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APPARENT MOLAR VOLUME OF STANNOUS CHLORIDE IN 40 %(V/V) ETHANOL-WATER SOLVENT SYSTEM AT 298ºK.

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Abstract:- In the present investigation the density of, widely used industrial chemical stannous chloride is measured in binary solution of 40 %(v/v) ethanol-water at 298ºK.The related parameters of density, like apparent molar volume (ϕ_v), apparent molar volume at infinite dilution (ϕ_V^*), experimental slope (S_V^*), and excess molar volume (V^E) are calculated and reported. The large and positive values of apparent molar volume (ϕ^0_v) are for stannous chloride in 40 %(v/v) ethanol-water solution, suggesting the presence of strong solute – solvent interaction.

Key words: Density, molar volume, stannous chloride, apparent molar volume, excess molar volume, binary mixture.

Introduction:-Thermodynamic and physical properties data have a well recognized importance in design calculations involving chemical separations, fluid flow and heat transfer. Studies on the volumetric and transport properties of binary liquid mixtures provide information on the nature of the interactions between the constituents (1). Thermodynamic functions of mixtures represent the difference between the functions of actual and ideal solutions, and thus are useful in the study of molecular interactions and arrangements. In particular, they reflect the interactions that take place between solute-solute, solute-solvent, and solvent-solvent. Stannous chloride is used as a mordant in textile dyeing because it gives brighter colours with some dyes e.g. Cochineal(2), as a catalyst in the production of the plastic polylactic acid (PLA), reducing agent(2).Stannous chloride is also added as a food additive where it serves as a colour-retention agent and antioxidant.$SnCl_2$ is used in radionuclide angiography to reduce the radioactive agent technetium-99m-pertechnetate to assist in binding to blood cells(3). Aqueous stannous chloride is used by many precious metals refining hobbyists as an indicator of gold and platinum group metals in solutions. Stannous chloride is studied in 40%(v/v)ethanol-water at 298ºK.The data of densities is used to analyse of apparent molar volume (ϕ_v), limiting apparent molar volume (ϕ_V^0), experimental slope (S_V^*), molar volume (V) and excess molar volume(V^E) .

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Experimental:-Apparatus:- Double armed pycnometer ,beaker , volumetric flask , Digital analytical balance etc.

Reagents:- Ethanol, stannous chloride and doubled distilled water **.**

Procedure:- A stock solution of 1.00M of stannous chloride is prepared in 40 %(v/v) ethanol- water solvent by direct weighing. Mass dilution technique used for preparation of other concentrations. The concentration of the solutions involved in the experiment was taken in range from 0.10M to 1.00M. Mass dilution technique was applied to prepare the solution of different concentration. Densities of solutions of stannous chloride in 40%(v/v)ethanol-water at 298°K are determined using 10 cm^3 double armed pycnometer. The pycnometer was calibrated at these temperatures with distilled water and benzene. The estimated accuracy of density measurement of solution was 0.00003 g cm^{-3}.

Results and discussion :-Densities of stannous chloride in 40 %(v/v) ethanol-water binary mixture is received and the required parameters are calculated. Densities of stannous chloride in 40 %(v/v) ethanol-water is calculated by the following equation (4)

$$\rho/\rho_1 = W/W_1 \qquad [1]$$

Where, W and W_1 are weight of stannous chloride in acetone-water respectively. ρ is density of stannous chloride and $\rho 1$ is density of ethanol-water solution . Densities of stannous chloride solutions, determined as a function of their concentration a 298 °K temperature in 40 %(v/v)ethanol-water solution . The densities of solute were obtained as an intercept of plot between concentration and density of solutions (using Microsoft Excel). The data is reported in Table -1.

Table-1. Densities, ρ, of stannous chloride in 40%(v/v)ethanol-water at 298°K.

Concentration (Mol.L^{-1})c	Density (Kg.M^{-1}) ρ
0.1000	0.9651
0.2000	0.9793
0.3000	0.9604
0.4000	1.0314
0.5000	1.0453
0.6000	1.0514
0.7000	1.0587
0.8000	1.0876
0.9000	1.0981
1.0000	1.1137

Apparent molar volume, ϕv, is calculated by following the equation (5)

$$\phi v = (\rho_1-\rho)/c\rho\rho_1 + M/\rho \qquad [2]$$

Where, c is Morality of the solution, M is Molar mass of the solute,ρ andρ$_1$ Density of solution and solute. The result of ϕv of stannous chloride are reported in Table- 2.

The apparent molar volume at infinite dilution ϕ_V^0 were calculated by the method of least square and fit to plot of ϕ_v vs $c^{1/2}$ in accordance with the Masson's (6)empirical relation ,

$$\phi_v = \phi_V^0 + S_V^* c^{1/2} \qquad [3]$$

Where, S_V^* is experimental slope. The slope is calculated by the extrapolation of the plots to zero concentration (using Microsoft excel). The positive and less negative values of experimental slope are generally associated with the solutes showing an overall hydrophilic character as in the present investigation. The values of apparent molar volume are reported in Table-2.

Table-2.Apparent molar volume ϕ_v, apparent molar volume infinite dilution, ϕ_V^0 and experimental slope, S_V^* of stannous chloride in 40%(v/v)ethanol-water at 298°K.

Concentration (Mol.L^{-1})c	Apparent molar volume (M^3.Mol^{-1}) ϕ_v	ϕ_V^0	S_V^*
0.1000	233.8618		
0.2000	230.4135		
0.3000	234.9065		
0.4000	218.8029		
0.5000	215.8367	238.0930	37.0475
0.6000	214.6532		
0.7000	213.1387		
0.8000	207.4985		
0.9000	205.4645		
1.0000	202.5925		

The molar volumes (V) of solutions are derived from the following expression (7),

$$V = (X_1M_1+X_2M_2)/\rho \qquad [4]$$

Where, X_1 and X_2 are Mole fraction of mixed solvent and Mole fraction of solute.M_1 and M_2 Molecular weight of solvent and Molecular weight of solute ρ is density of solution respectively. The data of molar volume of solution is reported in Table-3. The molar volume of 40 %(v/v) ethanol-water solution is 48.8718.The molar volume of stannous chloride is 201.1458 respectively. Knowledge of the excess molar volume is of important property in design, storage and handling facilities of mixtures.

Table-3.Molar volume of stannous chloride in 40 %(v/v) ethanol-water at 298ºK.

Concentration c (Mol.L^{-1})	Molar volume V (M3.Mol^{-1}) (10^2)
0.1000	22.9056
0.2000	11.4517
0.3000	7.6354
0.4000	5.7237
0.5000	4.5785
0.6000	3.8153
0.7000	3.2700
0.8000	2.8607
0.9000	2.5426
1.0000	2.2881

The excess molar volume (V^E) for these solutions are obtained by the given expression(8),

$$V^E = V - (X_1V_1 + X_2 V_2) \quad [5]$$

Where, V, V_1 and V_2 are the molar volume of solution, mixed solvent and solute respectively. Positive excess molar volume arises due to increased interaction between the unlike molecules. All the values are positive. The data of compound is reported in Table -4.

Table-4. Excess molar volume of stannous chloride in 40 %(v/v) ethanol-water at 298°K.

Concentration (Mol.L^{-1})c	**Excess molar volume V^E (10^2)**
0.1000	20.6566
0.2000	9.2029
0.3000	5.3863
0.4000	3.4757
0.5000	2.3307
0.6000	1.5676
0.7000	1.0225
0.8000	0.6136
0.9000	0.2957
1.0000	0.0415

Conclusion

The data of densities increases as function of concentration .The positive value of ϕv indicate greater solute-solvent interactions. The values of $\phi 0v$ are large and positive for stannous chloride in 40%(v/v)ethanol-water solution, suggesting the presence of strong solute – solvent interaction. The experimental slope of stannous chloride is positive showing ion-ion interaction.

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