Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2012, 4(8):3869-3876

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Viscometric study of glycine, α-alanine and β-alanine in aqueous and aqueous D-glucose solutions at different temperatures

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ABSTRACT

The viscosity values of glycine, α-alanine and β-alanine have been determined in aqueous and aqueous D-glucose solutions at four different temperatures ranging from 298.15K to 313.15K at 5K intervals. The viscosity data have been analyzed by means of Jones-Dole equation to obtain Falkenhagen co-efficient,A and Jones-Dole co-efficient, B, free energy of activation of viscous flow per mole of solvent, $\Delta\mu_1^{0*}$ and solute, $\Delta\mu_2^{0*}$ and enthalpy, ΔH^* and entropy of activation, ΔS^*,of viscous flow. These parameters are discussed in terms of solute-solute, solute-solvent and solvent-solvent interactions.

Keywords : viscosity coefficient ,D-glucose, amino acid, molecular interaction.

INTRODUCTION

The study of solute-solvent interaction has got great importance in various fields including medicinal chemistry, biochemistry, industrial processes, etc. The viscosity and its derived parameters provide qualitative information regarding molecular interactions in solutions[1-8].Thermodynamical studies of ternary systems (amino acid + Glucose +water) are useful to understand several biochemical processes such as protein dehydration, denaturation, aggregation, etc. Amino acids are model compounds for interpretation of the behavior of proteins, which are essential for the growth and repair of cells and tissues in human body[9-13]. The present work aims at determining the viscosity coefficients,A and B and the free energy of activation for viscous flow of solvent and of solution,$\Delta\mu_1^{0*}$ and $\Delta\mu_2^{0*}$,respectively ,enthalpy, $\Delta H^*$and entropy of activation, ΔS^*,of viscous flow at 298.15 K,303.15 K,308.15 K and 313.15 K for the solutions of amino acids in water and in water + D-glucose (5,10,15 and 20 wt%) solutions. The main objective of this study is to characterize the molecular interactions in these systems.

EXPERIMENTAL SECTION

All chemicals used were of AnalaR grades. Conductivity water (Sp.cond. ~ 10^{-6} S cm^{-1}) was used to prepare solutions of D-glucose (5,10,15 and 20 wt%) and the solutions were used on the same day. The solutions of glycine, α-alanine and β-alanine were prepared on the molal basis and conversion of molality to molarity was done by using the standard expression[14] using the density values of the solutions determined at 298.15K. Viscosity measurements were made by using an Ostwald's viscometer(25 ml capacity) in a water thermostat whose temperature was controlled to ±0.05K. The flow time of water and flow time of solution were measured with a

digital stop clock with an accuracy of 0.01s.The values of viscosity so obtained were accurate to within ± 0.3× 10^{-3} c P. The amino acid content in the solutions varied over a range of 0.01 to 0.08M in all the solvents.

Theoretical Aspects

Viscosity co-efficients(A and B):

The empirical equation of Jones-Dole [15] relates the relative viscosity of an electrolytic solution to the concentration c of the electrolyte as follows:

$$\eta_r = \eta/\eta_0 = 1 + Ac^{1/2} + Bc \quad (1)$$

where η_r is the relative viscosity.
η is the viscosity co-efficient of the solution
η_0 is the viscosity co-efficient of the solvent
A is the Falken-Hagen[16] co-efficient
and B is the Jones-Dole co-efficient
A and B were obtained from the plot of $(\eta/\eta_0 - 1)/c^{1/2}$ vs $c^{1/2}$.

Free energy of Activation:

The viscosity data were analyzed on the basis of the transition state theory for the relative viscosity of amino acid solutions as suggested by Feakins et al [17] using the equation

$$\Delta\mu_2^{0*} = \Delta\mu_1^{0*} + \left(RT/\overline{V}_1^{\,0}\right)\left[1000B_J - \left(\overline{V}_1^{\,0} - \overline{V}_2^{\,0}\right)\right] \quad (2)$$

where $\Delta\mu_1^{0*}$ is the free energy of activation for viscous flow of solvent and
$\Delta\mu_2^{0*}$ is the corresponding value for solution,
$\overline{V}_1^{\,0}$ is the partial molar volume of the solvent
$\overline{V}_2^{\,0}$ is the partial molar volume of the solute and
B_J is the Jones-Dole parameter.

$\Delta\mu_1^{0*}$ was calculated from equation(3)

$$\Delta\mu_1^{0*} = 2.303RT \log (\eta_0 V_1^{\,0}/ h N) \quad (3)$$

$$\overline{V}_1^{\,0} = M_{solvent}/d \quad (4)$$

and

$$\overline{V}_2^{\,0} = V_\Phi^{\,0} \quad (5)$$

The free energy of activation of viscous flow of solutions, $\Delta\mu^{0*}$ was calculated by using the equation[18]

$$\Delta\mu^{0*} = n_1 \Delta\mu_1^{\,0*} + n_2 \Delta\mu_2^{\,0*} \quad (6)$$

where n_1 and n_2 are the number of moles of mixed solvent and solute, respectively.

The enthalpy ΔH^* and entropy, ΔS^* of activation of viscous flow were computed using the equation

$$\Delta\mu^{0*} = \Delta H^* - T\Delta S^* \quad (7)$$

The values of ΔH^* and ΔS^* were obtained from the intercepts and slopes respectively of the plots of $\Delta\mu^{0*}$ vs T.

These parameters contribute to the structural information regarding solute and solute-solvent interactions.

RESULTS AND DISCUSSION

The experimentally determined values of viscosity (η) for water and water + D-glucose (5,10,15 and 20 wt%)solutions at 298.15,303.15,308.15 and 313.15 K are presented in Table 1.

Table 1:Values of η_r and η for glycine, α-alanine & β-alanine in water + D-Glucose mixtures at different temperatures.

Wt % D-Glucose	Temp. K	c (mol dm^{-3})	η_r	$\eta \times 10^3$ (Pa.s)	η_r	$\eta \times 10^3$ (Pa.s)	η_r	$\eta \times 10^3$ (Pa.s)
			Glycine		α-alanine		β-alanine	
5	298.15	0.01	1.006	0.900	1.003	0.997	1.024	1.018
		0.02	1.007	1.000	1.005	0.999	1.039	1.032
		0.04	1.011	1.005	1.011	1.005	1.077	1.070
		0.05	1.015	1.008	1.031	1.025	1.085	1.078
		0.06	1.026	1.020	1.033	1.027	1.096	1.089
		0.08	1.052	1.046	1.042	1.035	1.102	1.095
	303.15	0.01	1.005	0.851	1.001	0.848	1.023	0.866
		0.02	1.006	0.852	1.002	0.849	1.035	0.877
		0.04	1.011	0.856	1.008	0.853	1.072	0.908
		0.05	1.014	0.859	1.024	0.867	1.077	0.912
		0.06	1.025	0.868	1.028	0.870	1.088	0.921
		0.08	1.051	0.890	1.033	0.875	1.093	0.926
	308.15	0.01	1.005	0.779	1.000	0.776	1.022	0.792
		0.02	1.006	0.780	1.002	0.777	1.032	0.800
		0.04	1.009	0.782	1.008	0.781	1.063	0.824
		0.05	1.011	0.784	1.014	0.786	1.073	0.832
		0.06	1.024	0.794	1.018	0.789	1.082	0.839
		0.08	1.044	0.809	1.026	0.795	1.084	0.841
	313.15	0.01	1.001	0.702	1.000	0.701	1.018	0.713
		0.02	1.004	0.704	1.002	0.702	1.030	0.722
		0.04	1.006	0.706	1.005	0.705	1.063	0.745
		0.05	1.010	0.708	1.010	0.708	1.067	0.748
		0.06	1.024	0.718	1.015	0.712	1.081	0.758
		0.08	1.030	0.722	1.020	0.715	1.084	0.760
10	298.15	0.01	1.002	1.147	1.007	1.152	1.024	1.171
		0.02	1.004	1.148	1.011	1.157	1.063	1.216
		0.04	1.010	1.156	1.022	1.170	1.076	1.231
		0.05	1.014	1.160	1.044	1.194	1.084	1.240
		0.06	1.018	1.165	1.047	1.198	1.096	1.254
		0.08	1.031	1.180	1.050	1.201	1.109	1.269
	303.15	0.01	1.000	0.979	1.004	0.982	1.021	0.999
		0.02	1.003	0.982	1.010	0.988	1.062	1.039
		0.04	1.009	0.988	1.021	1.000	1.074	1.051
		0.05	1.012	0.990	1.022	1.001	1.081	1.057
		0.06	1.017	0.995	1.024	1.002	1.094	1.071
		0.08	1.031	1.009	1.026	1.004	1.107	1.083
	308.15	0.01	1.000	0.871	1.003	0.873	1.018	0.887
		0.02	1.003	0.874	1.007	0.877	1.060	0.923
		0.04	1.007	0.877	1.018	0.886	1.072	0.933
		0.05	1.011	0.880	1.020	0.888	1.079	0.939
		0.06	1.016	0.885	1.022	0.890	1.093	0.952
		0.08	1.024	0.892	1.026	0.893	1.097	0.955
	313.15	0.01	0.996	0.766	1.003	0.771	1.016	0.781
		0.02	0.999	0.768	1.004	0.772	1.059	0.815
		0.04	1.006	0.774	1.010	0.776	1.068	0.821
		0.05	1.008	0.775	1.011	0.778	1.074	0.826
		0.06	1.011	0.778	1.017	0.782	1.089	0.837
		0.08	1.019	0.784	1.023	0.787	1.091	0.839
15	298.15	0.01	1.038	1.410	1.003	1.362	1.003	1.362
		0.02	1.040	1.412	1.005	1.364	1.019	1.383
		0.04	1.043	1.416	1.014	1.376	1.041	1.413
		0.05	1.046	1.421	1.022	1.388	1.046	1.420
		0.06	1.048	1.423	1.030	1.399	1.092	1.483
		0.08	1.053	1.430	1.032	1.401	1.106	1.501
	303.15	0.01	1.016	1.190	1.002	1.175	1.002	1.174

		0.02	1.026	1.202	1.005	1.177	1.005	1.178
		0.04	1.032	1.209	1.012	1.186	1.019	1.194
		0.05	1.042	1.221	1.015	1.190	1.027	1.203
		0.06	1.047	1.226	1.017	1.192	1.081	1.267
		0.08	1.052	1.233	1.027	1.204	1.094	1.282
	308.15	0.01	1.012	1.061	1.002	1.050	1.000	1.049
		0.02	1.016	1.066	1.004	1.053	1.004	1.053
		0.04	1.028	1.078	1.010	1.058	1.015	1.064
		0.05	1.038	1.088	1.012	1.061	1.026	1.075
		0.06	1.039	1.090	1.016	1.065	1.074	1.125
		0.08	1.050	1.101	1.022	1.071	1.085	1.137
	313.15	0.01	1.004	0.909	0.996	0.902	1.000	0.905
		0.02	1.016	0.919	1.003	0.908	1.003	0.908
		0.04	1.027	0.930	1.009	0.913	1.010	0.915
		0.05	1.035	0.937	1.012	0.916	1.020	0.923
		0.06	1.039	0.940	1.015	0.919	1.065	0.964
		0.08	1.047	0.948	1.017	0.921	1.078	0.976
20	298.15	0.01	1.003	1.589	1.003	1.588	1.003	1.588
		0.02	1.004	1.591	1.010	1.599	1.034	1.637
		0.04	1.008	1.596	1.015	1.607	1.062	1.681
		0.05	1.010	1.599	1.023	1.620	1.068	1.691
		0.06	1.013	1.604	1.025	1.624	1.072	1.697
		0.08	1.029	1.630	1.041	1.648	1.074	1.701
	303.15	0.01	1.003	1.353	1.002	1.352	1.002	1.352
		0.02	1.004	1.355	1.009	1.361	1.030	1.389
		0.04	1.007	1.359	1.013	1.366	1.038	1.400
		0.05	1.008	1.360	1.015	1.369	1.045	1.410
		0.06	1.011	1.364	1.024	1.382	1.049	1.416
		0.08	1.014	1.368	1.035	1.397	1.052	1.419
	308.15	0.01	1.001	1.169	1.001	1.169	1.001	1.169
		0.02	1.003	1.171	1.008	1.176	1.029	1.202
		0.04	1.007	1.175	1.010	1.180	1.037	1.211
		0.05	1.008	1.177	1.012	1.181	1.045	1.220
		0.06	1.010	1.179	1.021	1.192	1.049	1.225
		0.08	1.012	1.181	1.035	1.208	1.051	1.227
	313.15	0.01	1.001	1.048	1.000	1.047	1.000	1.047
		0.02	1.003	1.050	1.006	1.053	1.012	1.059
		0.04	1.007	1.054	1.010	1.058	1.024	1.072
		0.05	1.008	1.055	1.011	1.059	1.033	1.081
		0.06	1.009	1.056	1.018	1.066	1.036	1.084
		0.08	1.011	1.059	1.033	1.082	1.037	1.086
Water	298.15	0.01	1.015	0.903	1.012	0.901	1.016	0.904
		0.02	1.018	0.906	1.023	0.911	1.023	0.911
		0.04	1.032	0.918	1.033	0.920	1.029	0.916
		0.05	1.036	0.922	1.043	0.929	1.035	0.922
		0.06	1.042	0.927	1.046	0.932	1.050	0.935
		0.08	1.049	0.934	1.050	0.935	1.052	0.937
	303.15	0.01	1.008	0.797	1.009	0.798	1.011	0.799
		0.02	1.013	0.800	1.017	0.804	1.016	0.803
		0.04	1.021	0.807	1.029	0.813	1.023	0.809
		0.05	1.033	0.816	1.037	0.820	1.025	0.811
		0.06	1.035	0.817	1.044	0.825	1.030	0.814
		0.08	1.039	0.821	1.047	0.827	1.032	0.816
	308.15	0.01	1.007	0.725	1.009	0.726	1.009	0.727
		0.02	1.010	0.728	1.014	0.730	1.011	0.728
		0.04	1.020	0.735	1.025	0.739	1.019	0.734
		0.05	1.032	0.743	1.034	0.745	1.023	0.737
		0.06	1.034	0.745	1.042	0.750	1.028	0.740
		0.08	1.038	0.748	1.046	0.754	1.030	0.742
	313.15	0.01	1.004	0.653	1.008	0.655	1.003	0.652
		0.02	1.010	0.657	1.013	0.659	1.010	0.657
		0.04	1.017	0.661	1.021	0.664	1.018	0.662
		0.05	1.030	0.067	1.031	0.670	1.022	0.665
		0.06	1.031	0.671	1.041	0.677	1.027	0.668
		0.08	1.038	0.675	1.044	0.679	1.030	0.670

The values of the viscosity co-efficients, A_F and B_J and those of $\Delta\mu_1^{0*}$ and $\Delta\mu_2^{0*}$ have been evaluated and are presented in Tables 2 and 3 respectively.

Table 2 : Values of the parameters A($dm^{3/2}$ $mol^{-1/2}$) and B(dm^3mol^{-1}) of glycine, α-alanine and β-alanine in water + Glucose(5,10,15,20 wt %) at different temperatures

Amino acids	298.15 K		303.15K		308.15K		313.15K		dB/dT
	A ($dm^{3/2}$ $mol^{-1/2}$)	B (dm^3mol^{-1})	A ($dm^{3/2}$ $mol^{-1/2}$)	B (dm^3 mol^{-1})	A ($dm^{3/2}$ $mol^{-1/2}$)	B (dm^3 mol^{-1})	A ($dm^{3/2}$ $mol^{-1/2}$)	B (dm^3 mol^{-1})	
	5wt% Glucose								
Glycine	-0.031	0.617	-0.033	0.613	-0.028	0.526	-0.05	0.538	-0.005
α-alanine	-0.052	0.745	-0.068	0.705	-0.047	0.494	-0.036	0.388	-0.024
β-alanine	0.181	0.829	0.175	0.727	0.163	0.657	0.115	0.829	0
	10 wt% Glucose								
Glycine	-0.03	0.463	-0.05	0.531	-0.04	0.437	-0.088	0.576	0.008
α-alanine	-0.006	0.751	0.022	0.326	0.003	0.366	-0.002	0.293	-0.030
β-alanine	0.271	0.528	0.242	0.611	0.227	0.603	0.214	0.582	0.004
	15wt% Glucose								
Glycine	0.46	-1.068	0.153	0.14	0.077	0.369	0.003	0.656	0.115
α-alanine	-0.03	0.568	-0.012	0.381	-0.007	0.308	-6.20E-02	0.504	-0.004
β-alanine	-0.155	1.939	-0.213	1.898	-0.206	1.775	-0.195	1.609	-0.022
	20wt% Glucose								
Glycine	-0.008	0.319	0.022	0.097	0.004	0.146	0.004	0.139	-0.012
α-alanine	-0.018	0.557	-0.02	0.494	-0.034	0.511	-0.041	0.517	-0.003
β-alanine	0.006	1.212	0.034	0.699	0.025	0.73	-0.039	0.751	-0.031
	Water								
Glycine	0.117	0.212	0.045	0.383	0.025	0.448	-0.004	0.543	0.022
α-alanine	0.111	0.312	0.059	0.454	0.036	0.509	0.026	0.51	0.013
β-alanine	0.136	0.185	0.113	0.026	0.07	0.157	0.006	0.416	0.015

Table 3:The values of $\Delta\mu_1^{0*}$ and $\Delta\mu_2^{0*}$(k J mol^{-1})for Glycine, α-alanine & β-alanine in water + D-Glucose solutions at different temperatures.

Temp K	Wt % Glucose	$\Delta\mu_1^{0*}$ (k J mol^{-1})	$\Delta\mu_2^{0*}$ (k J mol^{-1})		
			Glycine	α-alanine	β-alanine
298.15	0	9.16	37.29	55.02	36.94
	5	9.49	84.16	106.89	111.67
	10	9.92	61.92	104.79	69.83
	15	10.42	-130.9	78.84	245.33
	20	10.89	42.08	75.26	151.97
303.15	0	9.02	61.89	75.20	15.85
	5	9.26	87.11	103.05	100.69
	10	9.69	74.62	50.66	85.07
	15	10.23	21.27	56.67	247.58
	20	10.67	15.41	68.98	91.75
308.15	0	8.93	72.12	85.74	34.76
	5	9.19	77.02	75.57	94.74
	10	9.57	63.28	56.75	86.31
	15	10.12	52.28	48.04	235.11
	20	10.48	22.71	72.22	97.25
313.15	0	8.82	87.54	87.37	72.84
	5	9.09	80.49	61.83	119.97
	10	9.41	83.23	48.34	84.98
	15	9.91	91.05	74.71	217.67
	20	10.38	22.67	74.09	102.23

The values of ΔH^* and ΔS^* are given in Table 4 at 298.15 K only,for all the amino acids in aqueous and aqueous D-glucose solutions at the experimental temperatures.

Table 4: The values of enthalpy, ΔH^*,entropy , ΔS^* of activation of viscous flow of amino acids in aqueous D-glucose solutions at different temperatures.

Wt % D-glucose	Conc (mol dm^{-3})	ΔH^* (kJ mol^{-1})	ΔS^* (J $mol^{-1}K^{-1}$)	ΔH^* (kJ mol^{-1})	ΔS^* (J $mol^{-1}K^{-1}$)	ΔH^* (kJ mol^{-1})	ΔS^* (J $mol^{-1}K^{-1}$)
		Glycine		α-alanine		β-alanine	
0	0.01	-0.83	-3.08	-0.49	-2.01	-0.64	-2.39
	0.02	-1.75	-6.29	-1.07	-4.16	-1.38	-4.92
	0.04	-3.58	-12.74	-2.23	-8.47	-2.84	-9.99
	0.05	-4.5	-15.96	-2.82	-10.62	-3.58	-12.52
	0.06	-5.42	-19.17	-3.39	-12.77	-4.31	-15.05
	0.08	-7.26	-25.61	-4.56	-17.07	-5.78	-20.12
5	0.01	0.3	0.56	1.17	3.39	0.08	-0.24
	0.02	0.51	0.98	2.25	6.65	0.07	-0.62
	0.04	0.94	1.83	4.42	13.15	0.06	-1.38
	0.05	1.15	2.25	5.49	16.41	0.05	-1.76
	0.06	1.36	2.67	6.58	19.66	0.04	-2.14
	0.08	1.78	3.51	8.74	26.16	0.02	-2.89
10	0.01	-0.15	-0.88	1.16	3.43	-0.1	-0.77
	0.02	-0.4	-1.94	2.23	6.69	-0.31	-1.69
	0.04	-0.9	-4.04	4.35	13.23	-0.72	-3.57
	0.05	-1.15	-5.09	5.42	16.49	-0.92	-4.5
	0.06	-1.4	-6.14	6.48	19.76	-1.12	-5.44
	0.08	-1.9	-8.25	8.61	26.29	-1.53	-7.3
15	0.01	-4.16	-13.79	0.29	0.58	0.92	2.07
	0.02	-8.41	-27.73	0.48	0.99	1.74	3.97
	0.04	-16.92	-55.61	0.87	1.84	3.38	7.79
	0.05	-21.17	-69.56	1.06	2.26	4.19	9.69
	0.06	-25.42	-83.49	1.25	2.68	5.02	11.61
	0.08	-33.93	-99.39	1.64	3.52	6.65	15.42
20	0.01	0.43	1.18	0.17	0.16	1.09	3.03
	0.02	0.77	2.19	0.25	0.17	2.08	5.91
	0.04	1.44	4.23	0.39	0.18	4.05	11.65
	0.05	1.78	5.25	0.47	0.19	5.04	14.53
	0.06	2.12	6.27	0.54	0.19	6.03	17.4
	0.08	2.79	8.31	0.69	0.20	8.01	23.15

In all the solvents, the viscosity increased with increasing weight percent of D-glucose as well as with increasing concentrations of amino acids. Typical plots are shown in Fig.1 at 298.15 K only.

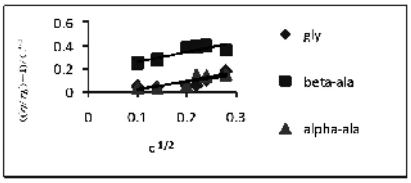

Figure-1(a): Plot of $(\eta/\eta_0-1)/c^{1/2}(dm^{3/2}mol^{-1/2})$ vs $c^{1/2}(mol^{1/2}\ dm^{-3/2})$ in 5 wt% D-glucose at 298.15 K.

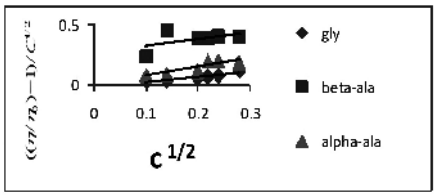

Figure-1(b): Plot of $(\eta/\eta_0-1)/c^{1/2}(dm^{3/2}mol^{-1/2})$ vs $c^{1/2}(mol^{1/2}\ dm^{-3/2})$ in 10 wt% D-glucose at 298.15 K.

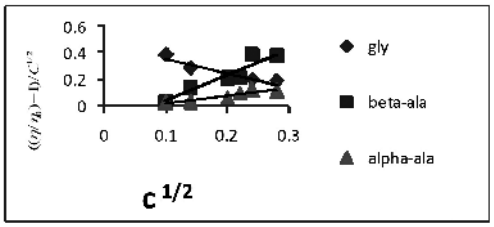

Figure-1(c) : Plot of $(\eta/\eta_0-1)/c^{1/2}(dm^{3/2}mol^{-1/2})$ vs $c^{1/2}(mol^{1/2}\ dm^{-3/2})$ in 15 wt% D-glucose at 298.15 K.

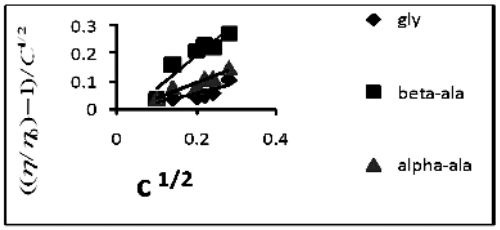

Figure-1(d) : Plot of $(\eta/\eta_0-1)/c^{1/2}(dm^{3/2}mol^{-1/2})$ vs $c^{1/2}(mol^{1/2}\ dm^{-3/2})$ in 20 wt% D-glucose at 298.15 K.

A perusal of Table 2 shows that the values of A_F are negative in almost all cases. Since A_F is considered to be a measure of ion-ion interaction, the negative A_F values may indicate the absence(as ion-ion interactions vanish at infinite dilution) or the presence of very weak ionic interactions in all the solutions in all solvents. However, in the case of ionic interactions, it is evident that the interactions are dependent on the nature of the solute and also on the structure of the solvent. Thus, the variation of A_F values depends on the nature of amino acids and the structure of the compositions of water + D-glucose mixtures.

The co-efficient B_J is a measure of the effective solvodynamic volume of the solvated ions and is governed by ion-solvent interactions, that is ,the structural effect of the solvent in solution[19,20]. It is a fact that when a solute dissolves in a solvent, some of the solvent molecules are attached to the ions (generated from the solute) because of ion-solvent interactions and this causes an increase in viscosity of the solution(a positive contribution to the co-efficient B_J).On the other hand, these solvent molecules have to be wrenched out of the bulk solvent and this breaking of the solvent structure causes a decrease in viscosity of the solution (a negative contribution to B_J).Thus, the value of B_J in the solution is the resultant of these two opposing factors. As observed, the values of B_J are, excepting few cases, positive and large indicating the existence of strong ion-solvent interactions.

As observed, the values of B_J are larger as compared to A_F values supporting the behavior of φ_v^0 and S_v respectively [21] . This again supports to the fact that the solute-solvent interactions dominate over solute-solute interactions.
The temperature co-efficient, dB_J/dT is found to be positive in water and less negative in almost all compositions of D-glucose in water. As dB_J/dT is a measure of ion-solvent interactions, the positive temperature co-efficient indicates strong ion-solvent interactions in water and decrease with increasing D-glucose content in water.The strong interactions of amino acids with water are thus expected which should decrease with increasing D-glucose concentration.

Table 3 displays the values of $\Delta\mu_1^{0*}$ and $\Delta\mu_2^{0*}$ for the amino acids in water and water + D-glucose mixtures. As observed, the $\Delta\mu_2^{0*}$ values are positive and large. The positive and large values of $\Delta\mu_2^{0*}$ indicate that the formation of the transition state accompanied by the rupture and distortion of the intermolecular forces in solvent structure takes place to a greater extent.

It is observed from Table 4 that ΔH^* values are negative in water for all amino acids, and in 15wt% D-glucose for only glycine and in 10 wt% D-glucose for glycine and β-alanine. This may be due to the fact that the formation of

the activated species necessary for viscous flow is energy releasing whereas the positive ΔH^* values for other cases suggest the energy consuming process. The ΔS^* values are negative in water for all amino acids, and in 15wt% D-glucose for glycine and in 10 wt% D-glucose for glycine and β-alanine. These values of ΔS^* show a pronounced decrease with increase in the concentration of amino acids in the mixture[22].This might be attributed to the fact that the formation of the activated species required for viscous flow appears easy as the amount of the acid increases in the solution. The positive values of ΔS^*,which increase with increasing concentration of amino acids, suggest that the net order of the system decreases as the concentration of amino acid increases[23].This indicates the presence of strong solute-solvent interactions in various mixed solvent systems. Further, it points to the fact that the intermolecular interaction of amino acids with water and different compositions of D-glucose solutions depend on the nature of the acid and the solvent structure.

CONCLUSION

From the viscosity values and the related parameters for amino acids in water and water + D-glucose (5,10,15 and 20 wt%) mixtures, it is concluded that there exists a molecular interaction between amino acids and the solvents studied. The intermolecular interactions depend on the nature of the amino acid and the structure of the solvent.

REFERENCES

[1] JM McDowali; CAVincient,*J.Chem.Soc.,Faraday Trans* I, **1974,**70,1862.
[2] GK Ward; FJ Millero,*J.Soln.Chem*., **1974,**3, 417.
[3] MRJ Dack; KJ Bird; A Parker,.*Aust.J.Chem*., **1975,**28,955.
[4] UN Dash; SK Nayak,*Thermochim Acta.,* **1979,**32,331.
[5] MLParmer; AKundra,*Electrochim Acta.*, **1983,**28,1665.
[6] UN Dash; SP Kalia,*Acta Ciencia Indica.*, **1984,**90,I.
[7] MLParmer; AKhanna,*J.Electrochem.Soc.India.*, **1986,**32,283.
[8] UN.Dash; BK Mohanty,.*Indian J.Chem*.,**1996,**35A,188,983.
[9] Q Lin; X Hu; RLin;W Sang; S Li, *J.Chem.Eng.Data.*, **2001,**46,522.
[10] TH Lilley,*Pure App Chem.*, **1993,**65,2551.
[11] M Hackel; HJ Hinz; GR Hedwig,*J.Mol.Biol.*, **1999,**291(1),197.
[12] A Ali; S Hyder; S Sabir; D Chand ; AK Nain,*J.Chem.Thermodyn.*, **2006,**38,136.
[13] G Castronuovo; VElia and F.Velleca,*J.Soln Chem.*, **1996,**25,51.
[14] RA Robinson; RH Stokes, *ElectrolyteSolutions*,Butterworths Scientific Publication,London,**1955**,p.30.
[15] G Jones; M Dole,*J.Am.Chem.Soc.*, **1929,**51,2950.
[16] Falken-Hagen; ELVernan, *Z. Phys*., **1932,**35,140.
[17] D Feakins; JD Freemantle, KG Lawrence, *J.Chem.Soc FaradayTrans*.,**1976,**I,82, 563.
[18]D Feakins;JD Freemantle;KG.Lawrence,*J.ChemSoc.Faraday Trans*., **1974 ,**I 70, 795.
[19]RH.Stokes;R.Mills,International Encyclopedia of Physical Chemistry and Chemical Physics,Pergamon,New York,1965.
[20]RW Gurney, Ionic Processes in Solutions, Dover, New York,**1962**,Ch.9.
[21] Sanjibita Das;Upendra Nath Dash,*J.Chem.Pharm.Res.*,**2012**,4(1),754-762.
[22]A Ali;Shahjahan,*J.Iranian Chem.Soc*.,**2006**,3(4),340-350.
[23] A Ali; S Khan;F.Nabi,*J.Serb.Chem.Soc.*, **2007**,72(5), 495.