© 2019 IJSRST | Volume 6 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology
DOI : https://doi.org/10.32628/IJSRST196525

Effect of Temperature and Electrolytic Concentration on Density and Viscosity of Ethanol-Water Mixed Solvent Systems

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ABSTRACT

The density and Viscosity of Ethanol-Water mixed solvent systems (5%, 10%, 20% ,40% v/v) has been determined at 298,303,308 and 313 K. The same parameters has been determined for the KCl-Ethanol-Water mixture (2%, 4%, 6%, 8%, 10% w/v)The results obtained from these determinations were discussed. The effect of temperature and KCl electrolyte on density and viscosity of mixed solvent systems and mixture has been studied. The increase in temperature of mixed solvent system results in decrease in density and Viscosity. But with the addition of KCl electrolyte in mixed solvent system results in increase in density and viscosity at constant temperature but the same parameters decrease when temperature increases. The variation of these parameters is due to solute-solvent and solvent-solvent interaction.

Keywords : *Ethanol-Water, KCl Electrolyte, Density, Viscosity*

I. INTRODUCTION

The density and viscosity of solution plays an important role in transportation of minerals and other vital components from one place to other in human and plant body. These are important physicochemical properties which are useful in understanding the nature of solution. Maximum biochemical process in human and plant body takes place in liquid media which has to be present in sufficient amount. Therefore the transport of the liquid from one place to other place depends upon the nature of liquid. The density of liquid is the ratio of mass and volume. As the mass increases the density also increases. This is the reason now a day maximum patients are suffering from cardiac diseases[1] because of deposition of fats in body. The viscosity of liquid is resistance to flow which is due to internal friction of layers and also impurities in liquids. But the temperature of liquid decreases the viscosity of liquid. Anis Ahmed Sheikh et.al has proposed that temperature and viscosity are inversely proportion to each other.[2] The electrolyte in mixed solvent system also plays an important role for deciding the density and viscosity of solvents.[3] With change in electrolytic concentration like KCl and NaCl the density and viscosity also changes. It is due to solute-solvent interaction. Ummul Khair Asema et.al has proposed the effect of sodium chloride electrolyte on density and viscosity of ethanol-water mixed solvent systems and concluded that the increase in viscosity with electrolyte is due to solute-solvent interaction.[4] From our previous investigation of effect of electrolyte on density and viscosity of ethanol water mixed solvent system[5-9] we have now determined the viscosity and density of ethanol-water mixed solvent system and ethanol-water-KCl

mixtures at different temperature and the results are discussed.

II. EXPERIMENTAL

All the chemicals were AR grade of SD-fine and Sigma Aldrich brand. The refluxed ethanol was used. Doubly distilled water used for preparation of mixed solutions and mixtures. The density and viscosity parameters were determined by Pyknometer and Ostwald's Viscometer.

The different sets of ethanol-water mixed solvents (5%, 10%,20%,40%) were prepared by adding 5,10,20 and 40 ml ethanol in 100 ml water (v/v). All the sets were kept in thermostat to attain the uniform temperature. The density of each mixed solvent set was determined by Pyknometer at 298,303,308 and 313 K and results are tabulated (table1).The viscosity of these sets were determined by Ostwald's Viscometer by flow time method using formula and the results are tabulated (table 2).To each set of mixed solvent system 2,4,6,8 and 10 gram KCl was added to make 2%, 4%, 6%8% and 10% mixture and kept in thermostat.(w/v).Then the density and viscosity of each mixture was determined at said temperatures and results obtained are tabulated in table 3 and 4 respectively.

Calculation:

The density of each set of mixed solvent system and mixtures was determined by using the following formula.

$$\boldsymbol{Density}\ (\boldsymbol{\rho}) = \frac{\text{Weight of definite voulme of solvent}}{\text{Weight of same Volume of mixture}}$$

$$\boldsymbol{Viscosity}\ (\eta\,\mathbf{2}) = \frac{\boldsymbol{t\,2}}{\boldsymbol{t\,1}} \cdot \frac{\boldsymbol{\rho 2}}{\boldsymbol{\rho 1}} \cdot \eta\mathbf{1}$$

Where

η_2 = Viscosity of mixed mixture
t_1 = Flow time for mixed solvents
t_2 = Flow time for mixture
ρ_1 = Density of mixed solvents
ρ_2 = Density of mixed mixture
η_1 = Viscosity of mixed solvents

From the above formulae the density and viscosity of all the sets of mixed solvent systems and mixtures were determined.

Table 1. Density of Mixed solvent systems at different Temperatures

Mixed Solvents Systems ($EtOH+H_2O$) ↓	T (K) →	298	303	308	312
5%		0.987	0.977	0.970	0.824
10%		0.998	0.989	0.977	0.959
20%		1.003	0.998	0.987	0.976
40%		1.009	1.001	0.997	0.988

Table 2. Viscosity of Mixed Solvent Systems at different Temperatures

Mixtures (EtOH+H_2O) ↓	T (K) →	298	303	308	312
5%		0.0096	0.0080	0.0034	0.0063
10%		0.0109	0.0103	0.0072	0.0068
20%		0.0140	0.0121	0.0096	0.0080
40%		0.0185	0.0171	0.0138	0.0113

Table 3. Density of Mixtures in different solvent systems at different temperatures

EtOH+ H_2O	EtOH+H_2O+ KCl ↓	T(K) →	298	303	308	312
5%	2%		0.877	0.850	0.847	0.843
	4%		0.887	0.862	0.860	0.850
	6%		0.898	0.871	0.866	0.857
	8%		0.905	0.884	0.873	0.863
	10%		0.910	0.892	0.888	0.872
10%	2%		0.809	0.804	0.801	0.791
	4%		0.818	0.810	0.807	0.803
	6%		0.825	0.819	0.813	0.809
	8%		0.866	0.875	0.822	0.811
	10%		0.893	0.877	0.841	0.824
20%	2%		0.842	0.816	0.810	0.806
	4%		0.853	0.819	0.813	0.810
	6%		0.830	0.820	0.815	0.812
	8%		0.869	0.822	0.820	0.814
	10%		0.872	0.826	0.823	0.817
40%	2%		0.820	0.815	0.812	0.810
	4%		0.843	0.820	0.819	0.815
	6%		0.855	0.829	0.26	0.823
	8%		0.873	0.841	0.832	0.831
	10%		0.878	0.857	0.848	0.843

Table 4. Viscosity (in poise) of Mixtures in different solvent systems at different temperatures

EtOH+ H_2O	EtOH+H_2O+ KCl ↓	T(K) →	298	303	308	312
5%	2%		0.0073	0.0072	0.0071	0.0067
	4%		0.0082	0.0081	0.0074	0.0071
	6%		0.0085	0.0084	0.0083	0.0077
	8%		0.0087	0.0085	0.0084	0.0079
	10%		0.0090	0.0089	0.0087	0.0083
10%	2%		0.0082	0.0080	0.0078	0.0074
	4%		0.0083	0.0082	0.0080	0.0077
	6%		0.0094	0.0093	0.0090	0.0079
	8%		0.0096	0.0095	0.0099	0.0083
	10%		0.0099	0.0097	0.0102	0.0094
20%	2%		0.0080	0.0098	0.0088	0.0074
	4%		0.0106	0.0104	0.0097	0.0095
	6%		0.0109	0.0108	0.0105	0.0103
	8%		0.0111	0.0109	0.0107	0.0105
	10%		0.0115	0.0110	0.0109	0.0106
40%	2%		0.0147	0.0138	0.0134	0.0128
	4%		0.0149	0.0141	0.0137	0.0135
	6%		0.1053	0.0144	0.0140	0.0139
	8%		0.0157	0.0151	0.0143	0.0141
	10%		0.0159	0.0157	0.0147	0.0145

III.CONCLUSION

From our investigation it is revealed that the density of mixed solvent system (5% to 40%) and mixtures (2% to 10%) for all sets decreases as the temperature increases. But the same parameter increases at constant temperature (Table No 1 & 3). Similarly the viscosity of mixed solvent system (5% to 40%) and mixtures (2% to 10%) for all sets also decreases as the temperature increases.(table No. 2 & 4).This variation is due to solvent-solvent and solute-solute interaction. From this investigation we are going to study the effect of electrolytic concentration on density and viscosity for other solutes and solvents.

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Cite this article as :

Anis Ahmed Sheikh, Syed U.K. Asema, Mohamad Asif, Shaukat Patel, "Effect of Temperature and Electrolytic Concentration on Density and Viscosity of Ethanol-Water Mixed Solvent Systems", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 6 Issue 6, pp. 01-05, November-December 2019. Available at doi : https://doi.org/10.32628/IJSRST196525 Journal URL : http://ijsrst.com/IJSRST196525