ISSN No:-2456-2165

Studies on Salvation Consequences of Amino Acid in Aqueous Acetaminophen leading to Human Body by Thermodynamic and Physico-Chemical Approaches

Binoy Chandra Saha and Mahendra Nath Roy*
Department of Chemistry, University of North Bengal, Darjeeling.
West Bengal, India.

Abstract:- Viscosity *B*-coefficient ,apparent molar volume (ϕ_V)Specific conductance and molar refraction (R_M) resolute of Acetaminophen solution in different amino acid supplemented with the density (ρ), viscosity (η) and refractive index (n_D) and conductance data at various temperature 298.15 K, 303.15 K and 308.15 K respectively at different mass fractions. The limiting apparent molar volumes (ϕ_V^0) *and experimental slopes (SV*) were derived from the Masson equation.* ($\phi_V = \phi_V^0 + S_V^* \sqrt{m}$)*,have been interpreted in terms of solute–solvent and solute–solute interactions respectively.* ($\delta^2\phi_V^0/\delta T^2)_P$ *values sign ability of the structure making or structure* **breaking ability of Asparagine and glutamine. The viscosity data were analyzed using the Jones–Dole equation ($(\eta/\eta_0 - 1)/\sqrt{m} = A + B\sqrt{m}$) **and the derived parameter *B coefficient* has also been interpreted in terms of solute–solvent interactions present in the solutionsThe increase in the transform volume of the solute with acetaminophen concentration was explained by the Friedman and Krishnan Co sphere models. The application of the transition state of the theory has also computed and explained the viscosity activation parameters for the studied solutions.Molar refraction** ($R_M = \left\{\left(\frac{n_D^2 - 1}{n_D^2 + 2}\right)\right\}\frac{m}{\rho}$) **has been calculated using the Lorentz - Lorenz equation. Molecular interaction of two amino acids in acetaminophen solution in aqueous medium was investigated by conducting moles at three different temperatures.**

Keywords:- *Acetaminophen ,Asparagines , Glutamine ,Solute-Solvent, Interactions, Apparent Molar Volume, Viscosity, Conductance.*

I. INTRODUCTION

N-acetyl para aminophenol(paracetamol) is also known as acetaminophen. Acetaminophen (APAP) is used a pain reliever and fever reducer[1]. It is used to treatment of headache, arthritis,etc. Paracetamol consists of a benzene ring core, a hydroxyl group, and a nitrogen atom of the amide group in the position of para (1,4). It is a mostly synthesized system, a single pair of hydroxyl oxygen, a benzene π cloud, a nitrogen loan pair, a P orbit of carbon in the carbonyl and a single pair of carbonyl oxygen. The presence of two active groups makes the benzene ring highly responsive.

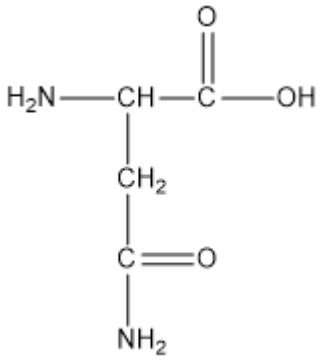


Fig 1:- Acetaminophen

Glutamine (glen) is a significant amino acid. L-Glutamine is found in animal foods, supplements and the human body. It is a part of the protein involved in the immune function of our body within the intestine [2]. Glutamine is an energy source for the gut and immune cells. It helps maintain a wall between the interior and the rest of our body. It develops properly with the intestinal cells of body.

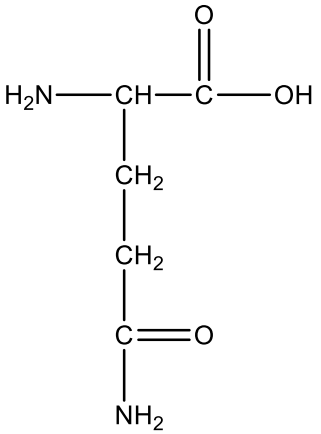


Fig 2:- Glutamine

The role of Asparagine (Asan) in the biosynthesis of glycoproteins. It is a necessary synthesis of other proteins in the human nervous system. It also needs this amino acid to be able to balance.It is required to develop the function of the brain and solvent–solvent interactions [2]. We did a systematic study on density, viscosity, refractive index and conductivity of 0.001M,0.003M,0.005M aqueous solution of Acetaminophen with amino acid(Asparagines, Glutamine) at 298.15 K, 303.15 K and 308.15 K, and we

ISSN No:-2456-2165

have attempted to report the limiting apparent molar volume (ϕ_V^0), experimental slopes (S_V*), viscosity *A* and *B*-coefficients and molar refraction (R_M) for the Acetaminophen .

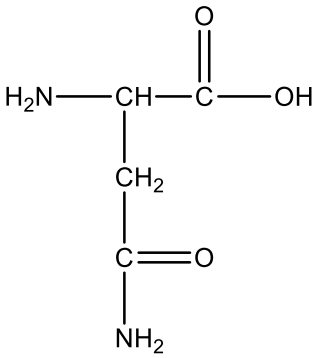


Fig 3:- Asparagine

The volumetric and visuometric behaviors of the solids have been established as very effective in explaining the various interactions that occur in solutions [3]. Studies on the effect of solubility (molality), The apparent molar volume widely used to obtain information on aqueous amino acid , solute- solvent and solvent-solvent intaraction[4] aqueous amino acids.

II. EXPERIMENTAL METHODS

➢ *Source and Purity of Samples:*

APAP was purchased from Sd. Fine Chemicals Limited, Mumbai, India and Amino acid was purchased from Acros Organics, of New Jersey, USA. Its purity as supplied is 99.5%. Both were always stored over P_2O_5 in a desiccators before use. Triply distilled water with a specific conductance $<10^{-6}$ S cm^{-1} was used for the preparation of different solutions.

➢ *Apparatus and Procedure*

The density (ρ) was measured by means of vibrating-tube Anton Paar Density-Meter (DMA 4500M), manufactured by Anton Paar, Gewerbepark 78142,Wundschuh, Austria with an accuracy of 0.00001 × 10^{-3} (kg m^{-3}).It was calibrated by double-distilled water and dry air. [8] The temperature was automatically set to± 0.01 K. Viscosity was determined using the Brookfield DV-III Ultra Programmable Rheometer, developed by Scinteck.A aBrookfield Digital Bath TC-500 with spindle size-42 calibrated at 298.15 K with doubly distilled water and purified methanol. [9] The viscosity uncertainty measurements is within 0.003 mPa.s.

The Refractive index was measured at Digital Refractometer Mettler Toledo, manufactured by Mittler-Toledo India Private Ltd. The light source was LED,λ = 589.3 nm. The refractometer was calibrated twice using distilled water and every few measurements were tested. The uncertainty of the measurement of the refractive index is ± 0.0002 units.

III. RESULTS AND DISCUSSIONS

Physical properties of aqueous solutions of acetaminophen at different temperatures are reported in Table-1

Solvent Mixture	ρ x 10^{-3} (kg.m^{-3})				η (m.Pa. s)		n_D
	298K	303K	308K	298K	303K	308K	298 K
Aq.0.001(M)APAP sol.	0.99698	0.99558	0.99401	0.8595	0.7167	0.6905	1.3316
Aq.0.003(M) acetaminophen sol.	0.99704	0.99564	0.99405	0.8847	0.7919	0.7069	1.3318
Aq.0.005(M) acetaminophen sol	0.99838	0.99728	0.99695	0.9684	0.8896	0.8112	1.3320
Solvent Mixture	ρ x 10^{-3} (kg.m^{-3})				η (mPa. s)		n_D
	298K	303K	308K	298K	303K	308K	298 K
Aq.0.001(M)APAP sol.+Glutamine	0.99779	0.99631	0.99479	0.8936	0.7971	0.7197	1.3317
Aq.0.003(M) acetaminophen sol+Glutamine	0.99823	0.99687	0.99522	0.9046	0.8615	0.7741	1.3319
Aq.0.005(M) acetaminophen+Glutamine	0.99944	0.99802	0.99612	0.922	0.8263	0.7646	1.3321

Table 1:- Physical properties of aqueous Acetaminophen solution.

The investigational values of densities (ρ), viscosities (η) along with the apparent molar volume (ϕ_V) and $(\eta/\eta_0 - 1)/\sqrt{m}$ values of Asparagines and glutamine in aqueous solution of Acetaminophen at 298.15 K, 303.15 K and 308.15 K respectively are reported in Table-2.

ISSN No:-2456-2165

m (mol. kg^{-1})	ρ x 10^{-3} (kg. m^{-3})	η (mPa. s)	ϕ_V x 10^{6} (m^3. mol^{-1})	$(\eta / \eta_0 - 1) / \sqrt{m}$ (mol. kg^{-1})$^{-1/2}$
Glutamine in aqueous 0.001M Acetaminophen solutions				
T = 298.15 K				
0.0101	0.99795	0.9707	134.4377	0.053
0.0201	0.99812	0.9734	131.9323	0.063
0.0403	0.99856	0.9783	128.1741	0.074
0.0606	0.99906	0.9836	125.9192	0.085
0.0813	0.99966	0.9890	123.5391	0.096
0.1014	1.00031	0.9954	121.6099	0.107
T = 303.15K				
0.0101	0.99644	0.7221	135.6438	0.075
0.0201	0.99659	0.7247	133.6364	0.079
0.0403	0.99701	0.7302	129.6217	0.094
0.0606	0.99751	0.7357	126.9452	0.108
0.0813	0.99811	0.7414	124.3524	0.121
0.1014	0.99874	0.7481	122.4956	0.138
T = 308.15 K				
0.0101	0.9949	0.6956	136.8577	0.074
0.0201	0.99506	0.6986	133.8420	0.083
0.0403	0.99547	0.7036	130.0724	0.095
0.0606	0.99598	0.7091	127.1405	0.110
0.0813	0.99656	0.7151	124.7949	0.125
0.1014	0.99720	0.7215	122.2290	*0.141*
Asparagine in aqueous 0.001M Acetaminophen solutions				
T = 298.15 K				
0.0101	0.99714	0.8961	107.4345	0.028
0.0201	0.99737	0.8981	103.9239	0.036
0.0403	0.99794	0.9016	99.4102	0.045
0.0606	0.99865	0.9051	95.5653	0.052
0.0813	0.99947	0.9084	92.2636	0.058
0.1014	1.00032	0.9114	89.9817	0.063
T = 303.15K				
0.0101	0.99571	0.7992	110.5988	0.026
0.0201	0.99591	0.8009	107.0833	0.034
0.0403	0.99647	0.8041	101.3078	0.044
0.0606	0.99718	0.8069	96.8715	0.050
0.0813	0.99802	0.8101	93.1489	0.057
0.1014	0.99887	0.8129	90.6105	0.062
T = 308.15 K				
0.0101	0.99412	0.7215	112.7856	0.0250
0.0201	0.99430	0.7231	109.4324	0.0334
0.0403	0.99479	0.7260	104.2344	0.0437
0.0606	0.99548	0.7287	99.2042	0.0509
0.0813	0.99630	0.7314	95.0544	0.0573
0.1014	0.99719	0.7340	91.8602	0.0625
Asparagine in aqueous 0.003M Acetaminophen solutions				
T = 298.15 K				
0.0101	0.99718	0.8891	109.4339	0.087
0.0201	0.99740	0.8917	105.4220	0.098
0.0403	0.99795	0.8972	100.6579	0.116
0.0606	0.99866	0.9026	96.3953	0.129
0.0813	0.99949	0.9081	92.7596	0.138
0.1014	1.00039	0.9139	89.8760	0.146

T = 303.15K				
0.0101	0.99575	0.7958	112.6009	0.085
0.0201	0.99593	0.7985	109.0856	0.098
0.0403	0.99646	0.8040	103.0593	0.114
0.0606	0.99715	0.8096	98.3722	0.128
0.0813	0.99801	0.8154	93.8944	0.139
0.1014	0.99888	0.8218	91.1072	0.146
T = 308.15K				
0.0101	0.99414	0.7104	114.7930	0.088
0.0201	0.99430	0.7129	111.2721	0.103
0.0403	0.99483	0.7177	104.2302	0.122
0.0606	0.99552	0.7229	99.2002	0.133
0.0813	0.99638	0.7285	94.5476	0.141
0.1014	0.99728	0.7342	91.3536	0.152
Glutamine in aqueous 0.003M Acetaminophen solutions				
T = 298.15 K				
0.0101	0.99842	0.9125	134.3744	0.050
0.0201	0.99858	0.9171	132.3710	0.056
0.0403	0.99896	0.9256	129.8668	0.070
0.0606	0.99942	0.9332	127.6964	0.082
0.0813	0.99994	0.9401	125.8600	0.093
0.1014	1.00051	0.9466	124.2572	0.104
303.15K				
0.0101	0.99698	0.8688	135.5703	0.049
0.0201	0.99714	0.8735	133.0625	0.059
0.0403	0.99755	0.8811	129.5515	0.076
0.0606	0.99803	0.8885	127.2108	0.091
0.0813	0.99858	0.8954	125.1628	0.104
0.1014	0.99918	0.9016	123.4323	0.119
308.15K				
0.0101	0.99534	0.7809	135.7937	0.049
0.0201	0.99550	0.7854	133.2818	0.060
0.0403	0.99593	0.7930	129.2626	0.076
0.0606	0.99643	0.7994	126.7506	0.092
0.0813	0.99704	0.8052	124.1130	0.108
0.1014	0.99768	0.8114	122.2290	0.122
Asparagine in aqueous 0.005M Acetaminophen solutions				
T = 298.15 K				
0.0101	0.99723	0.9374	111.4320	0.143
0.0201	0.99743	0.9444	107.4204	0.154
0.0403	0.99796	0.9574	102.1552	0.179
0.0606	0.99867	0.9678	97.3915	0.192
0.0813	0.99947	0.9783	93.8813	0.206
0.1014	1.00042	0.9879	90.2709	0.217
T = 303.15K				
0.0101	0.9958	0.8379	114.6016	0.140
0.0201	0.99597	0.8450	110.5844	0.160
0.0403	0.99653	0.8568	103.0521	0.184
0.0606	0.99726	0.8672	97.6958	0.201
0.0813	0.99809	0.8765	93.7622	0.214
0.1014	0.99901	0.8862	90.4982	0.228
T = 308.15K				
0.0101	0.99418	0.7739	117.8027	0.122
0.0201	0.99435	0.7798	112.2701	0.140
0.0403	0.99488	0.7895	104.7258	0.162
0.0606	0.99557	0.7990	99.5286	0.183
0.0813	0.99643	0.8068	94.7924	0.194
0.1014	0.99735	0.8155	91.3471	0.210

ISSN No:-2456-2165

Glutamine in aqueous 0.005M Acetaminophen solutions				
T = 298.15K				
0.0101	0.99962	0.9707	131.2155	0.024
0.0201	0.99981	0.9734	129.2145	0.036
0.0403	1.00026	0.9783	126.4630	0.051
0.0606	1.00076	0.9836	124.7121	0.064
0.0813	1.00134	0.9890	122.8361	0.075
0.1014	1.00197	0.9954	121.2102	0.088
T = 303.15K				
0.0101	0.99818	0.8913	133.4061	0.019
0.0201	0.99835	0.8939	131.4022	0.034
0.0403	0.99877	0.8987	128.3964	0.051
0.0606	0.99927	0.9041	126.0585	0.066
0.0813	0.99984	0.9096	124.0128	0.079
0.1014	1.00046	0.9162	122.2845	0.094
T = 308.15K				
0.0101	0.99630	0.8133	134.6604	0.0259
0.0201	0.99647	0.8164	132.1508	0.0453
0.0403	0.99689	0.8219	128.8884	0.0658
0.0606	0.99741	0.8281	126.1278	0.0848
0.0813	0.99801	0.8342	123.7437	0.0998
0.1014	0.99871	0.8421	121.3094	0.1199

Table 2:- Molality*(m)*, experimental values of densities *(ρ)* and viscosities *(η)*, along with the apparent molar volume (ϕ_V) and $(\eta/\eta_0 - 1)/\sqrt{m}$ values of Asparagine in aqueous Acetaminophen solutions at 298.15 K, 303.15 K and 308.15 K.

➢ *Apparent molar volume:*

The apparent molar volumes (ϕ_V) value were obtain from densities of the solution using the following equation [10].

$$\phi_V = M/\rho - 1000(\rho - \rho_0)/(m\rho\rho_0) \quad (1)$$

where M is the molar mass of the salt, ρ_0 and ρ are the densities of solvent mixture and m is the molality of the solution respectively.[5,6]

Masson (1929) create that the apparent molar volumes, ϕ_V, vary with the square root of the molal concentration($\sqrt{m}$)by the linear equation:[7-9]

$$\phi_V = \phi_V^0 + S_V^* \sqrt{m} \quad (2)$$

where ϕ_V^0 is the limiting apparent molar volume and S_V^* is the experimental slope. The plots of ϕ_V against $\sqrt{m}$ of Asparagines and glutamine in aqueous solution of Acetaminophen at 298.15 K, 303.15 K and 308.15 K were linear with negative slopes and the ϕ_V values increase as the concentration of Asparagines and glutamine in any Acetaminophen solution increase as well as temperature increases[9-12].

The values of ϕ_V^0 and S_V^* of Asparagines and glutamine in aqueous solution of Acetaminophen at 298.15 K, 303.15 K and 308.15K are reported in Table 3.

conc. of Acetaminophen	**ϕ_V^0 x 10^6 (m^3. mol^{-1})**			**S_V^* x 10^6 (m^3. $mol^{-3/2}$. $kg^{1/2}$)**		
	298.15 K	**303.15 K**	**308.15 K**	**298.15 K**	**303.15 K**	**308.15 K**
0.01M	115.4	120	123.1	-80.72	-93.55	-97.54
0.03M	118.3	123	126.3	-89.51	-100.8	-110.2
0.05M	121.2	126	129.6	-96.6	-113.1	-121.6
conc. of Glutamine	**ϕ_V^0 x 10^6 (m^3. mol^{-1})**			**S_V^* x 10^6 (m^3. $mol^{-3/2}$. $kg^{1/2}$)**		
	298 K	**303 K**	**308 K**	**298 K**	**303 K**	**308 K**
0.001M	135.6	138.6	140.8	-45.30	-51.15	-60.27
0.003M	139	140.9	142.0	-46.11	-55.55	-62.49
0.005M	140.2	142.0	143	-58.55	-61.50	-64.14

Table 3:- Limiting apparent molar volume (ϕ_V^0) and experimental slope (S_V^*) of Asparagine in aqueous Acetaminophen solutions at 298.15 K, 303.15 K and 308.15 K.

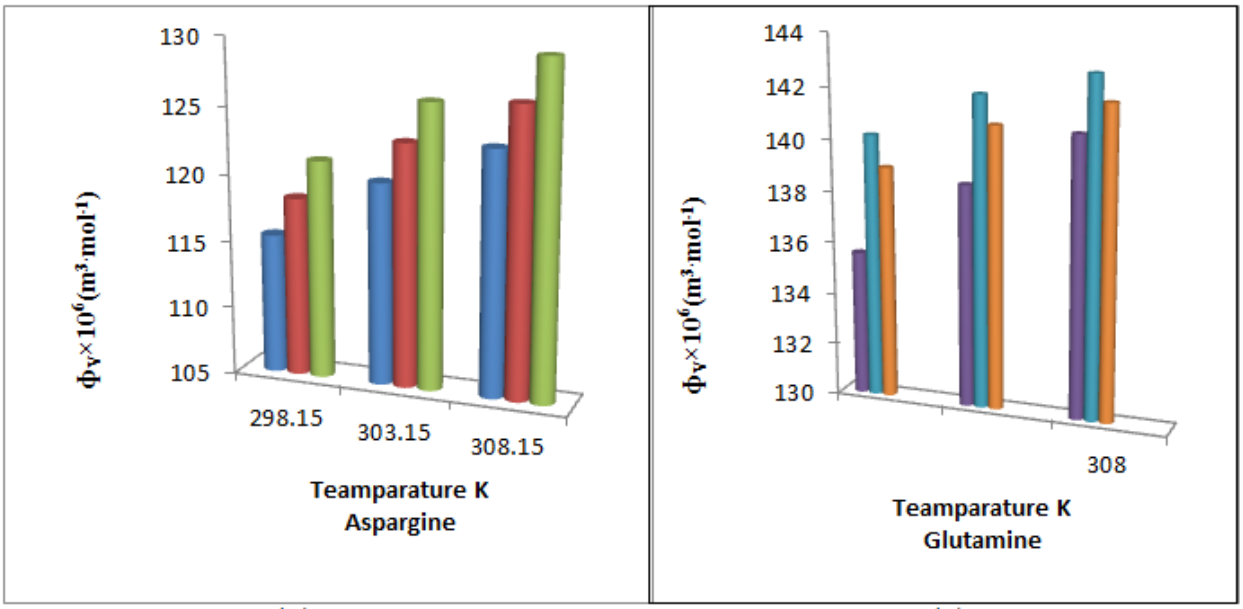


Fig 4:- Limiting apparent molar volumes (ϕ_V^0) of Glutamine(B) and Aspargine(A)in aqueous acetaminophen 0.001M, 0.003M, 0.005M solution at 298.15 K, 308.15 K and 318.15 K, respectively

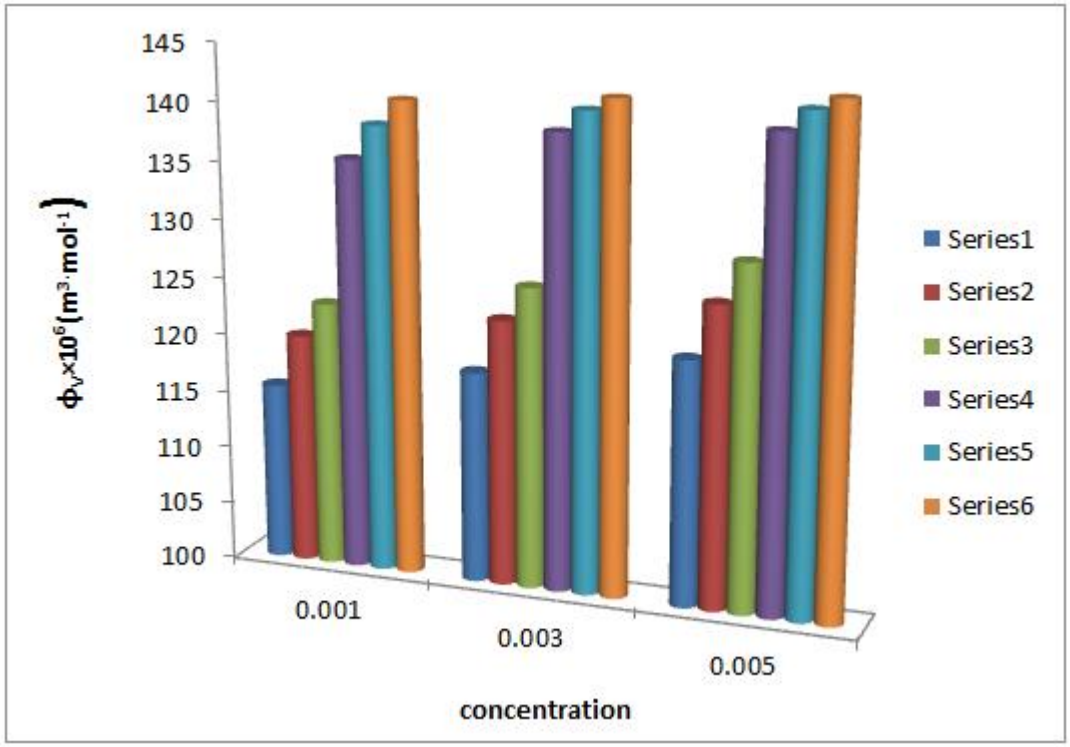


Fig 5: Limiting apparent molar volumes (ϕ_V^0) of 0.001M Asparagine And Glutamine in aquas Acetaminophen in 0.001M, 0.003M, 0.005M solution at 298.15 K, 308.15 K and 318.15 K, respectively.

ϕ_V^0 value indicates the extent of solute-solvent interaction [13]. A perusal of **Table 3** and **Fig- 4** shows that ϕ_V^0 values for Asparagine and Glutamine are positive . The ϕ_V^0 values increase with temprature and increase dilutation. This indicates the presence of strong solute-solvent interactions which is found to be maximum in 0.005M solution of Acetaminophen at 308.15K and the minimum occurrence in 0.001M solution of Acetaminophen at 298.15K. one hydroxyl (-OH) group and the nitrogen atom of amide group in the para (1,4) position. Acetaminophen is deprotonated at a nitrogen atom used a tautomeric kito /hydroxyl group as an electron with drawing group so two loosely hydrogen of -N-H and –COOH of Asparagine and glutamines in aqueous Acetaminophen -OH ,C=O –NH interaction occur in solutions . These interactions broadly set up the cohesion into solution under study. The positive value of ϕ_V^0 indicates the presence of interaction between N-H , COO^- group with –OH. So the interactions between

Acetaminophen solution in Asparagines, glutamine and the water molecule is a continuously increasing concentration increasing interaction. The ϕ_V^0 values can also be explained on the basis of cosphere overlap model in terms of solute- co solute interactions. According to the model, ionic (COO- or NH,-OH) interactions add positively to the ϕ_V^0 values. The parameter S_V^* is characterized by the pair-wise interaction of the solution in the solvated species. The sign of S_V^* is determined by the interaction between the solute-solute species [12]. In the present study S_V^* values were found to be negative . This tendency in S_V^* values indicates weak solute-solute interactions in the solution. S_V^* value is found to be minimum in 0.001M solution of Asparagine and glutamine at 308.15K and the maximum occurs in 0.005M solution of Asparagine and glutamine at 298.15 K. So the interaction between the Asparagine and glutamine molecules in aqueous Acetaminophen solution decreases with increase concentration at any certain temperature.

The variation of ϕ_V^0 with temperature of Asparagine and glutamine follows the polynomial equation.

$$\phi_V^0 = a_0 + a_1T + a_2T^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Over the temperature range under investigation where a_0, a_1 and a_2 are the coefficients . Values of the coefficients of the above equation for Asparagine and glutamine in aqueous solution of Acetaminophen at 298.15 K, 303.15 K and 308.15 K are reported in **Table 4**

Conc. of Asparagine	a_0 **x** 10^6 (m^3. mol^{-1})	a_1 **x** 10^6 (m^3. mol^{-1}. K^{-1})	a_2 **x** 10^6 (m^3. mol^{-1}. K^{-2})
0.001M	-2870	18.95	-0.030
0.003M	-2692	17.77	-0.028
0.005M	-2334	15.39	-0.024
Conc. of Glutamine	a_0 **x** 10^6 (m^3. mol^{-1})	a_1 **x** 10^6 (m^3. mol^{-1}. K^{-1})	a_2 **x** 10^6 (m^3. mol^{-1}. K^{-2})
0.001M	-1413	9.98	-0.016
0.003M	-1420	10.0	-0.016
0.005M	-1489	10.22	-0.016

Table 4:- Values of Coefficients for Asparagine and glutamine in aqueous Acetaminophen solution

The limiting apparent molar expansibilities (Φ_E^0) can be obtained by the following equation:

$$\Phi_E^0 = (\delta\phi_V^0/\delta T)_P = a_1 + 2a_2T \quad . \quad (4)$$

The values of Φ_E^0 of the studied compounds at 298, 303 and 308 K are determined and reported in **Table-5.**

Conc. of	Φ_E^0 **x** 10^6 (m^3. mol^{-1}. K^{-1})			$(\delta\Phi_E^0/\delta T)_P$
	298.15 K	**303.15 K**	**308.15 K**	
0.001M	1.0610	0.7610	0.4700	Negative
0.003M	1.0736	0.7936	0.5136	Negative
0.005M	1.0788	0.8388	0.5988	Negative

Table 5:- Limiting Apparent Molar Expansibilities (Φ_E^0) for Asparagine in aqueous Aetaminophen solutions at 298.15 K, 303.15 K and 308.15K

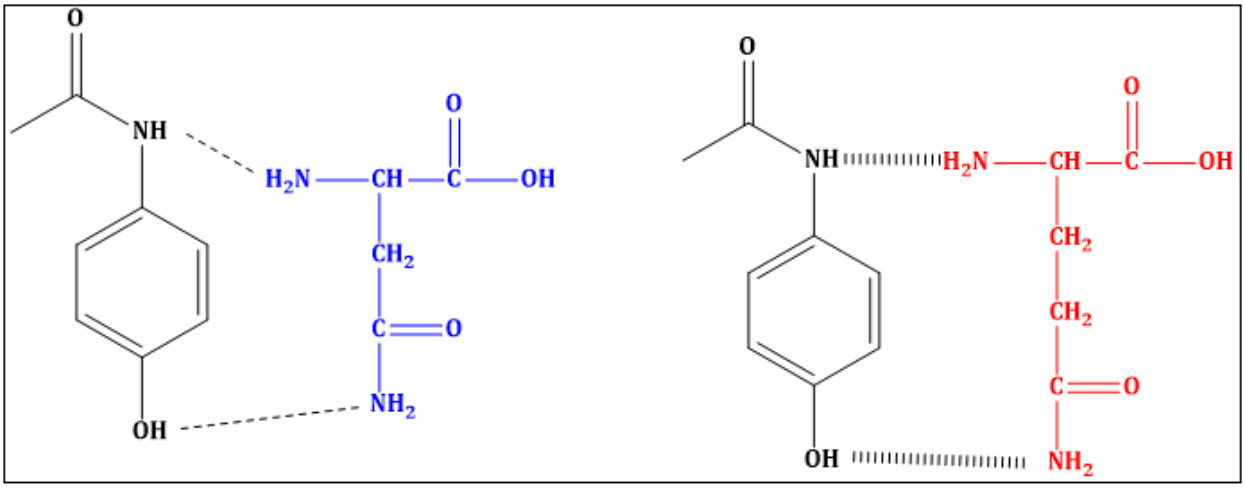
glutamine	Φ_E^0 **x** 10^6 (m^3. mol^{-1}. K^{-1})			$(\delta\Phi_E^0/\delta T)_P$
	298.15 K	**303.15 K**	**308.15 K**	
0.001M	0.4395	0.2792	0.1192	Negative
0.003M	0.4595	0.2992	0.1392	Negative
0.005M	0.4795	0.4192	0.3592	Negative

Table 6: Limiting Apparent Molar Expansibilities (Φ_E^0) of 0.01M Asparagine in aqueous Acetaminophen in 0.001M,0.003M,0.005M solution at 298.15 K, 308.15 K and 318.15 K, respectively.

It is found from **Table-6** and **Fig. 6** that with the increasein temparaturethe values of Φ_E^0 decrease which may be approved in the absence of caging or packing effects [13,31]. S_V^* is not the only value for the structure-forming or breaking nature of any solute. Hepler [14] developed a technique to test the $(\delta^2\phi_V^0/\delta T^2)_P$ values sing for the solute in terms of structure-making and breaking capacity. The solute in the mixed solvent systems using simple thermodynamic expression,

$$(\delta\Phi_E^0/\delta T)_P = (\delta^2\phi_V^0/\delta T^2)_P = 2a_2 \quad (5)$$

On the basis of this expression, it is hypothesized that the solutes should have positive values structure making, whereas negative value solute have structure-breaking .[15-16]. In our present investigation, it has been proved from Table-V that $(\delta^2\phi_V^0/\delta T^2)_P$ values are negative for Asparagine and glutamine in an aqueous solution of Acetaminophen investigated here, suggesting thereby that acts as a Asparagine and glutamine structure breaker in these Acetaminophen solutions. The interaction between Asparagine and glutamine in Acetaminophen in water can be summarized as follows, 1) the interaction of N-H atom of Acetaminophen with the N atom of Asparagine and glutamine 2)interaction of H atom of N-H group of Acetaminophen with O atom of –O-H group and C=O group of Asparagine and glutamine 3)interaction of hydrogen atom of COOH Asparagine and glutamine also interaction of –C=O of Acetaminophen .Therefore positive value of ϕ_v^0 Indicate that solute –solvent interaction prevail over solvent-solvent interaction.



Scheme1. Plausible interactions among acetaminophen, glutamine and asparagines.

➢ *Viscosity calculation*

The viscosity data has been analyzed using the Jones–Dole equation [17].

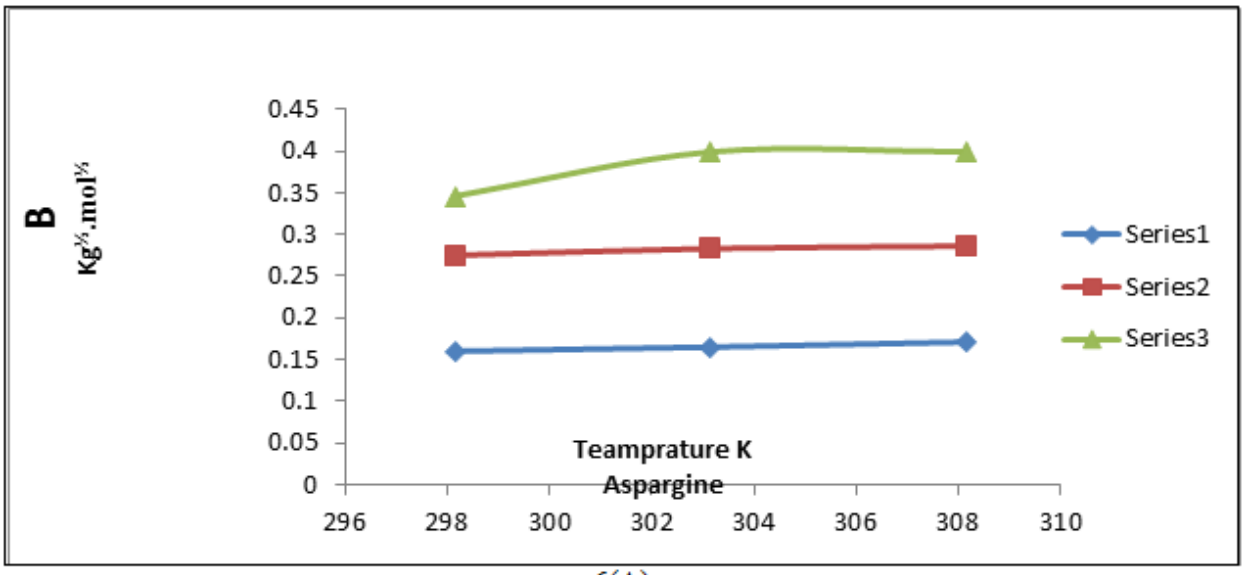
$$(\eta/\eta_0 - 1)/\sqrt{m} = A + B\sqrt{m} \quad (6)$$

where, η_0 and η are the viscosities of the solvent mixture and solution respectively. [32]are the viscosity co-efficient estimated by a least square method. The *A* and *B* values are obtained from the straight line by plotting $(\eta/\eta_0 - 1)/\sqrt{m}$ against $\sqrt{m}$ for Asparagine and glutamine in aqueous solution of Acetaminophen at 298.15, 303.15 and 308.15K respectively. *A* and *B* values as reported in **Table 7.**

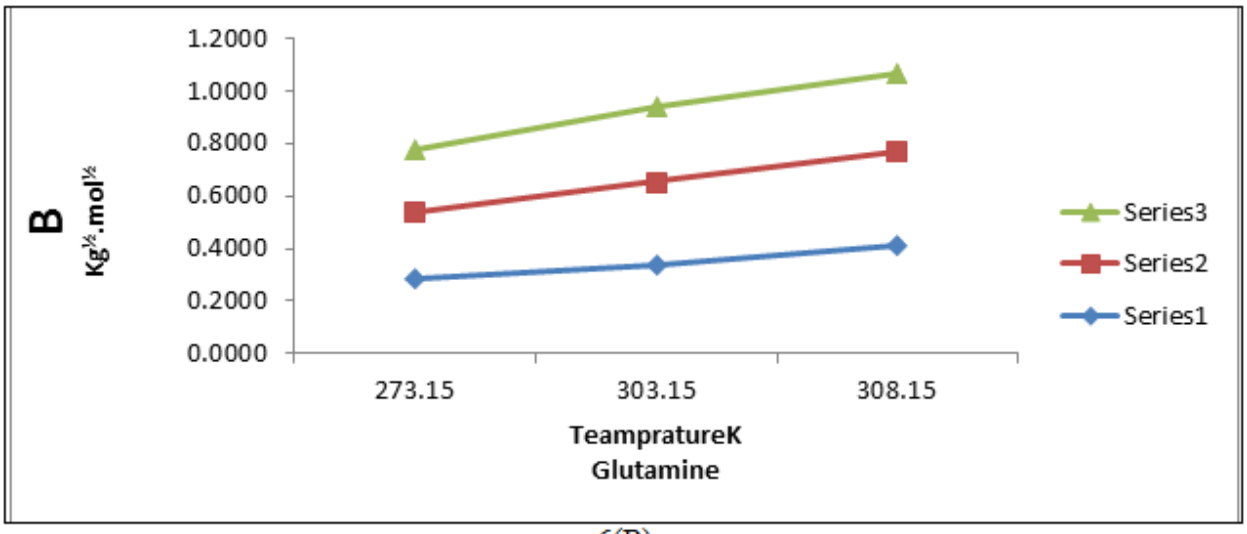
Conc. of Acetaminophen sol	***A* (kg. mol^{-1})**			***B* (kg$^{1/2}$. mol$^{-1/2}$)**		
	298 K	**303 K**	**308 K**	**298 K**	**303 K**	**308 K**
0.001M	0.107	0.102	0.082	0.160	0.165	0.171
0.003M	0.059	0.057	0.061	0.240	0.283	0.286
0.005M	0.012	0.010	0.008	0.285	0.335	0.399
Conc. of Glutamine sol	**A(kg.mol^{-1})**			**B (kg$^{1/2}$. mol$^{-1/2}$)**		
	298 K	**303 K**	**308 K**	**298 K**	**303 K**	**308 K**
0.001M	0.028	0.039	0.040	0.240	0.287	0.303
0.003M	0.021	0.014	0.015	0.251	0.318	0.350
0.005M	0.005	0.014	0.015	0.346	0.387	0.415

Table 7

A coefficient values decrease in increase the temperature and concentration, so solute –solute interaction decrease. The effect of solvent-solvent interaction on solvent viscosity can be estimated from *B*-coefficient [18, 19]. The solution is a valuable tool for providing information about the solubility of a B-coefficient. solvent.



6(A)



6(B)

Fig 6.(A+B) Jones-Dole cofficient,*B*, of 0.01M Asparagine and glutamine in aqueous Acetaminophen in 0.001M, 0.003M, 0.005M solution at 298.15 K, 308.15 K and 318.15 K, respectively

From **Table 7** and **Fig. 6** the values of the *B*-coefficient are positive, thereby signifying the presence of strong solute–solvent interactions [15-16]which are increase the temperature with strong dilution of the Acetaminophen solution. So, Asparagine and glutamine in 0.001M Acetaminophen solution at 308.15 K gives maximum solute-solvent interactions and in 0.005 M Acetaminophen solution at 298.15 K gives maximum solute-solute interactions. This is in conformity with the results obtained from density measurements.

Several studies have reported that *dB/dT* is a better value for determining the structure-making/breaking nature of any solute than just the *B*-coefficient[17-20]. The *B*-coefficient values with increasing temperature (positive *dB/dT*) suggesting the structure-breaking tendency of Asparagine and glutamine in the solvent systems. Since the values of the ion–solvent & ion–ion interaction results are in good agreement with those drawn from the value .

Moreover, The free energy of activation of viscous flow per mole of solvent, $\Delta\mu_1^{0\neq}$ could be calculated by Eyring and co-workers [21] from the following equation:

$$\eta_0 = (hN_A/ V_1^0) \exp(\Delta\mu_1^{0\neq}/RT) \quad (7)$$

Where h, N_A and V_1^0 are the Planck's constant, Avogadro's number and partial molar volume of the solvent respectively. The equation (7) can be retool as follows we obtain

$$\Delta\mu_1^{0\neq} = RT \ln (\eta_0 V_1^0/ hN_A) \quad (8)$$

Feakins et al.[22-24] suggested that if equations (6) and (8) are obeyed, then

$$B = (V_1^0 - V_2^0) + V_1^0 [(\Delta\mu_1^{0\neq} - \Delta\mu_2^{0\neq})/RT] \quad (9)$$

where V_2^0 is the limiting partial molar volume (φ_V^0) of the solute and $\Delta\mu_2^{0\neq}$ is the ionic activation energy per mole of solute at infinite dilution . Rearranging the equation (9) we get

$$\Delta\mu_2^{0\neq} = \Delta\mu_1^{0\neq} + (RT/V_1^0)[B - (V_1^0 - V_2^0)] \quad (10)$$

From table 8, It is clear that the $\Delta\mu_2^{0\neq}$ values are all positive and much larger than$\Delta\mu_1^{0\neq}$, suggesting that the interaction between the solvent ASP and the Glu solvent (aqueous acetaminophen mixture) molecules in the ground state is stronger than the transition state. Salvation of the solute in the transition state is unfavorable in terms of free energy.

The entropy of activation ($\Delta S_2^{0\neq}$) [22] for the solution has been calculated using relation:

$$\Delta S_2^{0\neq} = - d(\Delta\mu_2^{0\neq})/dT \quad (11)$$

where $\Delta S_2^{0\neq}$ has been obtained from using a least-squares treatment.

from the negative slope of the plots of $\Delta\mu_2^{0\neq}$ against T .

The enthalpy of activation ($\Delta H_2^{0\neq}$)[23] has been obtained from the relation:

$$\Delta H_2^{0\neq} = \Delta\mu_2^{0\neq} + T\Delta S_2^{0\neq} \quad (12)$$

The values of $\Delta S_2^{0\neq}$ and $\Delta H_2^{0\neq}$ are also reported in table 8.

T,K 0.001M	V_1-V_2	$\Delta\mu_1$=RTln(ηV1/hN)*100	$\Delta\mu_2$=$\Delta\mu_1$+RT/V[B-(V1-V2)]	$T\Delta S_2^{0\neq}$	$\Delta H_2^{0\neq}$
298.15	-97.35	9.07	44.41	-406.38	-361.97
303.15	-101.92	8.77	45.98	-413.19	-367.21
308.15	-104.99	8.83	47.87	-420.01	-372.14
0.003M					
298.15	-100.25	9.15	55.86	-416.81	-360.95
303.15	-104.92	9.02	63.10	-423.80	-360.70
308.15	-108.19	8.89	64.66	-430.79	-366.14
0.005M					
298.15	-103.17	9.37	62.74	-426.06	-363.32
303.15	-107.95	9.31	71.17	-433.20	-362.04
308.15	-111.54	9.23	81.67	-440.35	-358.67

Table 8

T,K 0.001M	V_1-V_2	$\Delta\mu_1$=RTln(ηV1/hN)*100	$\Delta\mu_2$=$\Delta\mu_1$+RT/V[B-(V1-V2)]	$T\Delta S_2^{0\neq}$	$\Delta H_2^{0\neq}$
298.15	-117.56	9.17	58.30	-1459.44	-1401.14
303.15	-120.53	9.04	65.89	-1483.92	-1418.03
308.15	-121.91	8.93	69.09	-1508.39	-1439.30
0.003M					
298.15	-120.97	9.20	60.33	-1269.22	-1208.89
303.15	-122.84	9.23	70.77	-1290.51	-1219.74
308.15	-123.91	9.11	76.24	-1311.79	-1235.55
0.005M					
298.15	-122.19	9.24	73.68	-1658.31	-1584.63
303.15	-123.96	9.12	80.53	-1686.12	-1605.59
308.15	-124.93	9.08	85.63	-1713.93	-1628.30

Table 9

It is evident from table VII, that $\Delta\mu_1^{0\neq}$ is practically constant at all the mass fraction of the aqueous acetaminophen mixture .The $\Delta\mu_2^{0\neq}$ is mainly dependent on the viscosity coefficients and ($V_1^0 - V_2^0$) terms.Positive$\Delta\mu_2^{0\neq}$ values at all studied temperature and solvent composition indicate that the process of viscous flow increases with increasing temperature and mass fraction. Therefore, the transition state becomes less favorable. According to Feakins et al. [23] suggested, positive $\Delta\mu_2^{0\neq} > \Delta\mu_1^0$ that is for solute containing positive B-coefficients that indicate more solute-solvent interactions. The solvent structure combines with the formation of a transition state with breaks and deformations to intermolecular forces [24,25]. The negative values of both $\Delta S_2^{0\neq}$ and $\Delta H_2^{0\neq}$ imply that the structure of the transition state is associated with bond-

ISSN No:-2456-2165

breaking. It may be suggested that the slip-plane is in disorder state [26].

Both the limiting apparent molar volume and viscosity *B*-coefficient describe the solute-solvent interaction in solution. The linear variation of limiting apparent molar volume (φ_V^0) and viscosity *B*-coefficient reflect the positive slope.

➢ *Refractive index calculation*

The molar refraction, R_M can be evaluated from the Lorentz–Lorenz relation [20].

$$R_M = \{(n_D^2-1) / (n_D^2+2)\} (M/\rho) \quad (13)$$

Whereas, R_m, N_D, M and ρ molar refraction, refractive index, molar mass and solute concentration, respectively. The substance of reflective index ratio of C_0 / C, where C is the speed of light in the medium. andC_o the speed of light at vacuum. The refractive index is a compound that reflects its photosynthetic ability to move from one medium to another [2 - 3], as the concentration of asparagine and glutamine in aqueous acetaminophen solution decreases as the concentration and refractive index (N_D) decrease the , Refractivity (RM) increases as shown in Table 10.

C (mol. Lit^{-1})	n_D	R_M **x 10^6 (m^3. mol^{-1})**
Asparagines in 0.001M aqueous Acetaminophen solutions		
0.010	1.3334	30.1570
0.020	1.3335	30.1576
0.040	1.3336	30.1583
0.060	1.3338	30.1587
0.080	1.3341	30.1591
0.100	1.3343	30.1595
Asparagine in 0.003M aqueous Acetaminophen solutions		
0.010	1.3335	30.1502
0.020	1.3336	30.1535
0.040	1.3338	30.1585
0.060	1.3340	30.1626
0.080	1.3343	30.1658
0.100	1.3345	30.1690
Asparagine in 0.005M aqueous Acetaminophen solution		
0.010	1.3337	30.1304
0.020	1.3338	30.1328
0.040	1.3340	30.1357
0.060	1.3342	30.1386
0.080	1.3345	30.1399
0.100	1.3347	30.1414
Glutamine in 0.001M aqueous Acetaminophen solution		
0.010	1.3335	27.2914
0.020	1.3337	27.2999
0.040	1.334	27.3066
0.060	1.33435	27.3131
0.080	1.3347	27.3166
0.100	1.3351	27.3230
Glutamine in 0.003M aqueous Acetaminophen solution		
0.010	1.3334	27.2828
0.020	1.3336	27.2917
0.040	1.334	27.3063
0.060	1.3344	27.3165
0.080	1.3348	27.3235
0.100	1.3352	27.3285
Glutamine in 0.005M aqueous Acetaminophen solution		
0.010	1.3337	27.3038
0.020	1.3341	27.3280
0.040	1.3346	27.3505
0.060	1.3351	27.3681
0.080	1.3356	27.3832
0.100	1.3361	27.3942

Asparagine in 0.005M aqueous Acetaminophen solution		
0.010	1.3337	30.1304
0.020	1.3338	30.1328
0.040	1.3340	30.1357
0.060	1.3342	30.1386
0.080	1.3345	30.1399
0.100	1.3347	30.1414

Table 10:- Refractive Index (n_D) and Molar Refraction (R_M) values along with concentration (c) of of Asparagines and glutamine in aqueous Acetaminophen solutions at 298.15 K.

From the above discussion, it is concluded that It is also in good agreement with the results obtained from the density and viscosity parameters.

➢ *Conductance Study:*

Conductivity study of the solvent interaction at three different temperatures - aqueous solution with acetaminophen between Asn and Gln amino acids. Conductive(Λ) measurements provide information about the interaction and transport phenomena of the ternary system. The aqueous solution of aqueous conductivity of asparagine and glutamine (1) in Acetaminophen at different temperatures with increasing concentration of amino acids is listed in Table -11 below.

Glutaine in Acetominophen				Asparagine in Acetomenophine			
$c \cdot 10^4$/ mol·dm^{-3} 0.001M	**$\Lambda \cdot 10^4$/ S·m^2·mol^{-1} 298.15K**	**$\Lambda \cdot 10^4$/ S·m^2·mol^{-1} 303.15K**	**$\Lambda \cdot 10^4$/ S·m^2·mol^{-1} 308.15K**	**$c \cdot 10^4$/ mol·dm^{-3} 0.001M**	**$\Lambda \cdot 10^4$/ S·m^2·mol^{-1} 298.15K**	**$\Lambda \cdot 10^4$/ S·m^2·mol^{-1} 303.15K**	**$\Lambda \cdot 10^4$/ S·m^2·mol^{-1} 308.15K**
0.010	52	57	62	**0.010**	**53**	59	63
0.020	39	41	46	**0.020**	**40**	43	47
0.040	25	28	32	**0.040**	**26**	30	33
0.060	18	24	28	**0.060**	**19**	26	29
0.080	13	17	21	**0.080**	**14**	19	22
0.100	11	14	18	**0.100**	**12**	16	19
0.003M				**0.003M**			
0.010	58	61	63	**0.010**	**60**	62	64
0.020	41	43	48	**0.020**	**43**	44	49
0.040	29	31	33	**0.040**	**31**	32	34
0.060	21	25	29	**0.060**	**23**	26	30
0.080	18	19	22	**0.080**	**20**	20	23
0.100	15	16	19	**0.100**	**17**	17	20
0.005M				**0.005M**			
0.010	61	64	70	**0.010**	**63**	65	72
0.020	56	58	62	**0.020**	**46**	56	64
0.040	40	44	48	**0.040**	**34**	35	42
0.060	31	35	38	**0.060**	**26**	30	36
0.080	23	26	29	**0.080**	**23**	27	31
0.100	17	19	21	**0.100**	**20**	20	23

Table 11:- Molar conductivities (Λ) of Asparagines and Glutamine in Acetaminophen at different temperatures

The molar conductance (Λ) has been obtained from the specific conductance (κ) value using the following equation.

$\Lambda=(1000\kappa)/c$ (14)

For each system it has been observed that (1) the value increases with increasing temperature, and the amino acid growth concentration increases with increasing temperature, with increasing temperature. Reduction of molar conductance increases the amount of amino acids because of the increasing viscosity and attractiveness.The strong intramolecular hydrophobic – hydrophobic attraction and other non covalent hydrophilic,π-π interaction, columbic attraction etc must develop aminoacid.some phenolic O-H,C=O interaction with amino acid –COOH,NH_2,C=O group formation of hydrogen bonding between acetaminophen and amino acid,

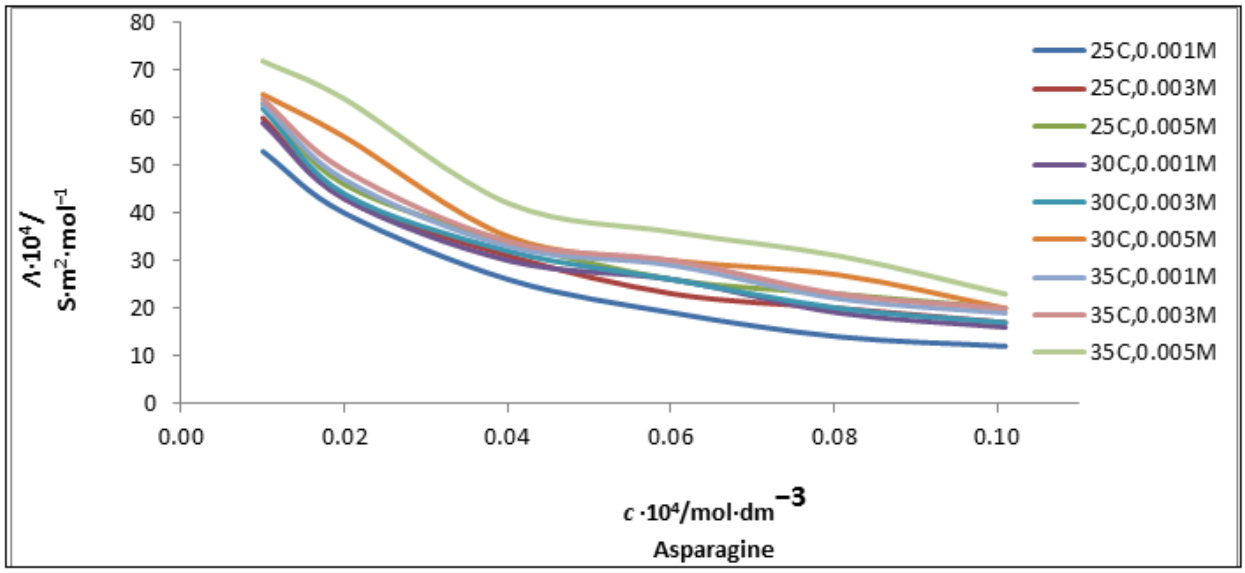


Fig-7 Variation conductivities (Λ) of aqueous Acetaminophen with Aspargine in different temperature.

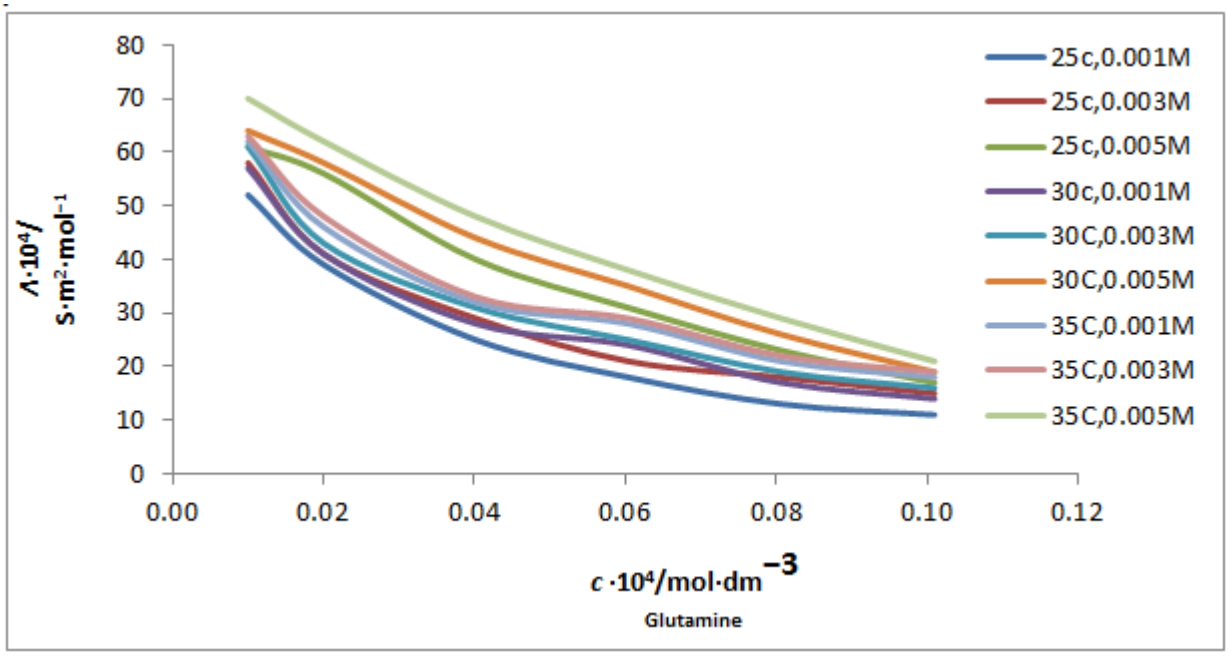


Fig 8:-Variation conductivities (Λ) of aqueous Acetaminophen with Glutamine in different temperature

IV. CONCLUSION

The limiting apparent molar volume (ϕV0) values and viscosity *B*-coefficient of the presence of solute-solvent interactions between aqueous solution of Asparagine and Glutamine in Acetaminophen and Water molecules and higher temperatures prevail when solvent-dissolving interactions intensify at lower temperatures.The solute – solvent interaction higher at low concentration and solute – solute interaction at higher concentration. $(\delta^2\phi_V^0/\delta T^2)_P$ values are negative indicates the structure breaker of solute in solution. The solute solvent interaction of two amino acid in acetaminophen solution in aqueous medium have been investigated by molar conductivity at three different temperature indicate the non covalent interaction among them and causing an increase of hydrodynamic radii of ions and a decrease of their ionic mobility hence decrease in molar conductance. The strong intermolecular hydrophobic –hydrophobic attraction and other non covalent hydrophilic-π interaction, columbic attraction etc must develop amino acid . The experimental data shows solute – solvent interaction of glutamine more than asparagines in aqueous acetaminophen solution. The refractive index and the molar refraction values also agree to the same facts.

ACKNOWLEDGEMENTS

The authors are grateful to the Department of Chemistry, NBU for the University Grants Commission for financial support and materials benefits for continuing my research work. Thanks to my supervisor, Professor M.N.Roy, Government of India, New Delhi, University Grants Commission for receiving one time grant under

Basic Scientific Research. His helpful active service research facilities make further research work easier.

REFERENCES

[1]. "Acetaminophen"American society of health system Pharmacists. Archived from 5th june 2016
[2]. H.Kumar ., M.Singla ., and R.Jindal . Viscosities of Glycine, L-Alanine, and ASPARAGINE AND GLUTAMINE in (0.2, 0.4, 0.6, and 0.8) mol·kg^{-1} Aqueous Trisodium Citrate Solutions at Different Temperatures J. Chem. Eng. Data, **59(2)**, 419-425 **(2004)**.
[3]. M.N.Roy,B.sinha,B.K.sarkar,J.Chem.Thermodyn.40,3 94(2008)
[4]. Yan Yang,Tong-Chun Bai, Yu-Li Li,J.Chem.Eng,56,412-420(2011)
[5]. M. N. Roy, B. Sinha and V. K. Dakua, Pakistan J. Sci. Ind. Res. **49**, 153 (2006).
[6]. M.N. Roy, B. Sinha, R. Dey, A. Sinha, Solute-Solvent and Solute-Solute Interactions of Resorcinol in Mixed 1, 4-Dioxane-Water Systems at Different Temperatures, International Journal of Thermophysics, **26**, 1549–1563 (2005) .
[7]. M.N. Roy, R. Dewan, P.K. Dewan, D. Biswas., Apparent Molar Volumes and Viscosity B-Coefficients of Carbohydrates in Aqueous Cetrimonium Bromide Solutions at (298.15, 308.15, 318.15) K, Journal of Chemical & Engineering Data, **55**, 3617–3624 (2010).
[8]. M.N.Roy.,A. Bhattacharjee ., P.Chakraborti ., Investigation on Molecular Interactions of Nicotinamide in Aqueous Citric Acid Monohydrate Solutions with Reference to Manifestation of Partial Molar Volume and Viscosity B-Coefficient Measurements, Thermochimica Acta, **507–508**, 135–141 (2010).
[9]. C.Zhao .,P. Ma ., J.Li ., Partial molar volumes and viscosity B-coefficients of arginine in aqueous glucose, sucrose and L-ascorbic acid solutions at T = 298.15 K, The Journal of Chemical Thermodynamics, **37**, 37–42 (2005) .
[10]. A.Bhattacharjee .,M.N. Roy ., Ion Association and Solvation Behavior of Tetraalkylammonium Iodides in Binary Mixtures of Dichloromethane + N, N-Dimethylformamide Probed by a Conductometric Study, Physical Chemistry Chemical Physics , **12**, 14534–14542 (2010).
[11]. M.N.Roy.,A Jha.,A. Choudhury A., Densities, Viscosities and Adiabatic Compressibilities of Some Mineral salts in Water at Different Temperatures, Journal of Chemical & Engineering Data, **49**, 291–296 (2004).
[12]. E.Ayranci ., Apparent Molar Volume and Viscosity of Compounds with Asymmetric Carbon Atoms, Journal of Chemical & Engineering Data, 42, 934–937 (1997).
[13]. F.J.Millero,J.H. Knox., Apparent molal volumes of aqueous sodium fluoride, sodium sulfate, potassium chloride, potassium sulfate, magnesium chloride, and magnesium sulfate solutions at 0.deg. and 50.deg., J Chem Eng Data, **18**, 407, (1973).
[14]. M.N.Roy.,D. Ekka andR. Dewan , Physico-Chemical Studies of Some Bio-active Solutes in Pure Methanoic Acid, Acta Chim. Slov. **58**, 792–796, (2011).
[15]. M. L.Parmar,.; D. S Banyal,., Effect of temperature on the partial molar volumes of some bivalent transition metal nitrates and magnesium nitrate in DMF + water mixtures, Indian J. Chem., **44A**, 1582–1588 (2005).
[16]. L.G Hepler., Thermal expansion and structure in water and aqueous solutions, Can. J. Chem., **47**, 4617 (1969).
[17]. G. Jones .,M. Dole , The viscosity of aqueous solutions of strong electrolytes with special reference to barium chloride, Journal of the American Chemical Society, 51, 2950–2964 (1929).
[18]. F.J. Millero., Molal volumes of electrolytes, Chemical Reviews, 71, 147–176 (1971).
[19]. Millero , A.Losurdo .,C Shin , The apparent molal volumes and adiabatic compressibilities of aqueous amino acids at 25.degree.C, The Journal of Physical Chemistry, 82, 784–792 (1978**).**
[20]. **S.**Kant ,A Kumar ,S. Kumar , Molar volume, viscosity and conductance studies of some alkali metal chlorides in aqueous ascorbic acid, Journal of Molecula Liquid, **150**, 39-42, (2009).
[21]. Z.Yan ,.Wang J, Kong W,J. Lu , Effect of temperature on volumetric and viscosity properties of some α-amino acids in aqueous calcium chloride solutions, Fluid Phase Equilibria, **215**, 143-150, (2004).
[22]. V. Minkin .,O. Osipov .,Y Zhdanov , Dipole Moments in Organic Chemistry, Plenum Press, New York, London, (1970).
[23]. D. Feakins, D. J. Freemantle, K. G. Lawrence, *J. Chem. Soc., Faraday Trans.1*. 70 **(1974)** 795.
[24]. A. Ali, S. Hyder, S. Sabir, D. Chand and A. K. Nain, *J. Chem. Thermodynamics*. 38 **(2006)** 136.
[25]. H. L. Friedman and C. V. Krishnan, *Water: A Comprehensive Treatise*, Plenum Press: New York, **1973**.
[26]. U. N. Dash, B. Samantaray and S. Mishra, *J. Teach. Res. Chem.* 11 **(2005)** 87.
[27]. M Born.,E. Wolf ., Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light, 7th ed. Cambridge University Press, London, (1999).
[28]. M. Deetlefs ,K.Seddon, M. Shara, Predicting physical properties of ionic liquids**,** Physical Chemistry Chemical Physics**, 8,** 642–649 (2006).
[29]. University of Maryland medical centre;vitamineB_3(Niacine)June18,2009.
[30]. M. N. Roy, R. K. Das, and A. Bhattacharjee*Russian Journal of Physical Chemistry A, 2010, Vol. 84, 2201–2210.(2010)*
[31]. M.R.J.Deck., K.J Bird., A.J., Parker Solvation of ions. Partial molal volumes of single ions in protic and dipolar aprotic solvents, Australian Journal of Chemistry, **28**, 955–963 (1975).
[32]. T.S.Banipal, D. Kaur,P.K. Banipal, Apparent molar volumes and viscosities of some amino acids in aqueous sodium acetate solutions at 298.15 K. J. Chem. Eng. Data, **49**, 1236-1246 (2004).