



INVESTIGATION OF DENSITY, VISCOSITY, AND EXCESS THERMODYNAMIC PARAMETERS IN TERNARY SYSTEMS COMPRISING ONE MOLAL AQUEOUS ALKALI METAL SALT SOLUTION, 18-CROWN- 6 ETHER, AND 1 CMC SURFACTANT.

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Abstract:-

The effect of surfactant and temperature on the Complexation of 18-crown-6 with aqueous alkali metal ion. The viscosities and densities of aqueous solution of RbBr with various Concentrations of 18-crown-6 with one CMC Surfactant (1-Decyl Trimethyl Ammonium Bromide) have been measured at 298.15K and 308.15K. The experimental data obtained were used to calculate the excess volume (V^E) and Viscosity deviation ($\Delta\eta$). These results are interpreted in terms of interaction and Complexation Rb^+ ion with Cavities of 18-Crown-6 in presence and absence of Surfactant. Water is the high polarity solvent therefore Rb^+ ion has more solvation. In presence of surfactant reduce the ability of complexation. Generally at higher temperature hydration of Rb^+ ion with water decreases and enhances the Complexation between 18-crown-6 with Rb^+ ion.

Key words

Viscosity, density, 18-crown-6, Surfactant, Complexation, interaction, Rb^+ ion.

1. Introduction:-

The molecular recognition for host–guest interaction has been acquiring a considerable amount of interest [1]. The alkali metal cations and 18-crown-6 ether complexation are highly affected by temperature and environment of solvent [2] at higher temperature often weakening the interaction between metal ion and ligand

complexation due to exothermic nature of the binding. [3] The presence of surfactant molecules can form micelles or aggregates that encapsulate crown ethers with metal ions; thereby enhancing complex formation through electrostatic effect. [4] The effect of temperature and type of surfactant on complexation is important for applications in ion transport, extraction of alkali metal ions, sensing and supramolecular chemistry. This investigation main aims to investigate these effects through measurement of density and viscosities of binary and ternary solutions at different temperatures providing perception into the interplay between complexation ability of 18-crown-6 ether with alkali metals ions. [5, 6]

2. Theory:-

Using the experimental data the following excess and interaction parameters has been calculated [7-8].

$$V^E = \frac{(X_1 M_1 + X_2 M_2)}{\rho} - (x_1 v_1 + x_2 v_2) \dots\dots\dots (1)$$

Where,

X_1 and X_2 are the mole fractions

M_1 and M_2 are the molecular weight

V_1 and V_2 are molar volume of aqueous solution of RbBr (1) and 18-Crown-6 (2) respectively.

The excess viscosities ($\Delta\eta$) of binary and ternary liquid systems were calculated by measuring flow time of the mixture.

$$\Delta\eta = \eta - \{X_1 \eta_1 + X_2 \eta_2\} \dots\dots\dots (2)$$

η viscosity of binary and ternary liquid mixture.

η_1 and η_2 are the viscosities of aqueous solution of RbBr (1) and 18-Crown-6 (2) respectively

Observation Tables:-

Table:- 1 Densities, Viscosities, Excess Molar Volumes, Deviation in Viscosities and apparent molar volume for the aqueous solution of RbBr (1) + 18-crown-6 ether (2) system

Temp	m (g cm ⁻³)	X ₁	ρ (gcm ⁻³)	η (mPa s)	V^E (cm mol ⁻¹)	$\Delta\eta$
298.15K	0	1	0.9963	0.8984	0	0
	0.00125	0.9999774	0.9973	0.9021	-0.016959	0.00372
	0.0025	0.9999549	0.9976	0.9063	-0.021233	0.00794
	0.005	0.9999098	0.9980	0.9101	-0.026161	0.01178
	0.01	0.9998195	0.9984	0.9128	-0.028779	0.01456
308.15K	0	1	0.9933	0.7265	0	0
	0.00125	0.9999774	0.9943	0.7259	-0.017050	-0.00058
	0.0025	0.9999549	0.9948	0.7295	-0.024980	0.00303
	0.005	0.9999098	0.9951	0.7334	-0.028095	0.00696
	0.01	0.9998195	0.9955	0.7369	-0.030686	0.01053

Table:- 2 Densities, Viscosities, Excess Molar Volumes, Deviation in Viscosities and apparent molar volume for the aqueous solution of RbBr (1) + 18-crown-6 ether (2) + 1-Decyl trimethyl ammonium bromide (D-TAB) Surfactant (3) system

Temp	m (g cm ⁻³)	X ₁	ρ (gcm ⁻³)	η (mPa s)	V ^E (cm mol ⁻¹)	$\Delta\eta$
298.15K	0	1	0.9963	0.8984	0	0
	0.00125	0.9997322	0.9970	0.9150	-0.000311	0.01684
	0.0025	0.9997097	0.9974	0.9272	-0.006422	0.02906
	0.005	0.9996644	0.9978	0.9366	-0.011373	0.03850
	0.01	0.9995738	0.9982	0.9470	-0.014006	0.04898
308.15K	0	1	0.9933	0.7265	0	0
	0.00125	0.9997322	0.9942	0.7436	-0.003799	0.01729
	0.0025	0.9997097	0.9945	0.7477	-0.008107	0.02141
	0.005	0.9996644	0.9948	0.7513	-0.011237	0.02504
	0.01	0.9995738	0.9951	0.7549	-0.012012	0.02870

3. Experimental:-

3.1 Source of Purity of Sample:-

All the chemicals in the present research work were analytical reagent (AR) and spectroscopic reagent grade of minimum assay 99.9% obtained from spectrochem which were used as such without purification. The purity of above chemicals were checked by density and viscosity determination. [9]

3.2 Method:-

The binary liquid mixture of different known concentration of 18-crown-6 in one millimole aqueous solution of RbBr were prepared in stopper amber colour bottles.

The densities of different concentration solution were determined using bicapillary pycnometer measurement of mass performed on an electronic balance with an accuracy of ± 0.1 mg. The pycnometer and viscometer is calibrated with triple distilled water, carbon tetrachloride, toluene as reference liquid. [10, 11]

Chemicals	Temp	Density		Viscosity	
		Literature	Calculated	Literature	Calculated
Water	298.15K	0.9970	0.9970	0.8900	0.8900
	308.15K	0.9940	0.9941	0.7191	0.7191
Carbon tetrachloride	298.15K	1.5867	1.5861	0.9010	0.8589
	308.15K	1.5989	1.5654	0.7928	0.8037
Toluene	298.15K	0.8623	0.8619	0.5733	0.5731
	308.15K	0.8550	0.8531	0.4662	0.4657

Results and discussion:-

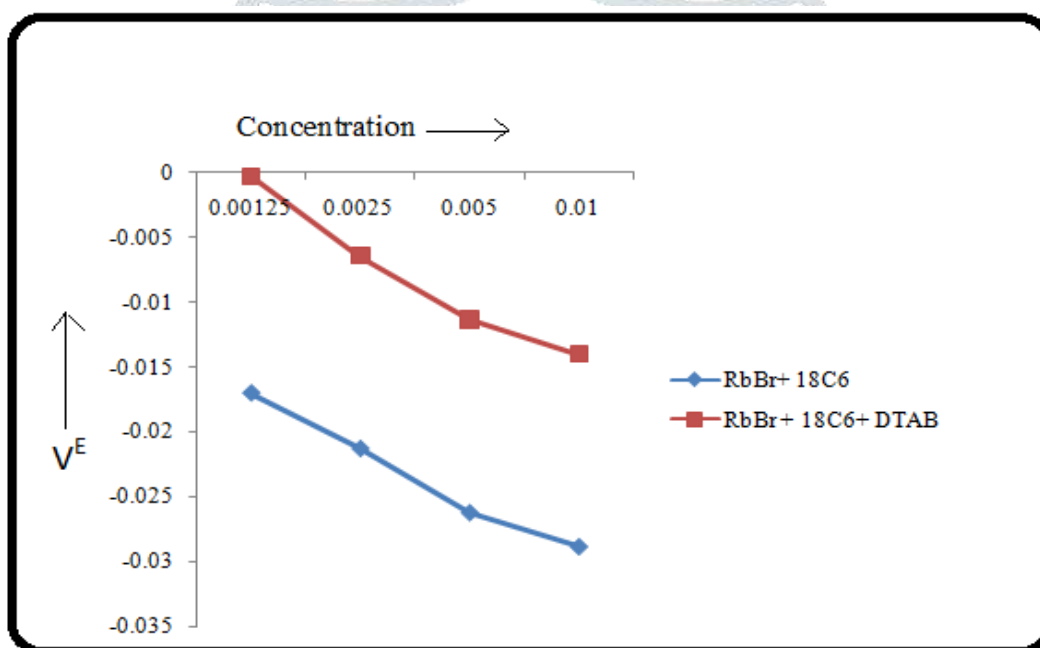
The experimental values of density, viscosity, excess molar volumes and viscosity deviation are presented in table 1 and 2. The sign and magnitude of V^E and $\Delta\eta$ gave a good estimate to the strength of unlike molecular

interactions in solution phase, positive V^E and negative $\Delta\eta$ indicates the weak interaction or complexation, whereas large negative V^E and positive $\Delta\eta$ indicated strong interaction or complexation [12, 13]. In the present investigation, the values of excess molar volumes V^E found negative and $\Delta\eta$ value positive to all concentrations of 18-crown-6 indicated that, strong interaction. However complexation enhanced with increased the concentration of 18-crown-6 with Rb^+ ion. This is due to the thermal description of interaction between metal cation and 18-crown-6. [14]

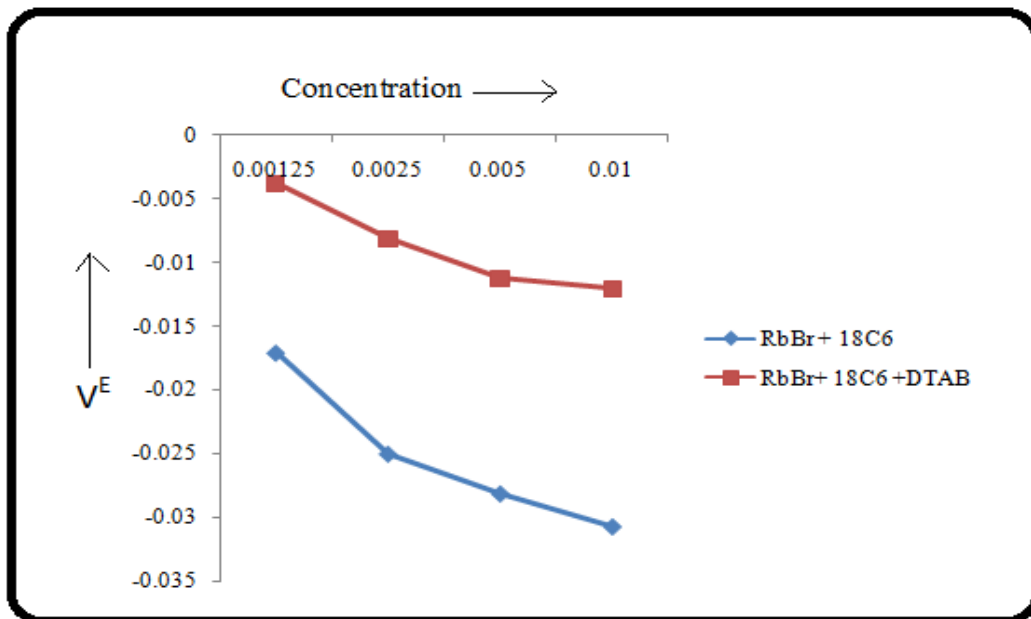
The presence of surfactant plays a vital role in modifying ion–ligand interaction in solvation particularly for 18-crown-6 ether. [17] In this research work, the cationic surfactant 1-decyl trimethyl ammonium bromide (D-TAB) strongly influences the complexation of Rb^+ with 18-crown-6. [15, 16]

The values of V^E and $\Delta\eta$ of ternary system presented in table 2. The values V^E are less negative and $\Delta\eta$ values are positive this indicated that reduced packing efficiency and weak complexation. [18]

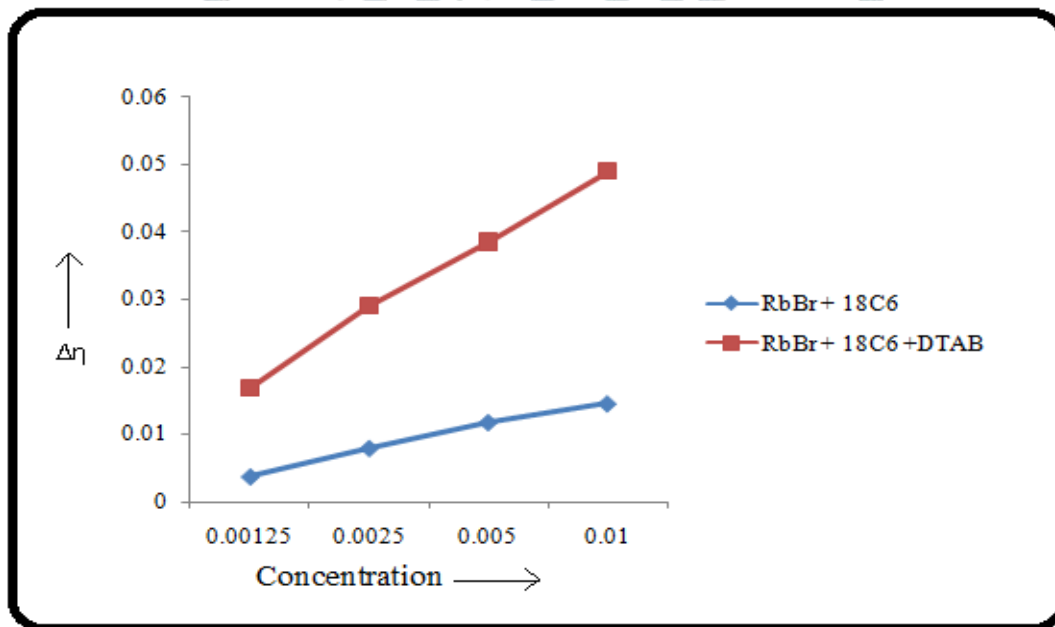
Graphs



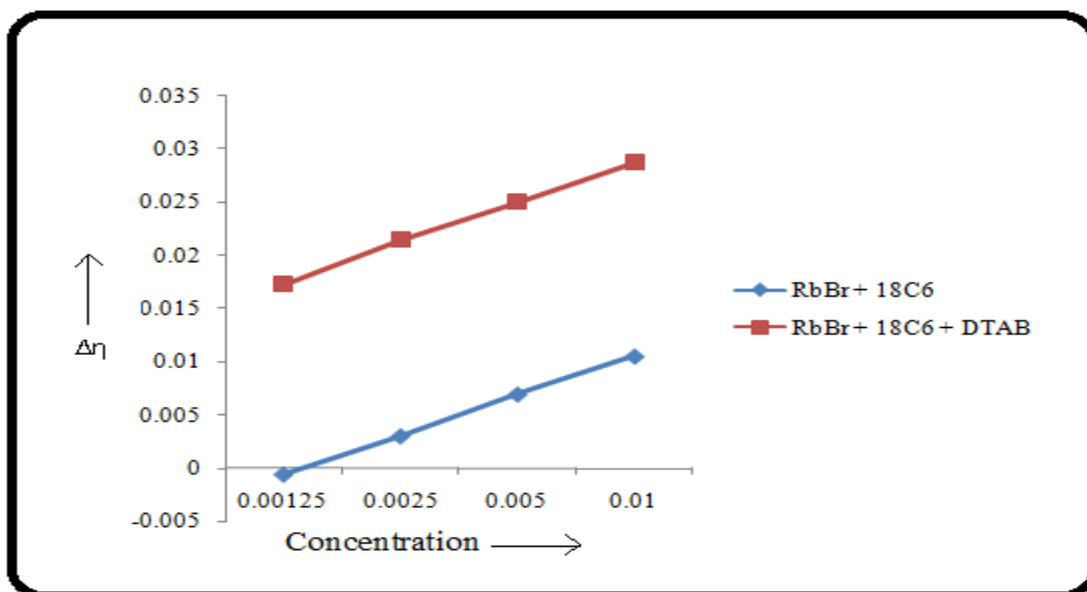
Graph: - 1 Excess molar volume (V^E) of RbBr for Binary and Ternary System at 298.15 K



Graph:-2 Excess molar volume (V^E) of RbBr for Binary and Ternary System at 308.15 K



Graph: - 3 Viscosity Deviation ($\Delta\eta$) of RbBr for Binary and Ternary System at 298.15K



Graph: - 4 Viscosity Deviation ($\Delta\eta$) of RbBr for Binary and Ternary System at 308.15K

Conclusion:-

The present investigation showed that, greater complexation in between 18-crown-6 and Rb^+ cation at lower temperature and in the absence of surfactant.

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