Studies in Intermolecular Interaction of Glucose with Transition Metal Salt in Aqueous Solution at 31°C Temperature

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ABSTRACT

Densities and viscosities of glucose at constant temperature have been measured from experimental data. The apparent molar volume (ϕv), relative viscosity (n_r) were calculated by using Jones-Dole equation. The results show strong ion-ion interaction that indicates for the observed viscosity concentration dependence of dilute electrolyte solutions

Key Words: Viscosity, density, Apparent Molar Volume, relative viscosity, Jones-Dole equation,

Introduction

Viscosity is one the property of liquid. It implies resistance to flow. Those liquid flow slowly (glycerin, honey, caster oil, etc.) are said to have high viscosity while those which flow readily (water, alcohol, dioxin, etc.) are said to have low viscosity. It may be looked upon as the force of friction between two layers of a liquid moving past one another with different velocities. Viscosity measurement like other transport properties of electrolyte, provide useful information about solute-solute and solute-solvent interactions. These interactions have been studied in aqueous and nonaqueous solution by many workers. The determination volume of a solution at different concentration is very important because it helps to calculate the properties like apparent molar volume (ϕv). Apparent molar volume is the difference between the volume of solution containing one mole of substance and the volume of contained solvent. The apparent molar volume of electrolyte solution have proved very important tool in elucidating the structural interactions i.e. ion-ion, ion-solvent and solute-solvent interactions occurring in solution Viscosity and apparent molar volume of many electrolytes in mixed organic solvent were found earlier. But the intermolecular interactions of glucose with biochemical medicine at different concentrations in aqueous solution at room temperature by density measurement and viscosity measurement are not studied so far. Therefore, present work is undertaken to make systematic study of nature and strength of intermolecular interactions of glucose with biochemical medicines in aqueous solution at 31^0 room temperature by measuring the densities and viscosities of the solutions.

Theoretical and Mathematical:

The apparent molar volumes (ϕv) of salts in solutions are determined respectively, from density of solution (ds) using equation

$$\varnothing v = (M / ds) + (do - ds)\, 10^3/m\ ds\ do \ldots\ldots\ldots\ldots (1)$$

Where, do is the density of water, m (0.01) is molality, M is molar mass of solute. The values of $\varnothing v$ were plotted Vs $\sqrt{}$concentration. The curve represented the least squares and given as

$$\varnothing v = \varnothing v^{\circ} + S_V \sqrt{c} \ldots\ldots\ldots (2)$$

Where $\varnothing v$ ° is limiting apparent molar volume at the infinite dilution and S_V is experimental slop

Calculation:

The values of apparent molar volume($\varnothing v$)for glucose solution, glucose - $MnSO_4$, glucose - $CuSO_4$, glucose- $NiCl_2$, glucose –$FeCl_3$, glucose – $CoS0_4$ solution are calculated from equation (1). The relative viscosities (n_r) of the solutions as calculated from the equation

$$n_r = \frac{\eta_s}{\eta_o} = \frac{d_s X\ t_s}{d_o X\ t_o} \ldots\ldots\ldots\ldots (3)$$

Where n_s and n_o(0.000818) are viscosities of solution and water respectively.d_s and do are densities of solution and water respectively. t_s and to are flow times for the solution and water respectively.

Then the values of η_r are analyzed in terms of Jones-Dole Equation.

$$\frac{n_r - 1}{\sqrt{c}} = A + B\sqrt{c} \ldots\ldots\ldots\ldots (4)$$

Where viscosity parameter A is measure of solute-solute interactions. Viscosity parameter B is measure of solute-solvent interactions. The values of A and B are determined by from the slope of the plot.

Density of water (do) =0.9965

Wt of density bottle =5.819

Table No. 1 Determination of Density (d), Combination in conc. (m\l) solution, Apparent molar volume ($\varnothing v$), Time of flow t(s) & relative viscosities (n_r) of glucose- $MnSO_4$ solution at 31°C,

Conc. m/l		Wt.of solution (gm)	Volume of solution (cc)	d (gcm-3)	$\varnothing v$ (cm^3mol^{-1})	t(s)	ns x 10^{-3} (cp)	nr	$\frac{nr-1}{\sqrt{c}}$
Glucose	$MnSO_4$								
0.009	0.001	15.425	10	0.9606	4060.17	34.88	1.8968	2.31	7.33
0.008	0.002	15.547	10	0.9728	2709.66	35.36	1.9473	2.38	7.52
0.007	0.003	15.560	10	0.9748	2567.74	36.75	1.9641	2.40	7.59
0.006	0.004	15.570	10	0.9741	2458.84	35.85	1.9790	2.41	7.64
0.005	0.005	15.591	10	0.9772	2230.86	35.55	1.9666	2.40	7.60
0.004	0.006	15.600	10	0.9781	2122.64	36.05	1.9961	2.44	7.71
0.003	0.007	15.541	10	0.9724	2753.40	36.00	1.9817	2.42	7.66
0.002	0.008	15.557	10	0.9738	2600.46	36.26	1.9989	2.44	7.72
0.001	0.009	15.534	10	0.9715	2851.95	37.00	2.0349	2.48	7.86

Table No. 2 Determination of Density (d), Combination in conc. (m\l) solution, Apparent molar volume (Øv),Time of flow t(s) & relative viscosities (n_r) of glucose-$CuSO_4$ solution at 31°C,

Conc. m/l		Wt.of solution (gm)	Volume of solution (cc)	d (gcm-3)	Øv (cm^3mol^{-1})	t(s)	ns x 10^{-3} (cp)	nr	nr -1 / √c
Glucose	$CuSO_4$								
0.009	0.001	15.641	10	0.9822	1691.98	35.29	1.9622	2.39	7.58
0.008	0.002	15.611	10	0.9792	2014.65	35.35	1.9596	2.39	7.57
0.007	0.003	15.597	10	0.9778	2165.90	35.53	1.9667	2.40	7.60
0.006	0.004	15.619	10	0.980	1928.41	35.71	1.9811	2.42	7.65
0.005	0.005	15.573	10	0.9754	2426.21	35.54	1.9624	2.39	7.58
0.004	0.006	15.562	10	0.9743	2545.94	35.60	1.9635	2.40	7.59
0.003	0.007	15.552	10	0.9733	2655.03	35.90	1.9783	2.41	7.64
0.002	0.008	15.543	10	0.9724	2753.40	36.18	1.9916	2.43	7.69
0.001	0.009	15.536	10	0.9717	2873.87	36.73	2.0205	2.42	7.65

Table No. 3 Determination of Density (d),Combination in conc. (m\l) solution, Apparent molar volume (Øv),Time of flow t(s) & relative viscosities (n_r) of glucose-$NiCl_2$ solution at 31°C,

Conc. m/l		Wt.of solution (gm)	Volume of solution (cc)	d (gcm-3)	Øv (cm^3mol^{-1})	t(s)	ns x 10^{-3} (cp)	nr	nr -1 / √c
Glucose	$NiCl_2$								
0.009	0.001	15.575	10	0.9756	2404.47	34.74	1.9234	2.35	7.43
0.008	0.002	15.571	10	0.9752	2447.96	34.86	1.9302	2.35	7.46
0.007	0.003	15.563	10	0.9744	2535.05	34.94	1.9267	2.35	7.44
0.006	0.004	15.542	10	0.9723	2425.52	35.05	1.9316	2.36	7.46
0.005	0.005	15.522	10	0.9703	2983.64	34.87	1.9176	2.37	7.41
0.004	0.006	15.508	10	0.9689	3137.68	34.09	1.8633	2.27	7.20
0.003	0.007	15.569	10	0.9650	3569.16	34.64	1.8933	2.31	7.31
0.002	0.008	15.559	10	0.9640	3680.36	35.68	1.9455	2.37	7.52
0.001	0.009	15.400	10	0.9589	4307.37	35.86	1.9663	2.40	7.60

Table No. 4 Determination of Density (d), Combination in conc. (m\l) solution, Apparent molar volume (ϕv), Time of flow t(s) & relative viscosities (n_r) of glucose –$FeCl_3$ solution at 31°C,

Conc. m/l		Wt.of solution (gm)	Volume of solution (cc)	d (gcm-3)	ϕv ($cm^3 mol^{-1}$)	t(s)	ns x 10^{-3} (cp)	nr	$\frac{nr-1}{\sqrt{c}}$
Glucose	$FeCl_3$								
0.009	0.001	15.580	10	0.9761	2350.15	36.02	1.9904	2.43	7.69
0.008	0.002	15.628	10	0.9809	1831.56	36.55	2.0281	2.47	7.84
0.007	0.003	15.628	10	0.9809	1831.56	36.71	2.0385	2.49	7.88
0.006	0.004	15.588	10	0.9769	2236.37	36.11	1.9970	2.44	7.72
0.005	0.005	15.660	10	0.9788	2057.82	35.84	1.9859	2.42	7.67
0.004	0.006	15.634	10	0.9815	1767.09	35.75	1.9734	2.41	7.62
0.003	0.007	15.630	10	0.9818	1810.06	36.01	1.9855	2.42	7.67
0.002	0.008	15.593	10	0.9774	2209.20	36.01	1.9925	2.43	7.70
0.001	0.009	15.559	10	0.9740	2578.65	36.00	1.9895	2.43	7.69

Table No. 5 Determination of Density (d), Combination in conc. (m\l) solution, Apparent molar volume (ϕv),Time of flow t(s) & relative viscosities (n_r) of glucose–$CoS0_4$ solution at 31°C,

Conc. m/l		Wt.of solution (gm)	Volume of solution (cc)	d (gcm-3)	ϕv ($cm^3 mol^{-1}$)	t(s)	ns x 10^{-3} (cp)	nr	$\frac{nr-1}{\sqrt{c}}$
Glucose	$CoS0_4$								
0.009	0.001	15.599	10	0.9780	2144.27	36.15	1.9976	2.44	7.72
0.008	0.002	15.580	10	0.9781	2133.45	36.00	1.9976	2.44	7.72
0.007	0.003	15.575	10	0.9756	2404.47	36.00	1.9991	2.44	7.72
0.006	0.004	15.558	10	0.9739	2587.55	35.92	1.9865	2.42	7.67
0.005	0.005	15.554	10	0.9738	2633.19	35.84	1.9859	2.42	7.57
0.004	0.006	15.532	10	0.9734	2862.91	35.94	1.9839	2.44	7.67
0.003	0.007	15.529	10	0.9659	3469.28	36.00	1.9850	2.44	7.67
0.002	0.008	15.473	10	0.9655	3513.65	36.30	2.0085	2.45	7.76
0.001	0.009	15.451	10	0.9632	3769.49	37.75	2.0168	2.55	8.06

Result and Discussion

The present investigation the value of apparent molar volume, the relative viscosity (nr) and the values of A and B are determined from the slope of the plot for glucose solution, glucose-$MnSO_4$,glucose-$CuSO_4$, glucose-$NiCl_2$, glucose –$FeCl_3$,glucose–$CoS0_4$.The values of apparent molar volume, relative viscosity at 31°C temperature are in table 01-05.

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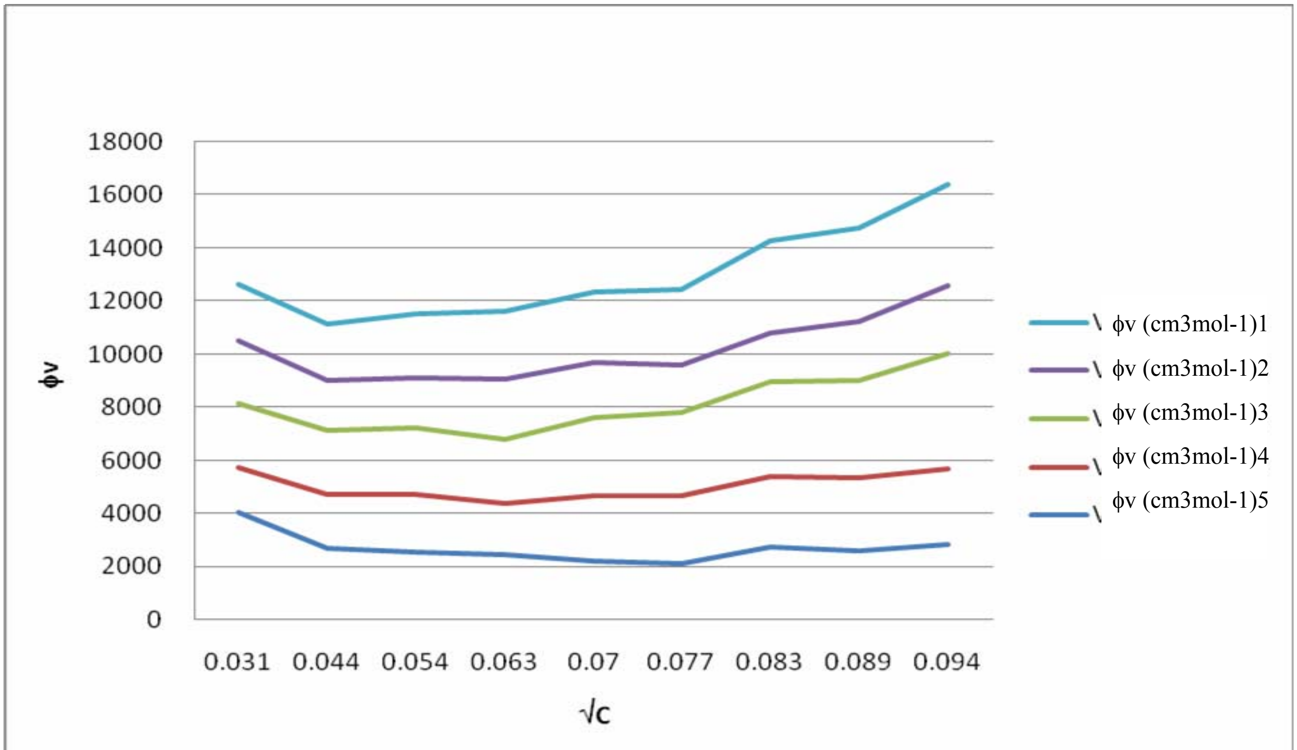

Figure 1 Plot of Apparent Molar volume Vs √c

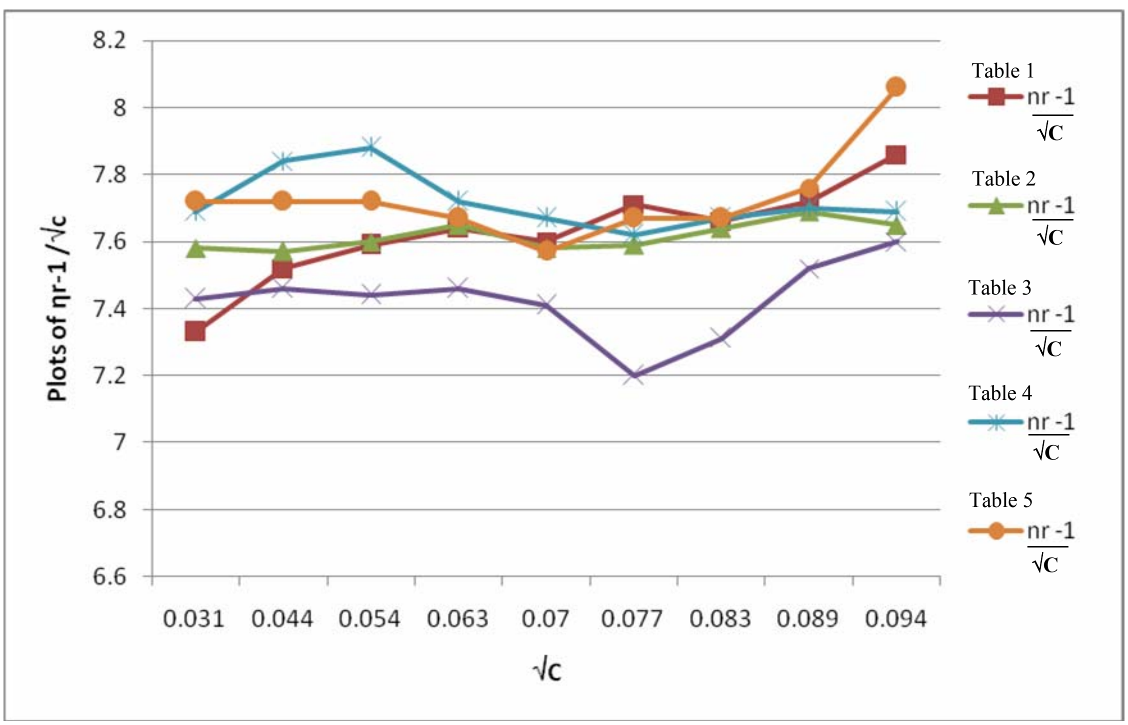

Figure 2 Plots of ηr-1 /√c Vs √c

In case of glucose solution at 31°C temperature the large value indicating strong interaction of glucose with water molecules with decreasing concentration of glucose. The apparent molar values shows slight increases and then decreases indicating only slight increasing in intermolecular interaction. The apparent molar values in $MnSO_4$ slight decreasing and then increasing indicating slight increasing in intermolecular interaction. The apparent molar values a slightly increasing indicating no change in nature and strength of intermolecular interaction.

In glucose $NiCl_2$ the apparent molar values are positive and large value is due to electrostatic effect of highly polar $NiCl_2$, with decreasing concentration of glucose solution. This concentration of glucose an increasing concentration of $NiCl_2$.

In case of glucose $FeCl_3$, at 31°C temperature with decreasing in concentration of glucose and increasing concentration of inorganic salt. The apparent molar values show irregular variation indication strong ion solvent interaction due to continuous breaking of hydrogen bond.

In case of glucose - $CoS0_4$ and glucose - $CuSO_4$ for apparent molar values are positive and large value indication strong interaction of glucose with water molecule with decreasing concentration of glucose. Apparent molar values are increasing indication change in nature and strength of intermolecular interaction.

According to viscosity measurements, the viscosity of glucose solution increases with decrease in concentration of glucose, which indicates increase in intermolecular interactions, this may be due to more interaction of water with glucose increase in dilution. In case of glucose-$CuSO_4$, glucose-$NiCl_2$, glucose–$CoS0_4$ the value of relative viscosity increases with decrease in concentration of glucose solution indicating increase in intermolecular interactions. .

In case of glucose-$MnSO_4$,glucose-$FeCl_3$ the viscosity irregular with decrease in concentration of glucose and increase concentration of $MnSO_4$,$FeCl_3$ indicating no appreciable change in strength of intermolecular interactions.

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