.2048	0.1859
0.02	0.4357	5.1323	4.1855	79.7560	0.1841
0.04	0.4339	5.0902	4.2572	81.0320	0.1787
0.06	0.4332	5.0730	4.3273	82.3364	0.1769
0.08	0.4321	5.0491	4.3999	83.6631	0.1737
0.10	0.4303	5.0067	4.4786	85.0440	0.1669
NPK-8					
0.01	0.4364	5.1491	4.1594	79.2806	0.1855
0.02	0.4354	5.1249	4.1955	79.9322	0.1832
0.04	0.4342	5.0964	4.2753	81.3992	0.1801
0.06	0.4328	5.0647	4.3574	82.8932	0.1760
0.08	0.4312	5.0276	4.449	84.4277	0.1705
0.10	0.4294	4.9843	4.5312	85.9877	0.1637
NPK-9					
0.01	0.4362	5.1433	4.1628	79.3236	0.1841
0.02	0.4348	5.1124	4.2015	80.0021	0.1805
0.04	0.4337	5.0861	4.2834	81.5079	0.1774

0.06	0.4328	5.0649	4.3665	83.0434	0.1746
0.08	0.4321	5.0484	4.4505	84.6026	0.1724
0.10	0.4314	5.0307	4.5364	86.1887	0.1696
NPK-10					
0.01	0.4367	5.1559	4.1536	79.1847	0.1864
0.02	0.4357	5.1323	4.1843	79.7331	0.1841
0.04	0.4345	5.1048	4.2533	80.9953	0.1810
0.06	0.4332	5.0741	4.3247	82.2865	0.1769
0.08	0.4320	5.0463	4.3984	83.6196	0.1728
0.10	0.4304	5.0088	4.4747	84.9695	0.1669

Table 4: Table 3: Some Acoustical Parameters of Schiff Bases in DMSO

DMSO					
NPK-1					
0.00	0.4021	4.3714	3.8802	73.5602	0.1587
0.01	0.4013	4.3540	3.9029	73.9701	0.1573
0.02	0.4001	4.3285	3.9279	74.3966	0.1541
0.04	0.3992	4.3091	3.9837	75.4187	0.1518
0.06	0.3984	4.2914	4.0406	76.4630	0.1495
0.08	0.3978	4.2785	4.0994	77.5471	0.1476
0.10	0.3971	4.2630	4.1609	78.6668	0.1448
NPK-2					
0.01	0.4015	4.3576	3.9074	74.0619	0.1577
0.02	0.4008	4.3423	3.9354	74.5732	0.1564
0.04	0.3998	4.3213	3.9998	75.7510	0.1536
0.06	0.3986	4.2950	4.0664	76.9513	0.1495
NPK-3					
0.01	0.4010	4.3485	3.9092	74.0690	0.1559
0.02	0.3997	4.3200	3.9401	74.5945	0.1518
0.04	0.3989	4.3022	4.0050	75.7877	0.1495
0.06	0.3980	4.2820	4.0722	77.0118	0.1462
0.08	0.3969	4.2588	4.1417	78.2624	0.1421
0.10	0.3947	4.2124	4.2170	79.5422	0.1328
NPK-4					
0.01	0.4011	4.3501	3.9010	73.9216	0.1564
0.02	0.4000	4.3254	3.9235	74.3004	0.1531
0.04	0.3988	4.2998	3.9746	75.2141	0.1495
0.06	0.3977	4.2764	4.0275	76.1586	0.1458
0.08	0.3962	4.2452	4.0828	77.1215	0.1402
0.10	0.3947	4.2118	4.1408	78.1199	0.1337
NPK-5					
0.01	0.4014	4.3559	3.9034	73.9862	0.1577
0.02	0.4006	4.3379	3.9289	74.4428	0.1559
0.04	0.3998	4.3216	3.9875	75.5252	0.1541
0.06	0.3988	4.3000	4.0484	76.6305	0.1508
0.08	0.3973	4.2685	4.1126	77.7609	0.1453
0.10	0.3957	4.2344	4.1791	78.9192	0.1388

NPK-6					
0.01	0.4012	4.3513	3.9087	74.0663	0.1564
0.02	0.4003	4.3322	3.9377	74.5824	0.1541
0.04	0.3990	4.3050	4.0030	75.7566	0.1499
0.06	0.3979	4.2796	4.0695	76.9542	0.1458
0.08	0.3966	4.2523	4.1392	78.1935	0.1407
0.10	0.3954	4.2264	4.2101	79.4544	0.1356
NPK-7					
0.01	0.4012	4.3529	3.9015	73.9373	0.1568
0.02	0.4002	4.3305	3.9241	74.3249	0.1541
0.04	0.3989	4.3026	3.9765	75.2560	0.1499
0.06	0.3975	4.2718	4.0309	76.2105	0.1448
0.08	0.3961	4.2411	4.0876	77.1981	0.1393
0.10	0.3948	4.2148	4.1459	78.2217	0.1342
NPK-8					
0.01	0.4011	4.3501	3.9056	74.0073	0.1564
0.02	0.4003	4.3321	3.9311	74.4640	0.1545
0.04	0.3996	4.3181	3.9894	75.5471	0.1531
0.06	0.3985	4.2946	4.0511	76.6605	0.1495
0.08	0.3971	4.2636	4.1157	77.7995	0.1439
0.10	0.3955	4.2299	4.1827	78.9668	0.1374
NPK-9					
0.01	0.4015	4.3579	3.9027	73.9792	0.1582
0.02	0.4007	4.3418	3.9274	74.4286	0.1568
0.04	0.4000	4.3251	3.9856	75.5034	0.1550
0.06	0.3988	4.3003	4.0460	76.5930	0.1513
0.08	0.3973	4.2685	4.1098	77.7147	0.1458
0.10	0.3955	4.2298	4.1769	78.8717	0.1384
NPK-10					
0.01	0.4012	4.3509	3.9018	73.9356	0.1564
0.02	0.3999	4.3247	3.9254	74.3287	0.1527
0.04	0.3988	4.3003	3.9777	75.2648	0.1490
0.06	0.3977	4.2754	4.0317	76.2254	0.1448
0.08	0.3962	4.2435	4.0891	77.2203	0.1388
0.10	0.3945	4.2083	4.1481	78.2290	0.1318

This is further supported by isentropic compressibility *(κ_S)* and relaxation strength *(r)*. The isentropic compressibility of the solutions in both the solvents is also found to decrease with increase of concentration, as shown in Tables 3 and 4 for DMF and DMSO solutions. This phenomenon can be explained by assuming that the solvated molecules fully compressed by the electrical forces of the ions (Yawale *et al.*, 1995). The compressibility of the solution is mainly due to the free solvent molecules. Due to solute-solvent interactions in the system, compressibility decreases with the increase in solute concentration. This is further confirmed by decrease in relaxation strength (as reported in Tables 3 and 4).

The Rao's molar sound function (R_m) and Vander Waal's constant *(b)* are also observed to increase linearly (correlation coefficient 0.9920-0.9998) with concentration for all the compounds in both the solvents. The linear increase of these parameters shows absence of complex formation in these systems.

Research Article

The isentropic compressibility of all the solutions was also fitted to the following Bachem's relation (Bachem, 1936):

$$\kappa_s = \kappa_s^0 + AC + BC^{3/2}$$

Where, κ_s^0 is the isentropic compressibility of pure solvent. From the plot of $(\kappa_s - \kappa_s^0)/C$ verses $\sqrt{C}$, values of *A* and *B* were evaluated from the intercept and slope respectively. The evaluated A and B values are given in Table 5.

Table 5: The Bachem's Constants *A* and *B*, ϕ^o_k and S_k, Φ^o_V and S_V of Schiff Bases in DMF and DMSO at 303.15 K

(A in $dyn^{-1}. cm^3mol^{-1}$; B in $dyn^{-1}. cm^{-1/2}mol^{-3/2}$; ϕ^o_k in $dyn^{-1}. mol^{-1}$; S_k in $dyn^{-1}. cm^{-3/2}mol^{-3/2}$; ϕ^o_V in $cm^2. mol^{-1}$ and S_V in $cm^2. dm^{1/2}.mol^{-3/2}$)

Comp. Code	-A . 10^{11} $dyn^{-1}. cm^3mol^{-1}$	B . 10^{11} $dyn^{-1}. cm^{-1/2} mol^{-3/2}$	- ϕ^o_k . 10^8 $dyn^{-1}. mol^{-1}$	S_k . 10^8 $dyn^{-1}. cm^{-3/2} mol^{-3/2}$	-ϕ^o_V $cm^2. mol^{-1}$	S_V $cm^2. dm^{1/2}.mol^{-3/2}$
DMF						
NPK-1	3.10	3.14	2.96	6.39	120	1142.86
NPK-2	1.78	0.58	1.32	2.83	73	892.31
NPK-3	1.68	0.63	1.28	3.01	96	1000.00
NPK-4	2.98	2.88	3.04	6.55	125	1208.33
NPK -5	2.00	0.58	2.06	4.35	118	1062.50
NPK -6	2.53	1.23	2.08	3.94	107	1089.29
NPK -7	1.83	0.94	2.25	6.73	86	918.03
NPK -8	2.25	1.60	1.51	2.87	100	1000.00
NPK -9	3.31	5.97	2.93	9.02	85	1206.90
NPK-10	1.90	1.08	1.38	3.21	109	1306.12
DMSO						
NPK-1	2.35	4.05	2.15	5.84	108	1000.00
NPK-2	1.70	1.89	1.33	3.47	90	915.79
NPK-3	2.75	4.74	2.55	7.54	75	878.05
NPK-4	2.43	3.01	2.03	4.20	86	847.46
NPK -5	1.80	2.29	0.98	1.71	98	927.84
NPK -6	2.10	2.14	1.75	4.08	79	935.06
NPK -7	1.98	1.54	1.93	3.05	87	855.26
NPK -8	2.30	2.89	1.05	1.72	94	953.27
NPK -9	1.60	1.88	0.80	0.96	109	1000.00
NPK-10	2.25	2.63	1.83	3.50	71	837.84

Further, the apparent molar compressibility (ϕ_k) of the solutions is fitted to Gucker (1933) relation:

$$\phi_k = \phi^o_k + S_k \sqrt{C}$$

From the plot of ϕ_k verses $\sqrt{C}$, ϕ^o_k and S_k values are evaluated from the intercept and slope. S_k is known as interaction parameter. These values are given in Table 5.

It is evident from Table 5 that for all the compounds, in both DMF and DMSO solutions, *A* and ϕ^o_k, values are negative whereas *B* and S_k values are positive. The negative *A* and ϕ^o_k confirms interaction

between solvent and compound molecules. Further, the positive values of B and S_k confirms the predominance of solute-solvent interactions in studied systems.
The predominance of solute-solvent interactions is indicated by Masson's equation (Masson, 1929):
$\phi_v = \phi^0_v + S_v \sqrt{C}$
From the plot of ϕ_v verses $\sqrt{C}$, ϕ^0_v and S_v values are evaluated from the intercept and slope and are given in Table 5.
Again, for all the compounds, in both DMF and DMSO solutions, ϕ^0_v values are negative and S_v values are positive. This suggests electrostrictive solvation of ions (Korey, 1993; Nikam and Hiray, 1991) i.e., interaction between solvent and compound molecules. i.e. interaction between solvent and compound molecules.

Conclusion

It is concluded that in the studied systems, solute-solvent interactions dominate in both DMF and DMSO solutions.

REFERENCES

Abou-Okeil A, El-Shafie MM and Zawahry E (2010). Eco friendly laccase–hydrogen peroxide /ultrasound-assisted bleaching of linen fabrics and its influence on dyeing efficiency. *Ultrasonics Sonochemistry* **17** 383–390.

Avivi S, Mastai Y and Gedanken A (2000). A New Fullerene-like Inorganic Compound Fabricated by the Sonolysis of an Aqueous Solution of $TlCl_3$. *Journal of the American Chemical Society* **122** 4331–4334.

Bachem CH (1936). The compressibility of electrolytic solution. *Zeitschrift Physik* **101** 541-577.

Baluja S and Kulshshtra A (2014). Ultrasonic studies of antiprotozoal drug in protic and aprotic solvents at 308.15K. *Latin American Applied Research* **44**.

Baluja S, Kachhadia N and Soni M (2008). Acoustical studies of some Schiff bases in 1,4-dioxane and DMF at 308.15 K. *International Journal of Applied Chemistry* **4** 71-80.

Baluja S, Solanki A and Kachhadia N (2010). Studies on thermodynamic properties of some imidazolinone derivatives in DMF at 308.15 K. *Chinese Journal of Chemical Engineering* **18** 306-311.

Banjoo DR and Nelson PK (2005). Improved ultrasonic extraction procedure for the determination of polycyclic aromatic hydrocarbons in sediments. *Journal of Chromatography A* **1066** 9–18.

Bhatia SC, Bhatia R and Dubey GP (2010). Ultrasonic velocities, isentropic compressibilities and excess molar volumes of octan—1-ol with chloroform, 1,2-dichloro ethane and 1,1,2,2-tetrachloroethane at 298.15 and 308.15K. *Physics and Chemistry of Liquids* **48** 199-230.

Bhesaniya K and Baluja S (2014). Molecular interactions in some synthesized pyrimidine derivatives in methanol and DMF solutions at 308.15 K. *Journal of Molecular Liquids* **191** 116-123.

Boucaud A, Machet L and Arbeille B (2001). In vitro study of low-frequency ultrasound -enhanced transdermal transport of fentanyl and caffeine across human and hairless rat skin. *International Journal of Pharmaceutics* **228** 69-77.

Dolatowski ZJ, Stadnik J and Stasiak D (2007). Applications of ultrasound in food technology. *Acta Scientiarum Polonorum, Technologia Alimentaria* **6** 89-99.

Douhéret G, Davis MI, Reis JCR and Blandamer MJ (2001). Isentropic Compressibilities—Experimental Origin and the Quest for their Rigorous Estimation in Thermodynamically Ideal Liquid Mixtures. *ChemPhysChem* **2** 148–161.

Foguel M, Uliana C, Tomaz U, Marques O, Yamanaka H and Ferreira A (2009). Evaluation of the CD trode cleaning constructed from gold recordable CD/galvanoplasty tape. *Eclética Química* **34** 59-66.

Friedrich H, Fussnegger B, Kolter K and Bodmeier R (2006). Dissolution rate improve -ment of poorly water-soluble drugs obtained by adsorbing solutions of drugs in hydrophilic solvents onto high surface area carriers. *European Journal of Pharmaceutics and Biopharmaceutics* **62** 171-177.

Gucker FT (1933). The Apparent Molal Heat Capacity, Volume, and Compressibility of Electrolytes, *Chemical Reviews* **13** 111-130.

Hagen R, Behrends R and Kaatze U (2004). Acoustical Properties of Aqueous Solutions of Urea: Reference Data for the Ultrasonic Spectrometry of Liquids. *Journal of Chemical & Engineering Data* **49** 988–991.

Hassun S, Shihab A and Jassim F (1989). Studies on ultrasonic absorption and visco-relaxation of poly (ethylene glycol) aqueous solutions. *Chinese Journal of Polymer Science* **7** 270-279.

Hong-xia G, Xiu-qiong G, Hong-ru B and Wang K (2010). Application of ultrasound wave in bamboo pulp bleaching. *Yinran Zhuji* **27** 34-35.

Inoue N, Hasegawa T and Matsuzawa K (1991). Ultrasonic velocity measurement of liquids in the frequency range 0.2-7 MHz using an improved ultrasonic interferometer. *Acustica* **74** 128-133.

José M, Esperança SS, Visak ZP, Plechkova NV, Seddon KR, Guedes HJR and Rebelo LPN (2006). Density, Speed of Sound, and Derived Thermodynamic Properties of Ionic Liquids over an Extended Pressure Range. 4. [C_3mim][NTf_2] and [C_5mim][NTf_2]. *Journal of Chemical & Engineering Data* **51** 2009–2015.

Juan C, Jose G, Antonio M, Ligia R and Enrique R (2010). Ultrasonically assisted antioxidant extraction from grape stalks and olive leaves, *Procedia* **3** 147-152.

Kim W, Yu M, Choi I and Kim M (1998). Measurement of ultrasonic relaxational characteristics in aqueous solution of $ZnCl_2$-DMF. *Ungyong Mulli* **11** 675-682.

Korey VB (1993). Adiabatic compressibilities of some aqueous ionic solutions and their variation with indicated liquid structure of the water. *Physical Reviews* **64** 350-357.

Laux D, Leveque G and Cereser C (2009). Ultrasonic properties of water/sorbitol solutions. *Ultrasonics* **49** 159-161.

Li X, Wei Z, Zifeng L and Xuhong M (2010). Study on the application of ultrasonic in the esterification deacidification of high-acid crude oil. *Shiyou Lianzhi Yu Huagong* **41** 6-10.

Li ZQ, Qiu LG, Xu T, Wu Y, Wang W, Wu ZY and Jiang X (2009). Ultrasonic synthesis of the microporous metal–organic framework $Cu_3(BTC)_2$ at ambient temperature and pressure: An efficient and environmentally friendly method, *Materials Letters* **63** 78–80.

Lovett I, Doust B and Orr N (1988). The Role of Ultrasound in the Diagnosis of Parenchymal Disease in Transplanted Kidneys. *Australasian Radiology* **32** 104–106.

Magazù S, Migliardo P, Musolino AM and Sciortino MT (1997). α,α-Trehalose- water solutions. 1. Hydration Phenomena and Anomalies in the Acoustic Properties. *Journal of Physical Chemistry B* **101** 2348–2351.

Mason TJ, Paniwnyk L and Lorimer JP (1996). Sonochemistry: The uses of ultrasound in food technology. *Ultrasonics Sonochemistry* **3** 253-260.

Masson DO (1929). Solute molecular volumes in relation to salvation and ionization. *Philosophical Magazine* **8** 218-235.

McNeil SJ and McCall RA (2011). Ultrasound for wool dyeing and finishing. *Ultrasonics Sonochemistry* **18** 401-406.

Mistik Sİ and Müge Yükseloglu S (2005). Hydrogen peroxide bleaching of cotton in ultrasonic energy, *Ultrasonics* **43** 811–814.

Nasir Baig RB and Varma RS (2012). Alternative energy input: mechano chemical, microwave and ultrasound-assisted organic synthesis, *Chemical Society Reviews* **41** 1559-1584.

Nath J and Dixit A (1984). Ultrasonic velocities in, and adiabatic compressibilities for, binary liquid mixtures of acetone with benzene, toluene, p-xylene, and mesitylene at 308.15 K. *Journal of Chemical & Engineering Data* **29** 320-321.

Nikam PS and Hiray RA (1991). Temperature and concentration dependence of ultrasonic velocity and allied parameters of monochloro acetic acid in ethanol-nitrobenzene mixtures. *Indian Journal of Pure and Applied Physics* **29** 601-605.

Pan J, Xia XX and Liang J (2008). Analysis of pesticide multi-residues in leafy vegetables by ultrasonic solvent extraction and liquid chromatography-tandem mass spectro –metry. *Ultrasonics Sonochemistry* **15** 25–32.

Petrier C and Francony A (1997). Incidence of wave-frequency on the reaction rates during ultrasonic wastewater treatment. *Water Science & Technology* **35** 175–180.

Riddick J, Bunger W and Sakano T (1986). *Organic Solvents: Physical Properties and Methods for Purification*, 4th edition, Techniques of Chemistry, **II**, (Wiely, New York, USA).

Saha M, Eskicioglu C and Marin J (2011). Microwave, ultrasonic and chemo-mechanical pre treatments for enhancing methane potential of pulp mill wastewater treatment sludge. *Biotechn*ology **102** 7815–7826.

Sandarve, Magotra U and Sharma M (2014). A Study of Acoustical and Transport Properties of Binary Mixtures of Dimethyl Sulphoxide and Acetonitrile with Water at 303.15K. *Chemical Science Transactions* **3** 608-613.

Sarvazyan AP (1991). Ultrasonic Velocimetry of Biological Compounds. *Annual Review of Biophysics and Biophysical Chemistry* **20** 321-342.

Sasaki K and Arakawa K (1973). Ultrasonic and thermodynamic studies on the aqueous solutions of tetramethylurea. *Bulletin of the Chemical Society of Japan* **46** 2738- 2741.

Takagi T (1978). Ultrasonic velocity in binary mixtures under high pressures and their thermodynamic properties.-Binary mixture for nitrobenzene-aniline. *Review of Physical Chemistry* **48** 10-16.

Vankar PS, Shanker R and Srivastava J (2007). Ultrasonic dyeing of cotton fabric with aqueous extract of *Eclipta alba*. *Dyes and Pigments* **72** 33-37.

Yaseen EI, Herald TJ, Aramoni FM and Alavi S (2005). Rheological properties of selected gum solutions. *Food Research International* **38** 111-119.

Yawale S, Pakade S and Adagonkar S (1995). Solid state variable frequency pulser-receiver system for ultrasonic measurements, I. *Journal of Pure and Applied Physics* **33** 638-642.