Available online at www.worldscientificnews.com

World Scientific News

WSN 44 (2016) 257-278 EISSN 2392-2192

Ultrasonic velocity, density and viscosity measurement of pyrimidine derivatives in 1,4-dioxane and DMF at various temperatures

Shipra Baluja*, Kajal Nandha, Paras Ramavat

Physical Chemistry Laboratory, Department of Chemistry, Saurashtra University, Rajkot - 360005 (Gujarat), India

*E-mail address: shipra_baluja@rediffmail.com

ABSTRACT

The estimation of density, viscosity and ultrasonic velocity of solution of pyrimidine derivatives in 1,4-dioxane and N,N-dimethylformamide was carried out as functions of concentration (0.01 to 0.1 M) and temperature (298.15 to 318.15 K). Some acoustical and apparent parameters such as acoustical impedance (Z), intermolecular free length (L_f), adiabatic compressibility (κ_s), molar compressibility (W), Vander Waals constant (b), relaxation strength (r), internal pressure (π), apparent molar compressibility (ϕ_k), apparent molar volume (ϕ_v) etc., have been evaluated using experimental data of ultrasonic velocity (U), density (ρ) and viscosity (η). The characterization of these synthesized compounds was done by IR, ^{1}H NMR and mass spectral data.

***Keywords*:** Pyrimidine derivatives; ultrasonic velocity; viscometry; molecular interaction; apparent molar compressibility

1. INTRODUCTION

Ultrasonic study is the important research topic and as its usefulness in the fields of biology, biochemistry, engineering, geography, geology, medicine and polymer industry is found very interesting [1, 2]. Ultrasonic velocity (U) together with density (ρ) and viscosity (η) data furnishes a wealth of information about bulk properties and intermolecular forces

[3,4], which find applications in several industries and technological processes. A literature survey reveals that ultrasonic velocity of various organic, inorganic and biological compounds in various solvents have been studied [5-10]. The drug-solvent molecular interaction and their temperature dependence play an important role in the understanding of drug action [11,12].

These pyrimidine derivatives have been proven to be attractive compounds because of their outstanding biological activities, such as anti HIV [13], antifungal [14,15], antihistaminic [16,17], central nervous activities [18], anticancer [19-21], analgesic [22], antimicrobial [23], antitumor [24,25], antimalerial [26,27] and antihypertensive [28]. In view of the medicinal, agricultural, pharmaceutical significance of pyrimidine moiety, some new pyrimidine derivatives have been synthesized and their density, sound velocity and viscosity in 1,4-dioxane and N,N-dimethylformamide (DMF) solutions were measured at 298.15 K, 308.15 K, and 318.15 K temperatures over a wide range of concentrations.

2. EXPERIMENTAL

2. 1. Materials

Different substituted benzaldehydes, isobutyl propionate, urea and phenacyl bromide used for the synthesis, was supplied from Spectrochem Pvt. Ltd. (Mumbai, India) and was used without any treatment.

The methanol and acetone used were of AR grade supplied by Spectrochem Pvt. Ltd. (Mumbai, India). 1,4-dioxane and DMF used were of AR grade supplied by LOBA Pvt. Ltd. All solvents were purified according to the standard procedure [29].

2. 2. Synthesis

Synthesis of dihydropyrimidine derivatives: A methanolic solution of different substituted aldehyde (0.01 mol), isobutyl propionate (0.01mol) and urea (0.012 mol) was refluxed for 16 hrs in presence of copper chloride and concentrated sulphuric acid. The completion of reaction was confirmed by analytical thin layer chromatography (TLC) (Performed on aluminum coated plates Gel $60F_{254}$ (E. Merck)) using (3:2 - Hexane : Ethyl acetate) as mobile phase. After completion of reaction, the reaction mass was cooled and the resulting solid was filtered, washed with methanol to remove unreacted reagents and dried under vacuum to give crude product.

Oxidation of dihydropyrimidine derivatives: 10 ml nitric acid (60%) was stirred at 0 °C for 10 min. and then above synthesized compound (0.01mol) was added fractionally to the chilled nitric acid. The mixture was then stirred at 0 °C temperature for 30 min. The progress of reaction was monitored by thin layer chromatography. The reaction mixture was then poured into cold water and was neutralized with saturated sodium bicarbonate solution. The solid was filtered, washed with water and dried. The crude product was directly used for the next step.

Synthesis of methyl 4-isopropyl-2-(2-oxo-2-phenylethoxy)-6-phenylpyrimidine-5-carboxy late derivatives: Equimolar solution of above product and phenacyl bromide in dry acetone was refluxed in presence of dry K_2CO_3 for 1hr. The solvent from the reaction mixture was evaporated to get solid mass. This solid mass was poured into crushed ice to remove

K_2CO_3. The solution was filtered. The resulting solid product was washed with cold water and dried under vacuum.

Overall, five pyrimidine derivatives are synthesized. The reaction scheme is given in Figure 1.

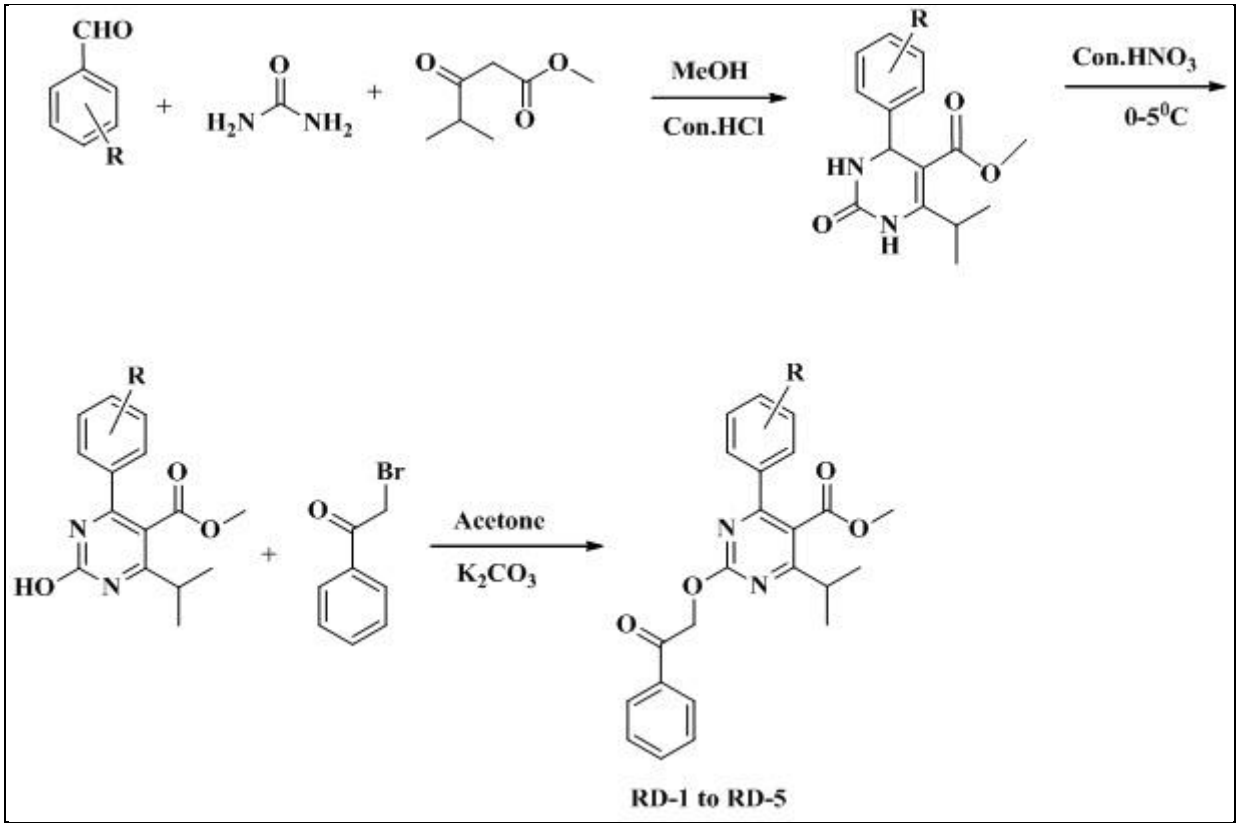

Figure 1. The reaction scheme.

2. 3. Spectroscopy study

The characterization of all these compounds was done by IR, ^{1}H NMR and mass spectral data. IR spectra were recorded on IR affinity 1S (furrier transport infra-red spectroscopy). ^{1}H NMR was determined in DMSO solution on a Bruker Ac 400 MHz spectrometer. The Mass spectra were recorded on Shimadzu GC-MS-QP-2010 model using direct inlet probe technique.

2. 4. Measurements of Density, Viscosity and Ultrasound Velocity

Solutions of different concentrations were made in 1,4-dioxane and DMF for all the five synthesized compounds and were kept in air tight bottles.

Measurements of Density, and Ultrasound velocity

Ultrasonic velocity and density measurements of pure 1,4-dioxane, pure DMF and solutions of compounds were done by using Anton Paar Density and Sound Velocity meter

(DSC 5000M) with accuracy of ±0.5 m/s and ±0.000005 g/cm^3 respectively. The instrument was fully automated and the temperature was automatically controlled. Calibration was carried out using Milli-Q-water (Millipore Pvt. Ltd. Bangalore, India).

Measurement of viscosity:

The Ubbelohde viscometer with 25 ml capacity having a pore size of capillary 0.5 mm was used for the measurement of viscosity. The Ubbelohde viscometer was also calibrated with Milli-Q-water (Millipore Pvt. Ltd. Bangalore, India). The flow time of water (t_w) and solvent/solution, (t_s) were measured with a digital stop watch with an accuracy of ±0.01 s (Model: RACER HS–10W) at the desired temperature. The temperature stability was maintained within ±0.1 K by circulating thermo stated (NOVA NV-8550 E) water around the viscometer. The flow time of water is 28.22 sec, 24.22 sec and 21.40 sec at 298.15 K, 308.15 K and 318.5 K respectively. The accuracy of viscosity is ±0.06 %.

3. RESULTS AND DISCUSSION

The physical properties of all the synthesized compounds are given in Table 1 with their side chain substitution.

Table 1. Physical constants of pyrimidine derivatives.

Compound Code	Substitution R	M.F.	M.W.	Yield (%)	R_f* value
RD-1	-4-F	$C_{23}H_{21}FN_2O_4$	408	86	0.53
RD-2	-4-Br	$C_{23}H_{21}BrN_2O_4$	469	85	0.54
RD-3	-3,4-di-OCH_3	$C_{25}H_{26}N_2O_6$	450	87	0.59
RD-4	-3-OCH_3	$C_{24}H_{24}N_2O_5$	420	82	0.58
RD-5	-4-Cl	$C_{23}H_{21}ClN_2O_4$	424	84	0.54

*0.4: 0.6 - Hexane: Ethyl acetate

3. 1. Spectral Data

RD-1:
IR (cm^{-1}): 1722.43 (carbonyl str. in $COOCH_3$), 1695.43 (Acyclic carbonyl str.), 1598.99 (Ar-C=C str.), 1390.68 (alkane C-H bending), 1334.78 (C-O str. of ester), 1066.64 (C-O str. of ether), 850.61 (p-di substituted aromatic ring). **^{1}H NMR (DMSO-d_6) δ(ppm):** 1.250 (6H, doublet, -CH_3 of isopropyl), 3.12 (1H, multiplet, C-H of isopropyl), 3.715 (3H, singlet, -$COOCH_3$), 5.983 (2H, singlet, -OCH_2), 7.017 (2H, doublet, Ar-CH), 7.520 (2H, doublet, Ar-CH), 7.600 (2H, triplet, Ar-CH),7.744 (1H, triplet, Ar-CH) and 8.043 (2H, doublet, Ar-CH).
MS: (m/z) = 408

RD-2:
IR (cm^{-1}): 1722.43 (carbonyl str. in $COOCH_3$), 1695.43 (Acyclic carbonyl str.), 1546.91 (Ar-C=C str.), 1390.68 (alkane C-H bending), 1334.74 (C-O str. of ester), 1066.64 (C-O str. of ether), 850.61 (p-di substituted aromatic ring). **^{1}H NMR (DMSO-d_6) δ(ppm):** 1.258 (6H, doublet, -CH_3 of isopropyl), 3.129 (1H, multiplet, C-H of isopropyl), 3.716 (3H, singlet, -$COOCH_3$), 5.985 (2H, singlet, -OCH_2), 7.019 (2H, doublet, Ar-CH), 7.528 (2H, doublet, Ar-CH),7.609 (2H, triplet, Ar-CH),7.746 (1H, triplet, Ar-CH) and 8.048 (2H, doublet, Ar-CH).
MS*: *(m/z) = 469

RD-3:
IR (cm^{-1}): 1722.43 (carbonyl str. in $COOCH_3$), 1695.43 (Acyclic carbonyl str.), 1546.91 (Ar-C=C str.), 1390.68 (alkane C-H bending), 1334.74 (C-O str. of ester), 1008.77 (C-O str. of ether). **^{1}H NMR (DMSO-d_6) δ(ppm):** 1.261 (6H, doublet, -CH_3 of isopropyl), 3.026 (1H, multiplet, C-H of isopropyl), 3.546 (3H, singlet, -$COOCH_3$), 3.827 (6H, singlet, -OCH_3), 5.885 (2H, singlet, -OCH_2), 7.014 (1H, doublet, Ar-CH), 7.115 (1H, doublet, Ar-CH), 7.214 (1H, singlet, Ar-CH), 7.598 (2H, triplet, Ar-CH), 7.740 (1H, triplet, Ar-CH), 8.040 (2H, doublet, Ar-CH).
MS*: *(m/z) = 450

RD-4:
IR (cm^{-1}): 1750.00 (carbonyl str. in -$COOCH_3$), 1541.12 (Acyclic carbonyl str.), 1446.61 (Ar-C=C str.), 1365.60 (alkane C-H bending), 1284.59 (C-O str. of ester), 1026.16 (C-O str. of ether), 840.99 (p-di substituted aromatic ring), 792.77 (m-di-substituted aromatic ring). **^{1}H NMR (DMSO-d_6) δ(ppm):** 1.260 (6H, doublet, -CH_3 of isopropyl), 3.024 (1H, multiplet, C-H of isopropyl), 3.536 (3H, singlet, -$COOCH_3$), 3.820 (1H, singlet, -OCH_3), 5.861 (2H, singlet, -OCH_2), 7.570 (7H, multiplet, Ar-CH) and 8.062 (2H, doublet, Ar-CH).
MS: (m/z) = 420

RD-5:
IR (cm^{-1}): 1730.21 (carbonyl str. in $COOCH_3$), 1670.00 (Acyclic carbonyl str.), 1554.68 (Ar-C=C str.), 1383.01 (alkane C-H bending), 1334.78 (C-O str. of ester), 1082.10(C-O str. of ether), 721.40 and 792.77 (m-di-substituted aromatic ring). **^{1}H NMR (DMSO-d_6) δ(ppm):** 1.255 (6H, doublet, -CH_3 of isopropyl), 3.125 (1H, multiplet, C-H of isopropyl), 3.715 (3H, singlet, -$COOCH_3$), 5.984 (2H, singlet, -OCH_2), 7.018 (2H, doublet, Ar-CH), 7.524 (2H, doublet, Ar-CH),7.608 (2H, triplet, Ar-CH),7.745 (1H, triplet, Ar-CH) and 8.047 (2H, doublet, Ar-CH).
MS: (m/z) = 424

3. 2. Density, viscosity and ultrasonic velocity study

Tables 2 and 3 show the experimental data of density, ultrasonic velocity and viscosity for the synthesized compounds in 1,4-dioxane and DMF at different temperatures respectively. It is evident from Table 2 and 3 that as concentration increases, density, ultrasonic velocity and viscosity increase.

To study molecular interactions of compounds in solutions, some acoustical and apparent parameters such as acoustical impedance (Z), intermolecular free length (L_f), adiabatic compressibility (κ_s), molar compressibility (W), Van der Waals constant (b),

relaxation strength (r), internal pressure (π), apparent molar compressibility (ϕ_k), apparent molar volume (ϕ_v) etc., have been evaluated using experimental data of ultrasonic velocity (U), density (ρ) and viscosity (η) by following equations:

Adiabatic compressibility [30]:

$$\kappa_s = 1/U^2\rho \qquad (1)$$

Intermolecular free path length:

$$L_f = K_j\kappa_s^{1/2} \qquad (2)$$

where, K_j is a temperature-dependent Jacobson's constant $(93.875 + 0.375T) \times 10^{-8}$.

Apparent molar compressibility:

$$\phi_k = 1000/m\rho_o\,(\rho_o\kappa_s - \rho\kappa_o) + (\kappa_o\, m\,/\rho_o) \qquad (3)$$

where κ_s, ρ and κ_0, ρ_0 are represents the adiabatic compressibility and density of solution and solvent respectively, m is the molar concentration of solute.

Further, the apparent molar compressibility (ϕ_k) of the solutions is fitted to Gucker's relation [31] and is given by:

$$\phi_k = \phi^\circ_k + S_k m^{1/2} \qquad (4)$$

where ϕ°_k and S_k are the limiting apparent molar compressibility at infinite dilutions and interaction parameter respectively. The values of ϕ°_k and S_k are calculated by the least square method.

Table 2. The density (ρ), ultrasonic velocity (U) and viscosity (η) of pyrimidine derivatives in 1, 4-dioxane at different temperatures.

Concentration (M)	**Density** [a] **Kg/m^3**	**Velocity** [b] **m/s**	**Viscosity** [c] **mPs**	**Density** [a] **Kg/m^3**	**Velocity** [b] **m/s**	**Viscosity** [c] **mPs**
			298.15 K			
		RD-1			***RD-2***	
0.00	1027.56	1344.92	1.1088	1027.56	1344.92	1.1088
0.01	1028.59	1346.79	1.1461	1028.97	1345.76	1.1142
0.02	1029.48	1347.57	1.1690	1029.97	1346.25	1.1205
0.04	1030.62	1348.86	1.1857	1032.39	1346.56	1.1415
0.06	1031.89	1350.03	1.2003	1033.58	1347.88	1.1674
0.08	1033.19	1350.26	1.2379	1035.32	1348.66	1.1937
0.10	1033.96	1351.29	1.2809	1037.97	1348.98	1.2083
		RD-3			***RD-4***	
0.00	1027.56	1344.92	1.1088	1027.56	1344.92	1.1088
0.01	1028.76	1346.74	1.1120	1028.66	1346.55	1.1671
0.02	1029.61	1347.67	1.1227	1029.26	1347.45	1.1770
0.04	1031.32	1349.84	1.1384	1030.20	1348.71	1.1878

0.06	1033.13	1351.25	1.1584	1031.52	1349.85	1.2064
0.08	1035.06	1352.95	1.2050	1032.71	1351.46	1.2344
0.10	1037.66	1353.15	1.2278	1033.97	1353.12	1.2618
		RD-5				
0.00	1027.56	1344.92	1.1088			
0.01	1028.81	1347.29	1.1274			
0.02	1030.06	1348.4	1.1644			
0.04	1031.05	1349.46	1.2013			
0.06	1032.05	1350.4	1.2129			
0.08	1033.65	1351.32	1.2361			
0.10	1035.27	1352.32	1.2545			

308.15 K

		RD-1			***RD-2***	
0.00	1016.23	1301.21	0.9465	1016.23	1301.21	0.9465
0.01	1017.30	1303.30	0.9606	1017.67	1302.69	0.9585
0.02	1018.24	1304.39	0.9771	1018.68	1303.21	0.9766
0.04	1019.38	1305.66	0.9990	1021.00	1303.97	0.9883
0.06	1020.67	1306.99	1.0196	1022.32	1304.67	1.0040
0.08	1021.98	1307.21	1.0334	1024.08	1305.51	1.0199
0.10	1022.74	1308.07	1.0591	1026.82	1305.89	1.0402
		RD-3			***RD-4***	
0.00	1016.23	1301.21	0.9465	1016.23	1301.21	0.9465
0.01	1017.49	1303.73	0.9553	1017.38	1303.53	0.9732
0.02	1018.33	1304.46	0.9704	1018.06	1304.25	0.9818
0.04	1020.08	1306.69	0.9920	1019.01	1305.31	0.9998
0.06	1021.91	1308.56	1.0420	1020.29	1306.86	1.0097
0.08	1023.90	1309.85	1.0710	1021.51	1308.35	1.0425
0.10	1026.52	1311.25	1.0975	1022.80	1310.17	1.0650
		RD-5				
0.00	1016.23	1301.21	0.9465			
0.01	1017.52	1303.8	0.9639			
0.02	1018.73	1305.25	0.9775			
0.04	1019.81	1306.9	0.9875			
0.06	1020.83	1307.3	1.0188			
0.08	1022.45	1308.28	1.0367			
0.10	1024.08	1309.3	1.0482			

318.15 K

		RD-1			***RD-2***	
0.00	1004.85	1258.03	0.8085	1004.85	1258.03	0.8085
0.01	1005.94	1260.27	0.8201	1006.31	1259.64	0.8187
0.02	1006.93	1261.65	0.8255	1007.33	1260.23	0.8249
0.04	1008.07	1263.07	0.8360	1008.99	1261.45	0.8351
0.06	1009.39	1264.16	0.8491	1010.99	1261.93	0.8561

0.08	1010.70	1264.99	0.8647	1012.78	1262.88	0.8756
0.10	1011.47	1265.58	0.8870	1015.62	1263.29	0.9243
		RD-3			***RD-4***	
0.00	1004.85	1258.03	0.8085	1004.85	1258.03	0.8085
0.01	1006.15	1260.78	0.8200	1006.04	1260.57	0.8177
0.02	1006.99	1261.98	0.8298	1006.75	1261.25	0.8216
0.04	1008.77	1264.77	0.8446	1007.69	1262.39	0.8411
0.06	1010.64	1266.12	0.8689	1009.01	1264.03	0.8635
0.08	1012.65	1267.65	0.8986	1010.26	1265.82	0.8777
0.10	1015.32	1269.46	0.9143	1011.56	1267.75	0.9110
		RD-5				
0.00	1004.85	1258.03	0.8085			
0.01	1006.17	1260.99	0.8178			
0.02	1007.64	1262.38	0.8258			
0.04	1008.53	1263.60	0.8356			
0.06	1009.56	1264.64	0.8475			
0.08	1011.20	1265.70	0.8671			
0.10	1012.84	1266.78	0.9073			

[a] : Uncertainty of Density is ±0.000005 g/cm^3
[b] : Uncertainty of Sound velocity is ±0.5 m/s
[c] : Uncertainty of digital stopwatch for Viscosity is ±0.01 s

Table 3. The density (ρ), ultrasonic velocity (U) and viscosity (η) of pyrimidine derivatives in DMF at different temperatures.

Concentration (M)	**Density [a] Kg/m^3**	**Velocity [b] m/s**	**Viscosity [c] mPs**	**Density [a] Kg/m^3**	**Velocity [b] m/s**	**Viscosity [c] mPs**
			298.15 K			
		RD-1			***RD-2***	
0.00	943.60	1456.29	0.8113	943.60	1456.29	0.8113
0.01	945.35	1457.89	0.8288	945.86	945.86	0.8202
0.02	947.81	1458.02	0.8415	947.01	947.01	0.8329
0.04	949.60	1458.65	0.8587	949.55	949.55	0.8445
0.06	951.19	1459.05	0.8756	953.11	953.11	0.8674
0.08	952.53	1459.83	0.8901	955.07	955.07	0.8798
0.10	953.88	1460.73	0.9014	957.64	957.64	0.9040
		RD-3			***RD-4***	
0.01	945.65	1458.57	0.8317	945.05	1458.34	0.8135
0.02	946.68	1460.10	0.8420	946.40	1458.96	0.8192
0.04	949.13	1461.03	0.8601	947.77	1459.94	0.8384
0.06	951.26	1461.78	0.8705	949.35	1460.92	0.8549
0.08	954.46	1462.17	0.9001	952.70	1460.93	0.8752
0.10	956.37	1463.00	0.9341	954.24	1462.54	0.9038

		RD-5				
0.01	945.32	1457.99	0.8248			
0.02	946.54	1458.46	0.8343			
0.04	948.90	1458.89	0.8608			
0.06	950.89	1459.73	0.8832			
0.08	953.79	1460.28	0.9058			
0.10	955.00	1461.56	0.9140			

308.15 K

		RD-1			***RD-2***	
0.00	935.50	1417.38	0.7177	935.50	1417.38	0.7177
0.01	936.21	1418.97	0.7298	934.84	934.84	0.7015
0.02	938.27	1419.51	0.7376	937.09	937.09	0.7164
0.04	940.06	1420.15	0.7570	940.08	940.08	0.7274
0.06	941.64	1420.68	0.7631	943.05	943.05	0.7543
0.08	942.99	1421.42	0.7713	945.34	945.34	0.7678
0.10	944.04	1422.66	0.7846	948.39	948.39	0.7837
		RD-3			***RD-4***	
0.01	936.12	1420.55	0.7221	935.50	1420.44	0.7197
0.02	937.23	1421.85	0.7275	936.85	1421.25	0.7263
0.04	939.63	1422.86	0.7378	938.22	1422.00	0.7378
0.06	942.22	1423.55	0.7602	939.82	1422.96	0.7487
0.08	944.92	1423.89	0.7771	942.87	1423.26	0.7667
0.10	946.66	1424.8	0.7939	944.71	1424.40	0.7798
		RD-5				
0.01	935.77	1419.66	0.7224			
0.02	936.98	1420.22	0.7340			
0.04	939.34	1421.03	0.7449			
0.06	941.35	1421.93	0.7629			
0.08	944.25	1422.36	0.7737			
0.10	945.46	1423.40	0.7832			

318.15 K

		RD-1			***RD-2***	
0.00	924.43	1378.80	0.6210	924.43	1378.80	0.6210
0.01	927.22	1380.28	0.6377	926.57	926.57	0.6253
0.02	929.23	1380.86	0.6464	928.62	928.62	0.6293
0.04	930.67	1381.85	0.6553	931.69	931.69	0.6458
0.06	932.65	1382.27	0.6640	934.64	934.64	0.6607
0.08	933.41	1383.42	0.6725	937.58	937.58	0.6829
0.10	935.25	1384.01	0.6814	940.63	940.63	0.7023
		RD-3			***RD-4***	
0.01	926.57	1382.54	0.6316	926.55	1382.00	0.6266
0.02	927.97	1383.77	0.6424	928.15	1382.83	0.6347
0.04	930.32	1384.87	0.6553	929.13	1383.93	0.6456

0.06	932.54	1385.54	0.6627	931.37	1383.97	0.6553
0.08	935.60	1386.11	0.6704	934.12	1384.86	0.6635
0.10	937.73	1386.85	0.6861	935.96	1385.94	0.6812
		RD-5				
0.01	926.68	1380.93	0.6259			
0.02	927.87	1381.92	0.6351			
0.04	930.24	1382.34	0.6571			
0.06	932.96	1383.26	0.6672			
0.08	934.87	1384.83	0.6751			
0.10	936.53	1385.61	0.6803			

The values of apparent molar volume (ϕ_v) have been calculated by the equation: Apparent molar volume:

$$\phi_v = (M/\rho)-[1000(\rho-\rho_o)/m\rho\rho_o] \qquad (5)$$

By using the following Masson relation [32]

$$\phi_v = \phi^\circ_v + S_v m^{1/2} \qquad (6)$$

the values of ϕ°_v and S_v are calculated by the least square method. ϕ°_v is the limiting apparent molar volume at infinite dilution and S_v is measure of solute-solvent interaction [33,34].

The interactions in solutions can also be suggested by Bachem's relation [35], which is:

$$\kappa_s = \kappa_0 + Am + Bm^{3/2} \qquad (7)$$

where A and B are constants and m is molar concentration of solutions. The constants A and B have been determined from the intercept and slope of the plots $(\kappa_s - \kappa_s^0)/m$ versus $m^{1/2}$. Some of these calculated parameters are given in Tables 4 and 5.

The variation of ultrasonic velocity (U), intermolecular free length (L_f) and acoustical impedance (Z) with concentration are shown in Figures 2, 3 and 4 respectively at 318.15 K. It is clear from these figures that ultrasonic velocity increases with concentration for all the compounds whereas intermolecular free length (L_f) decreases with increases in concentration. Thus, ultrasonic velocity is reverse of intermolecular free length (L_f). The decrease of intermolecular free length (L_f) with increase of concentration suggests the decrease of distance between solute and solvent molecules due to solute-solvent interactions which causes velocity to increase. It is clearly shown from the Figure 4 that acoustical impedance (Z) increases with increase in concentration whereas decreases with temperature. Increase in specific acoustic impedance with concentration shows that molecular interactions is associative [36].

Further, it is observed from Figure 2 that among the five studied compounds, ultrasonic velocity is maximum for RD-3 and minimum for RD-2, indicating thereby maximum molecular interactions for RD-3 and minimum for RD-2. The type and magnitude of interaction depends upon structure of compound as well as solvent. For all the compounds, central moiety is same but side chains are different.

It is clear from Tables 4 and 5 that adiabatic compressibility (κ_s) decreases with increase in concentration.

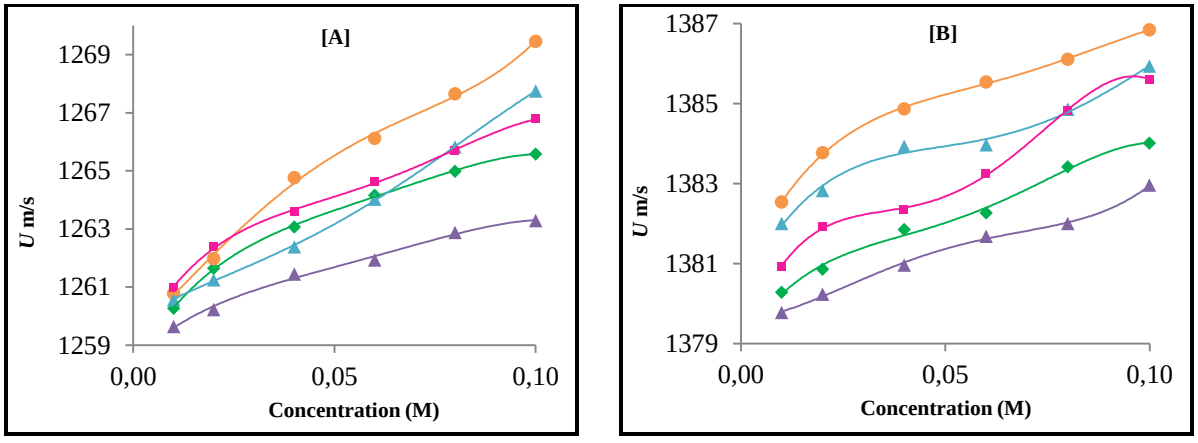

Figure 2. Variation of ultrasonic velocity (*U*) with molar concentration of synthesized compounds RD-1 to RD-5 in [A] 1,4-dioxane and [B] DMF at 318.15 K. RD-1, (♦); RD-2, (▲); RD-3, (●); RD-4, (▲); RD-5, (■).

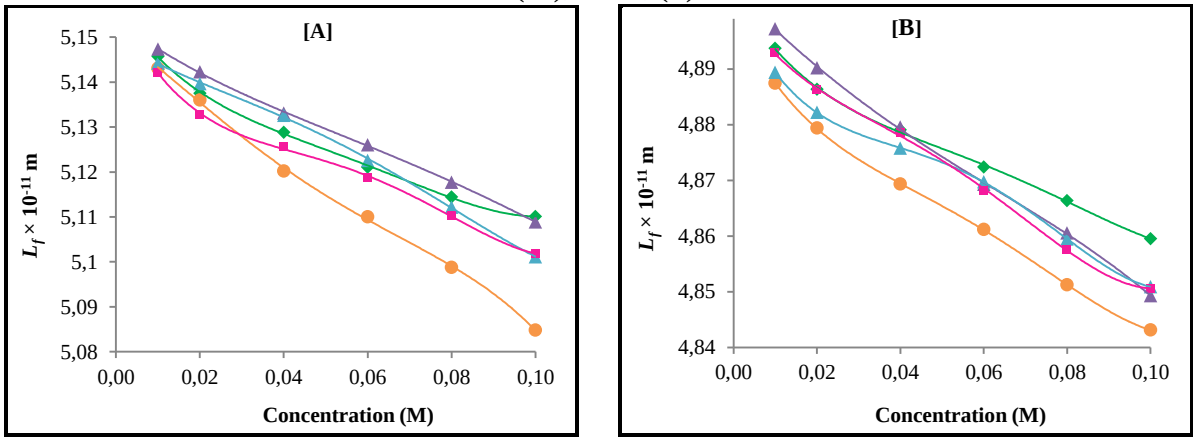

Figure 3. Variation of free path length (L_f) with molar concentration of synthesized compounds RD-1 to RD-5 in [A] 1,4-dioxane and [B] DMF at 318.15 K. RD-1, (♦); RD-2, (▲); RD-3, (●); RD-4, (▲); RD-5, (■).

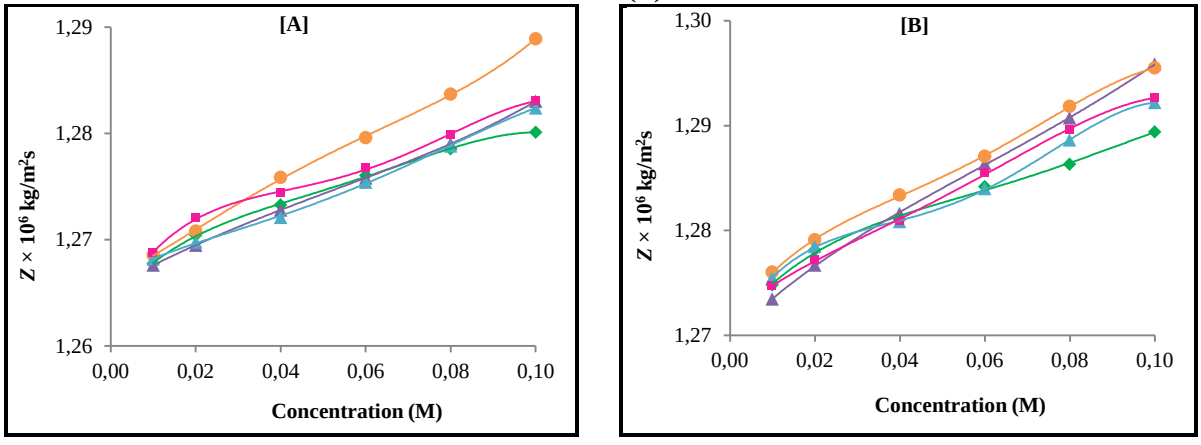

Figure 4. Variation of acoustical impidence (*Z*) with molar concentration of synthesized compounds RD-1 to RD-5 in [A] 1,4-dioxane and [B] DMF at 318.15 K. RD-1, (♦); RD-2, (▲); RD-3, (●); RD-4, (▲); RD-5, (■).

This again proves existence of strong interactions between solvent and solute molecules. By increasing the concentration of solute, molecular associations are enhanced and newly formed aggregates cause adiabatic compressibility to decrease.

The relaxation strength (r) decreases with increase in concentration whereas increases with temperature as shown in Tables 4 and 5. Further, relaxation strength increases with temperature. It is clear from Tables 4 and 5 that as concentration of solute and temperature increases, internal pressure (π) decreases for all the compounds in both the solvents. The internal pressure is a measure of cohesive energy and decrease of this cohesive energy suggests the presence of solute-solute interactions also in the system. However, solute-solvent interactions dominate as suggested by other acoustical properties. The variation of Vander Waal constant (*b*) suggests the absence of complex structure in solution (Tables 4 and 5).

Table 4. Some acoustical parameters in 1, 4-dioxane for pyrimidine derivatives at different temperatures.

Conc. (M)	$Z\times10^6$ Kg/m^{2}s	$\kappa_s\times10^{-5}$ m^2. N^{-1}	r	$\pi\times10^{10}$ N.m^{-2}	$b\times10^5$
		298.15 K			
		RD-1			
0.00	1.3820	5.3802	0.2934	1.6134	8.0906
0.01	1.3853	5.3599	0.2915	1.6132	8.2020
0.02	1.3873	5.3491	0.2906	1.6032	8.3137
0.04	1.3902	5.3330	0.2893	1.5639	8.5417
0.06	1.3931	5.3171	0.2881	1.5258	8.7676
0.08	1.3951	5.3087	0.2878	1.5044	8.9919
0.10	1.3972	5.2966	0.2867	1.4860	9.2207
		RD-2			
0.01	1.3850	5.3662	0.2923	1.5819	8.2425
0.02	1.3868	5.3570	0.2918	1.5521	8.3969
0.04	1.3901	5.3420	0.2918	1.5026	8.7000
0.06	1.3931	5.3254	0.2903	1.4581	9.0126
0.08	1.3963	5.3103	0.2895	1.4178	9.3181
0.10	1.4002	5.2943	0.2892	1.3749	9.6118
		RD-3			
0.01	1.3855	5.3594	0.2915	1.5827	8.2300
0.02	1.3876	5.3476	0.2905	1.5586	8.3716
0.04	1.3921	5.3216	0.2883	1.5089	8.6532
0.06	1.3960	5.3012	0.2868	1.4660	8.9322
0.08	1.4004	5.2780	0.2850	1.4420	9.2080
0.10	1.4041	5.2632	0.2848	1.4071	9.4745
		RD-4			
0.01	1.3851	5.3615	0.2917	1.6263	8.2094
0.02	1.3869	5.3512	0.2908	1.6048	8.3317
0.04	1.3894	5.3363	0.2894	1.5582	8.5777

0.06	1.3924	5.3205	0.2882	1.5198	8.8193
0.08	1.3957	5.3017	0.2865	1.4889	9.0612
0.10	1.3991	5.2823	0.2848	1.4594	9.3015
		RD-5			
0.01	1.3861	5.3548	0.2909	1.5975	8.2112
0.02	1.3889	5.3395	0.2898	1.5954	8.3308
0.04	1.3914	5.3260	0.2887	1.5652	8.5814
0.06	1.3937	5.3134	0.2877	1.5209	8.8310
0.08	1.3968	5.2980	0.2867	1.4870	9.0739
0.10	1.4000	5.2819	0.2856	1.4522	9.3152
		308.15K			
		RD-1			
0.00	1.3258	5.7871	0.3365	1.5400	8.2766
0.01	1.3282	5.7721	0.3354	1.5279	8.3902
0.02	1.3310	5.7545	0.3341	1.4960	8.6229
0.04	1.3340	5.7355	0.3327	1.4649	8.8532
0.06	1.3359	5.7262	0.3325	1.4315	9.0820
0.08	1.3378	5.7144	0.3316	1.4069	9.3154
0.10	1.3258	5.7871	0.3365	1.5400	8.2766
		RD-2			
0.01	1.3257	5.7905	0.3371	1.5296	8.3181
0.02	1.3275	5.7801	0.3366	1.5103	8.4756
0.04	1.3314	5.7602	0.3358	1.4562	8.7859
0.06	1.3338	5.7466	0.3351	1.4082	9.1035
0.08	1.3369	5.7294	0.3342	1.3643	9.4150
0.10	1.3409	5.7107	0.3338	1.3277	9.7135
		RD-3			
0.01	1.3265	5.7822	0.3361	1.5293	8.3052
0.02	1.3284	5.7710	0.3353	1.5104	8.4496
0.04	1.3329	5.7415	0.3330	1.4676	8.7367
0.06	1.3372	5.7148	0.3311	1.4479	9.0212
0.08	1.3412	5.6925	0.3298	1.4155	9.3020
0.10	1.3460	5.6658	0.3284	1.3841	9.5740
		RD-4			
0.01	1.3262	5.7846	0.3363	1.5482	8.2842
0.02	1.3278	5.7744	0.3355	1.5280	8.4082
0.04	1.3301	5.7596	0.3344	1.4899	8.6591
0.06	1.3334	5.7388	0.3329	1.4483	8.9061
0.08	1.3365	5.7188	0.3313	1.4249	9.1525
0.10	1.3400	5.6958	0.3295	1.3957	9.3974
		RD-5			
0.01	1.3266	5.7814	0.3360	1.5402	8.2859
0.02	1.3297	5.7618	0.3345	1.5237	8.4085
0.04	1.3328	5.7411	0.3328	1.4784	8.6635

0.06	1.3345	5.7319	0.3324	1.4520	8.9179
0.08	1.3377	5.7142	0.3314	1.4180	9.1655
0.10	1.3408	5.6963	0.3304	1.3818	9.4117
318.15 K					
RD-1					
0.00	1.2641	6.2880	0.3818	1.4976	8.2375
0.01	1.2678	6.2589	0.3796	1.4826	8.3531
0.02	1.2704	6.2391	0.3782	1.4628	8.4689
0.04	1.2733	6.2181	0.3768	1.4249	8.7064
0.06	1.2760	6.1992	0.3757	1.3916	8.9411
0.08	1.2785	6.1831	0.3749	1.3623	9.1748
0.10	1.2801	6.1726	0.3743	1.3393	9.4128
RD-2					
0.01	1.2676	6.2629	0.3802	1.4729	8.3955
0.02	1.2695	6.2507	0.3796	1.4458	8.5562
0.04	1.2728	6.2284	0.3784	1.3927	8.8793
0.06	1.2758	6.2113	0.3779	1.3531	9.1969
0.08	1.2790	6.1910	0.3770	1.3148	9.5146
0.10	1.2830	6.1697	0.3766	1.3014	9.8182
RD-3					
0.01	1.2685	6.2526	0.3791	1.4762	8.3822
0.02	1.2708	6.2355	0.3779	1.4545	8.5298
0.04	1.2759	6.1971	0.3751	1.4093	8.8228
0.06	1.2796	6.1724	0.3738	1.3758	9.1126
0.08	1.2837	6.1453	0.3723	1.3485	9.3989
0.10	1.2889	6.1117	0.3705	1.3134	9.6760
RD-4					
0.01	1.2682	6.2553	0.3793	1.4786	8.3608
0.02	1.2698	6.2442	0.3786	1.4561	8.4872
0.04	1.2721	6.2271	0.3775	1.4229	8.7433
0.06	1.2754	6.2029	0.3759	1.3941	8.9951
0.08	1.2788	6.1777	0.3741	1.3603	9.2464
0.10	1.2824	6.1509	0.3722	1.3426	9.4962
RD-5					
0.01	1.2688	6.2504	0.3789	1.4780	8.3627
0.02	1.2720	6.2275	0.3775	1.4589	8.4855
0.04	1.2744	6.2100	0.3763	1.4163	8.7473
0.06	1.2767	6.1935	0.3753	1.3784	9.0070
0.08	1.2799	6.1731	0.3742	1.3493	9.2596
0.10	1.2830	6.1526	0.3732	1.3372	9.5106

Table 5. Some acoustical parameters in DMF for pyrimidine derivatives at different temperatures.

Conc. (M)	$Z\times10^{6}$ Kg/m^{2}s	$\kappa_s\times10^{-5}$ m^2. N^{-1}	r	$\pi\times10^{10}$ N.m^{-2}	b
			298.15 K		
			RD-1		
0.00	1.3742	4.9971	0.1716	1.5606	7.2950
0.01	1.3782	4.9769	0.1697	1.5426	7.4292
0.02	1.3819	4.9631	0.1696	1.5227	7.5563
0.04	1.3851	4.9495	0.1689	1.4745	7.8340
0.06	1.3878	4.9385	0.1684	1.4295	8.1117
0.08	1.3905	4.9263	0.1675	1.3855	8.3902
0.10					
			RD-2		
0.01	1.3775	4.9845	0.1715	1.5236	7.4777
0.02	1.3798	4.9743	0.1708	1.4908	7.6682
0.04	1.3844	4.9547	0.1697	1.4190	8.0443
0.06	1.3893	4.9377	0.1700	1.3652	8.4061
0.08	1.3936	4.9179	0.1683	1.3064	8.7804
0.10	1.3981	4.8993	0.1674	1.2622	9.1446
			RD-3		
0.01	1.3793	4.9707	0.1690	1.5370	7.4625
0.02	1.3822	4.9549	0.1672	1.5046	7.6371
0.04	1.3867	4.9358	0.1662	1.4441	7.9800
0.06	1.3905	4.9197	0.1653	1.3829	8.3228
0.08	1.3956	4.9006	0.1649	1.3431	8.6513
0.10	1.3992	4.8852	0.1639	1.3079	8.9901
			RD-4		
0.01	1.3782	4.9754	0.1692	1.5255	7.4415
0.02	1.3808	4.9641	0.1685	1.4959	7.5877
0.04	1.3837	4.9502	0.1674	1.4460	7.8895
0.06	1.3869	4.9354	0.1663	1.3980	8.1878
0.08	1.3918	4.9180	0.1663	1.3592	8.4659
0.10	1.3956	4.8992	0.1644	1.3268	8.7601
			RD-5		
0.01	1.3783	4.9764	0.1696	1.5358	7.4426
0.02	1.3805	4.9667	0.1691	1.5086	7.5931
0.04	1.3843	4.9515	0.1686	1.4642	7.8924
0.06	1.3880	4.9354	0.1677	1.4194	8.1925
0.08	1.3928	4.9167	0.1670	1.3796	8.4809
0.10	1.3958	4.9019	0.1656	1.3299	8.7843
			308.15K		
			RD-1		

0.00	1.3239	5.3209	0.2152	1.5289	7.3442
0.01	1.3285	5.3049	0.2135	1.5064	7.4890
0.02	1.3319	5.2893	0.2129	1.4825	7.6218
0.04	1.3350	5.2744	0.2122	1.4391	7.9047
0.06	1.3378	5.2617	0.2116	1.3867	8.1877
0.08	1.3404	5.2487	0.2108	1.3397	8.4713
0.10	1.3430	5.2337	0.2094	1.2998	8.7569
			RD-2		
0.01	1.3265	5.3126	0.2135	1.4634	7.5542
0.02	1.3298	5.2995	0.2134	1.4369	7.7392
0.04	1.3347	5.2773	0.2126	1.3686	8.1183
0.06	1.3396	5.2552	0.2118	1.3214	8.4932
0.08	1.3433	5.2389	0.2113	1.2668	8.8709
0.10	1.3485	5.2154	0.2103	1.2199	9.2364
			RD-3		
0.01	1.3298	5.2937	0.2117	1.4893	7.5263
0.02	1.3326	5.2777	0.2103	1.4542	7.7034
0.04	1.3370	5.2568	0.2092	1.3900	8.0532
0.06	1.3413	5.2372	0.2084	1.3430	8.3977
0.08	1.3455	5.2198	0.2080	1.2958	8.7373
0.10	1.3488	5.2035	0.2070	1.2513	9.0844
			RD-4		
0.01	1.3288	5.2980	0.2119	1.4921	7.5051
0.02	1.3315	5.2843	0.2110	1.4644	7.6541
0.04	1.3341	5.2710	0.2101	1.4097	7.9615
0.06	1.3373	5.2550	0.2091	1.3591	8.2652
0.08	1.3419	5.2358	0.2087	1.3206	8.5517
0.10	1.3456	5.2172	0.2075	1.2794	8.8481
			RD-5		
0.01	1.3285	5.3023	0.2127	1.4949	7.5061
0.02	1.3307	5.2913	0.2121	1.4713	7.6595
0.04	1.3348	5.2719	0.2112	1.4154	7.9645
0.06	1.3385	5.2540	0.2102	1.3704	8.2701
0.08	1.3431	5.2347	0.2097	1.3240	8.5638
0.10	1.3458	5.2204	0.2086	1.2781	8.8729
			318.15 K		
			RD-1		
0.00	1.2746	5.6901	0.2574	1.4769	7.4178
0.01	1.2798	5.6609	0.2558	1.4644	7.5485
0.02	1.2831	5.6439	0.2552	1.4429	7.6841
0.04	1.2860	5.6271	0.2541	1.3909	7.9754
0.06	1.2892	5.6117	0.2536	1.3437	8.2597
0.08	1.2913	5.5978	0.2524	1.2981	8.5546
0.10	1.2944	5.5821	0.2518	1.2578	8.8366

			RD-2		
0.01	1.2785	5.6689	0.2563	1.4376	7.6087
0.02	1.2817	5.6527	0.2558	1.4005	7.7985
0.04	1.2866	5.6282	0.2551	1.3405	8.1832
0.06	1.2914	5.6045	0.2543	1.2850	8.5643
0.08	1.2957	5.5844	0.2539	1.2417	8.9409
0.10	1.3009	5.5586	0.2529	1.1999	9.3117
			RD-3		
0.01	1.2810	5.6463	0.2534	1.4473	7.5914
0.02	1.2841	5.6278	0.2520	1.4200	7.7693
0.04	1.2884	5.6047	0.2508	1.3604	8.1260
0.06	1.2921	5.5859	0.2501	1.3011	8.4806
0.08	1.2968	5.5631	0.2495	1.2487	8.8228
0.10	1.3005	5.5445	0.2487	1.2070	9.1716
			RD-4		
0.01	1.2805	5.6509	0.2539	1.4477	7.5647
0.02	1.2835	5.6344	0.2530	1.4233	7.7141
0.04	1.2859	5.6195	0.2519	1.3699	8.0306
0.06	1.2890	5.6056	0.2518	1.3215	8.3330
0.08	1.2936	5.5819	0.2508	1.2760	8.6276
0.10	1.2972	5.5623	0.2497	1.2415	8.9290
			RD-5		
0.01	1.2797	5.6588	0.2551	1.4468	7.5668
0.02	1.2822	5.6435	0.2540	1.4224	7.7232
0.04	1.2859	5.6257	0.2536	1.3814	8.0335
0.06	1.2905	5.6018	0.2526	1.3319	8.3375
0.08	1.2946	5.5777	0.2509	1.2833	8.6468
0.10	1.2977	5.5616	0.2500	1.2361	8.9564

Further, it is clear from Tables 6 and 7 that the values of A, ϕ^0_k and ϕ°_v are negative whereas B, S_k and S_v values are positive which indicate the structure forming tendency of compounds in 1,4-dioxane and DMF solutions which confirm solute-solvent interactions in all the solutions of compounds [37].

Table 6. Coefficients of equations (4), (6) and (7) for pyrimidine derivatives in 1, 4-dioxane at different temperatures.

Coefficient	**RD-1**	**RD-2**	**RD-3**	**RD-4**	**RD-5**
		298.15 K			
$-A$	1.79	1.09	1.98	1.27	1.94
B	3.09	0.77	2.57	0.98	3.16
$-\phi^\circ_k \times 10^{-2} N^{-1} mol^{-1}$	2.30	1.85	2.50	1.63	2.46

$S_k \times 10^{-13} m^3 . mol^{-1}$	3.62	1.54	2.65	1.08	3.58
$-\phi^\circ_v \times 10^{-1} N^{-1} m^3 mol^{-1}$	115.9	148.3	97.9	68.39	97
$S_v \times 10^8 N^{-1} m^{-3/2} . mol^{-3/2}$	177.3	177.7	17.85	20.35	79.46
308.15 K					
-A	2.25	1.34	2.47	1.54	2.71
B	4.09	1.06	3.37	1.28	5.16
$-\phi^\circ_k \times 10^{-2} N^{-1} mol^{-1}$	2.82	2.98	3.06	1.93	3.30
$S_k \times 10^{-13} m^3 . mol^{-1}$	4.71	5.12	3.47	1.39	5.67
$-\phi^\circ_v \times 10^{-1} N^{-1} m^3 mol^{-1}$	122.4	151.6	110.4	74.72	102.1
$S_v \times 10^8 N^{-1} m^{-3/2} . mol^{-3/2}$	193	182	67.17	34.35	89.27
318.15 K					
-A	2.74	1.97	3.31	1.76	2.90
B	5.07	2.62	5.24	1.31	5.08
$-\phi^\circ_k \times 10^{-2} N^{-1} mol^{-1}$	3.39	4.01	3.97	2.24	3.57
$S_k \times 10^{-13} m^3 mol^{-1}$	5.79	8.38	5.36	1.52	5.68
$-\phi^\circ_v \times 10^{-1} N^{-1} m^3 mol^{-1}$	126.2	162.1	114	17.37	107.3
$S_v \times 10^8 N^{-1} m^{-3/2} mol^{-3/2}$	198.7	249.2	70.72	35.87	98.91

Table 7. Coefficients of equations (4), (6) and (7) for pyrimidine derivatives in DMF at different temperatures.

Coefficient	***RD-1***	***RD-2***	***RD-3***	***RD-4***	***RD-5***
298.15 K					
-A	1.79	1.09	1.98	1.27	1.94
B	3.09	0.77	2.57	0.98	3.16
$-\phi^\circ_k \times 10^{-2} N^{-1} mol^{-1}$	2.30	1.85	2.50	1.63	2.46
$S_k \times 10^{-13} m^3 . mol^{-1}$	3.62	1.54	2.65	1.08	3.58
$-\phi^\circ_v \times 10^{-1} N^{-1} m^3 mol^{-1}$	115.9	148.3	97.9	68.39	97
$S_v \times 10^8 N^{-1} m^{-3/2} . mol^{-3/2}$	177.3	177.7	17.85	20.35	79.46
308.15 K					
-A	2.25	1.34	2.47	1.54	2.71
B	4.09	1.06	3.37	1.28	5.16
$-\phi^\circ_k \times 10^{-2} N^{-1} mol^{-1}$	2.82	2.98	3.06	1.93	3.30
$S_k \times 10^{-13} m^3 . mol^{-1}$	4.71	5.12	3.47	1.39	5.67
$-\phi^\circ_v \times 10^{-1} N^{-1} m^3 mol^{-1}$	122.4	151.6	110.4	74.72	102.1
$S_v \times 10^8 N^{-1} m^{-3/2} . mol^{-3/2}$	193	182	67.17	34.35	89.27

318.15 K					
-A	2.74	1.97	3.31	1.76	2.90
B	5.07	2.62	5.24	1.31	5.08
$-\phi^{\circ}_k \times 10^{-2} N^{-1} mol^{-1}$	3.39	4.01	3.97	2.24	3.57
$S_k \times 10^{-13} m^3 mol^{-1}$	5.79	8.38	5.36	1.52	5.68
$-\phi^{\circ}_v \times 10^{-1} N^{-1} m^3 mol^{-1}$	126.2	162.1	114	17.37	107.3
$S_v \times 10^{8} N^{-1} m^{-3/2} mol^{-3/2}$	198.7	249.2	70.72	35.87	98.91

Overall, in all the studied solutions both compound-solvent and compound-compound interactions exist. However, most of the acoustic and apparent properties indicate predominance of compound-solvent interactions. Molecular interactions are greater in DMF solutions as compared to in 1,4-dioxane solutions.

4. CONCLUSION

The present work further advances the existing knowledge of solute-solvent interactions in 1,4-dioxane and DMF solutions which increases with concentration but decreases with temperature. The solute-solvent interactions are affected by temperature and different substitutions in the compound.

References

[1] Nain, A.; Pal, R. and Sharma, R.; "Physicaochemical study of solute-solute and solute-solvent interactions of l-histidine in water+sucrose solutions at different temperatures." *J. Mol. Liq*., 165 (2012) 154-160.

[2] Jahagirdar, D. V.; Arbad, B. R.; Mirgane, S. R.; Lande, M. K. and Shankarwar A. G.; "Density, ultrasonic velocity and viscosity measurements of four pharmacologically significant drugs in methanol at 25 °C." *J. Mol. Liq*., 75 (1998) 33-43.

[3] Nozdrev, V. F.; "Application of Ultrasonic in Molecular Physics." Gordon and Breach, New York (1963).

[4] Pierce, D. C.; "Acoustics.", *Mc Graw Hill*, New York (1981).

[5] Laux, D.; Leveque, G. and Cereser C. V.; "Ultrasonic properties of water/sorbitol solutions." *Ultrason*., 49 (2009) 159-161.

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

[7] Ravichandran, S. and Ramanathan, K.; "Ultrasonic study and allied properties of cholesterol in chloroform solutions at 294 K." *J. Pure and Appl. Ultra*., 28 (2006) 40-45.

[8] Shashikant, I. A.; Rajput, P. R. and Narwade M. L.; "Studies on acoustic properties of some substituted pyrazole, isoxazole and pyrazoline in dioxane at 303 K." *Ind. J. Chem., Sec. A,* 44 (2005) 2495-2497.

[9] Agrawal, P. B. and Narwade, M. L.; "Prediction of viscosity and ultrasonic behavior of substituted flavone, isoxazole and pyrazole in 70% acetone water mixture." *Acta Cien. Ind., Chem*., 28 (2002) 163-166.

[10] Akhtar Y.; "Interaction studies of L-proline and L-glutamine with some electrolytes in aqueous media." *J. Ind. Council Chem*., 21 (2004) 43-47.

[11] Thakur S. K. and Chauhan S.; "Ultrasonic velocity and allied parameters of drug colimax in aq. 1-propanol at 298.15K." *J. Chem. Pharm. Res*., 3 (2011) 657-664.

[12] Dhondge, S. S.; Paliwal, R. L.; Bhave N. S. and Pandhurnekar, C. P.; "Study of thermodynamic properties of aq. binary mixture of glycine, L-alanine & β-alanine at low temp. (T = 275.15, 279.15, and 283.15) K." *J. Chem. Therm*., 45 (2012) 114-121.

[13] Liu, L. J. and Hong, J. H.; "Synthesis and anti-HIV activity of 4'-modified cyclopentenyl pyrimidine c-nucleosides." *Nucleosides, Nucleotides and Nucleic acids,* 28 (2009) 303-314.

[14] Gholap, A. R.; Toti, K. S.; Shirazi, F.; Deshpande, M. V. and Srinivasan, K. V.; "Efficient synthesis of antifungal pyrimidines via palladium catalyzed suzuki/sonogashira cross-coupling reaction from biginelli 3, 4-dihydropyrimidin-2(1h)-ones." *Tetrahedron*, 64 (2008) 10214-10223.

[15] Mai, A.; Rotili, D.; Massa, S.; Brosch, G.; Simonetti, G.; Passariello, C. and Palamara A. T.; "Discovery of uracil-based histone deacetylase inhibitors able to reduce acquired antifungal resistance and trailing growth in *Candida albicans*." *Bioorg. Med. Chem. Lett*., 17 (2007) 1221-1225.

[16] Rahaman, S. A.; Prasad, Y. R.; Kumar, P. and Kumar, B.; "Synthesis and anti-histaminic activity of some novel pyrimidines." *Sau. Pharm. J.*, 17 (2009) 255-258.

[17] Y. R. Prasad, S. A. Rahaman, "Anti-histamine activity of newly synthesized pyrimidines." *Int. J. Chem. Sci.*, 6 (2008) 2038-2044.

[18] Fhid, O.; Pawłowski, M.; Filipek, B.; Horodynska, R. and Maciag D.; "Central nervous system activity of new pyrimidine-8-on[2,1f]theophylline9alkylcarboxylicacids derivatives." *Pol. J. Pharmacol*, 54 (2002) 245-254.

[19] Amr, A. E.; Mohamed, A. M.; Mohamed, S. F.; Abdel-Hafez, N. A. and Hammam, A. G.; "Anticancer activities of some newly synthesized pyridine, pyrane, and pyrimidine derivatives." *Bioorg. Med. Chem*., 14 (2006) 5481-5488.

[20] Dudhe, R.; Sharma, P. K.; Verma, P. and Chaudhary, A.; "Pyrimidine As Anticancer Agent: A Review." *J. Adv. Sci. Res.*, 2 (2011) 10-17.

[21] Hammam, A. E. G.; Sharaf, M. A. and EI-Hafez, N. A. A.; "Synthesis and anti-cancer activity of pyridine and thiazolopyrimidine derivatives using 1-ethylpiperidone as a synthon." *Ind. J. Chem.*, 40 (2001) 213-221.

[22] Gupta, J. K.; Sharma, P. K.; Dudhe, R.; Mondal, S. C.; Chaudhary, A. and Verma, P. K.; "Synthesis and analgesic activity of novel pyrimidine derivatives of coumarin moiety." *Acta Pol. Pharm.*, 68 (2011) 785-793.

[23] Wyrzykiewicz, E.; Bartkowiak, G. and Kedzia, B. "Synthesis of anti-microbial properties of S-Substituted derivatives of 2-thiouracile." *Farmaco Poland*, 48 (1993) 979-988.

[24] Chitre, T. S.; Kathiravan, M. K.; Chothe, A. S.; Rakholiya, V. K.; Asgaonkar, K. D.; Patil, S. M. and Bothara, K. G.; "Synthesis and antitubercular activity of some substituted pyrimidine derivatives." *J. Pharm. Res*., 4 (2011) 1882-1883.

[25] Kandeel, M. M.; Ali, S. M.; ElALL, E. K. A. A.; Abdelgawad, M. A. and Lamie, P. F.; "Synthesis and antitumor activity of novel pyrazolo[3,4-*d*]pyrimidines and related heterocycles." *Der Pharma Chemica*, 4 (2012) 1704-1715.

[26] Sirichaiwat, C.; Intaraudom, C.; Kamchonwongpaisan, S.; Vanichtanankul, J.; Thebtaranonth, Y. and Yuthavong, Y.; "Target guided synthesis of 5-benzyl-2,4-diamono pyrimidines: Their antimalarial activities and binding affinities to wild type and mutant dihydrofolate reductases from plasmodium falciparum." *J. Med. Chem.*, 47 (2004) 345-354.

[27] Morgan, J.; Haritakul, R. and Keller, P. A. "Antimalarial activity of 2,4-diaminopyri midines." *Lett. Drug Des. Discov.*, 5 (2008) 277-280.

[28] Alam, O.; Khan, S. A.; Siddiqui, N.; Ahsan, W.; Verma, S. P.; Gilani, S. J.; "Antihyper tensive activity of newer 1, 4-dihydro-5-pyrimidine carboxamides: Synthesis and pharmacological evaluation." *Eur. J. Med. Chem*., 45 (2010) 5113-5119.

[29] Riddick, J. A.; Bunger, W. B. and Sakano, T. "Organic solvents-physical properties and methods of purification, techniques of chemistry." New York, (1986).

[30] Rathnam, M. V.; Mankumare, S.; Jain, K. and Kumar, M. S.; "Densities, viscosities and speeds of sound of binary mixtures of ethyl benzoate + hydrocarbons at (303.15, 308.15 and 313.15) K." *J. Solution Chem*., 41 (2012) 475-490.

[31] Gucker, F. T.; "The apparent molal heat capacity, volume, and compressibility of electrolytes." *Chem. Rev*., 13 (1933) 111-130.

[32] Masson, D. O.; "Solute molecular volumes in relation to solvation and ionization." *Philosophical. Magazine*, 8 (1929) 218-235.

[33] Gopal, R. and Siddiqi, M. A. "A study of ion-solvent interaction of some tetraalkylam monium and common ions in N-methylacetamide from apparent molal volume data." *J. Phys. Chem.* **1969,** *73*, 3390-3394.

[34] Saha, N.; Das, B. and Hazra, D. K.; "Viscosities and excess molar volumes for aceto nitrile + methanol at 298.15, 308.15, and 318.15 K." *J. Chem. Eng. Data*, 40 (1995) 1264-1266.

[35] Bachem, C. H.; "The compressibility of electrolytic solution." *Z. Physik*., 101 (1936) 541-577.

[36] Aswale, S. S.; Aswale, S. R. and Hajare, R. S.; "Adiabatic compressibility, intermole cular free length and specific acoustic impedance of antibiotic ampicillin sodium." *Int. J. Pharm. Pharm. Sci*., 5 (2013) 76-79.

[37] Nikam, P. S.; Ansari, H. R. and Hasan, M.; "Ultrasonic velocity studies of dextrose and sucrose in water and in aqueous ammonium chloride at different temperatures." *J. Pure Appl. Ultrason*., 20 (1998) 75-78.

(Received 05 March, 2016; accepted 20 March, 2016)