CHAPTER- V

SUMMARY

In the present investigations, the thermodynamic and transport properties of some solutions involving carbohydrates have been reported. The studies on thermodynamic property viz., the molar volumes of solutions involving carbohydrates from density measurements and the transport properties of some carbohydrate solutions from the investigations of the uncoupled and coupled transport processes have been described. The results of molar volumes and the viscosity studies have been discussed in the light of solute-solvent interactions. The studies of coupled transport phenomena reported here deal with the studies of electro-kinetic effects across a pyrex sintered disc (G_2) impregnated with cellulose acetate and the results have been discussed in the light of the principles of non-equilibrium thermodynamics.

A brief summary of the investigations reported here is given under the following Sections.

1. Thermodynamic Property viz molar volumes.
2. Uncoupled transport processes viz, Viscosity studies.
3. Coupled transport processes viz electro-kinetic effects.

1. Thermodynamic Properties

The thermodynamic quantity viz the apparent molar volumes (V_ϕ) of Sodium bicarbonate in:

I) aqueous solutions of glucose and sucrose and

II) solution of glucose in aqueous methanol and of sucrose in aqueous methanol has been evaluated. Dependence of apparent molar volume on concentration and temperature has been employed as a tool to study solute-solvent interactions.

Density of various solutions of Sodium bicarbonate in aqueous glucose, sucrose, aqueous methanol + glucose and sucrose+aqueous methanol was determined at different concentrations and temperatures and the data has been utilized to evaluate the apparent molar volume, V_ϕ using the following expression:

$$V_\phi = \frac{1000\,(d - d_o)}{m\,d\,d_o} + \frac{M_2}{d} \qquad (S.1)$$

It has been found that the apparent molar volumes, V_ϕ vary linearly with the square root of concentration $\sqrt{C}$. From the plots of V_ϕ versus $\sqrt{C}$ it is found that the equation:

$$V_\phi = V_\phi^o + S_v \sqrt{C} \qquad (S.2)$$

is valid in the present studies. The V_ϕ^o and S_v values have been obtained from the straight line plots of V_ϕ versus $\sqrt{C}$. S_v values have been found to be positive.

The structure making/breaking capacity of Sodium bicarbonate in different solutions has been inferred from the sign of $(\partial^2 V_\phi^\circ / \partial t^2)$ values. It has been observed that the $(\partial^2 V_\phi^\circ / \partial t^2)$ values are positive thereby indicating that Sodium bicarbonate behaves as structure maker in all the solutions studied here.

2. <u>Uncoupled Transport Processes</u>

Uncoupled transport process viz. viscous flow has been studied for different solutions involving:

I) Sodium bicarbonate in aqueous glucose and aqueous sucrose and

II) Sodium bicarbonate in glucose+aqueous methanol and sucrose+aqueous methanol, at different concentrations, and different temperatures. The concentration dependence of viscosity has been analysed in terms of the Jones-Dole equation:

$$\eta / \eta_0 = 1 + A\sqrt{C} + BC \qquad (S.3)$$

where A and B parameters of the Jones-Dole equation (S.3) have been estimated from the intercepts and slopes of linear plots of $(\eta/\eta_0 - 1)/\sqrt{C}$ versus $\sqrt{C}$. The dB/dT in all the concentrations studied has been found to be negative implying thereby that Sodium bicarbonate behaves as structure maker in all the concentrations reported here.

processes. The linear phenomenological relations:

$$I = L_{11} \Delta \phi + L_{12} \Delta P \qquad (S.5)$$

$$J = L_{21} \Delta \phi + L_{22} \Delta P \qquad (S.6)$$

are valid for the concentrations reported here.

Hydrodynamic permeability Data shows that out of the three carbohydrates used, the permeability of glucose is maximum and that of glucose is minimum and follows the order:

glucose > lactose > sucrose

The permeability flow increases from 20% aqueous methanol to 60% aqueous methanol solutions. The temperature dependence of hydrodynamic phenomenological coefficient L_{22} has been utilized to acalculate the activation energy parameters viz Energy of Activation (E_η), entropy of Activation (ΔS^*) and free energy of activation (ΔG^*).

Membrane characterization has been done with a view to calculate membrane constant (a/l), equivalent pore radius (r) and the number of pores (n).

Electro-osmotic Data shows that the electro-osmotic velocity order for the three carbohydrates studied in a fixed concentration of sodium bicarbonate at 303K is:

sucrose > lactose > glucose

Electro-osmotic flux decreases with the increase of methanol content.

The phenomenological coefficient L_{21} obtained from the electro-osmotic data has been used to determine the zeta potential. Zeta potential has been found to decrease with the decreasing concentration of electrolyte. This has been attributed to the tendency of cations to accumulate on the solution side of the double layer, thereby decreasing the thickness of the double layer. This leads to the decrease of zeta-potential with decreasing concentration of electrolyte. Further it is observed that zeta potential decreases with the increasing methanol content.

The efficiency of the electro-kinetic energy conversion, E_e, for different solutions has been estimated from the following equation:

$$E_e = - \frac{J \Delta P}{(\Delta \phi)^2 / R} \qquad (S.7)$$

It has been found that maximum conversion efficiency took place at half the value of the electro-osmotic pressure in each case.