

The measurement of molar refraction and polarizability constants of some substituted sulphonic acids at 303 K

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ABSTRACT

The refractive indices of liquid mixtures were measured with the help of Abbe's refractometer, specially designed to measure the refractive indices of the small quantities of the transparent liquids and solutions by direct reading. In present work molar refraction and polarizability constant of o-amino-benzene sulphonic acid, 6, 7-dihydroxy naphthalene-2-sulphonic acid, 4-amino-3-naphthol-sulphonic acid at different concentrations and in the different percentage of dioxane-water mixtures were determined. Also the molar refraction and polarizability constants of 6, 7-dihydroxy naphthalene-2-sulphonic acid were measured in different solvents. The results are used to make the conclusion about molecular interactions.

Key words: Molar refraction, polarizability constants, sulphonic acid.

INTRODUCTION

Refractive index is one of the important properties of liquid that can be measured easily with a high degree of accuracy. The properties of liquid such as viscosity, refractive index and ultrasonic velocity of binary mixtures are studied by many workers¹⁻³. Oswal et al⁴ have studied dielectric constants and refractive indices of binary mixtures. Burghate⁵, Agrawal⁶, have done study of refractive indices in mixed solvents.

Present work deals with the study of molar refraction and polarizability constant of some ligands at different concentrations and in the different percentage of acetone-water and ethanol-water mixtures. In the present investigation, refractive indices of liquid mixtures were measured with the help of Abbe's refractometer.

EXPERIMENTAL

The solutions of different concentration of ligand (0.01, 0.008, 0.006, 0.004, and 0.002M) in 70% dioxane-water were prepared. Also dioxane-water mixtures of varying compositions as well as solutions of ligand in different percentages of dioxane-water mixtures were prepared by weight within accuracy of ± 0.001 g. All weighing were made on Mechaniki Zaktady Precyzyjng Gdansk balance, made in Poland (± 0.001 g). The densities of solutions were determined by a bicapillary pycnometer ($\pm 0.2\%$) having a bulb volume of about 10 cm^3 and capillary having and internal diameter of 1mm. The refractive indices of solvent mixtures and solutions were measured by Abbe's refractometer at $30 \pm 0.1^\circ\text{C}$. The accuracy of Abbe's refractometer was within $\pm 0.001^\circ\text{C}$ unit. The temperature of the prism box was maintained at 30°C . Initially, the

refractometer was calibrated with the glass piece ($n = 1.5220$) provided with the instrument.

Mathematical

The molar refraction of solvent, dioxane-water mixtures were determined from-

$$R_{D-W} = X_1R_1 + X_2R_2$$

Where, R_1 and R_2 are molar refraction of dioxane and water respectively. The molar refraction represents actual volume of the substance molecules in one mole. The molar refraction of solutions of ligand in dioxane-water mixtures was determined from-

$$R_{Mz} = [(\eta^2 - 1)/(\eta^2 + 2)][(X_1M_1 + X_2M_2 + X_3M_3)/d]$$

Where, η is refractive index of solution, X_1 is mole fraction of dioxane, X_2 is mole fraction of

water, X_3 is mole fraction of solute, and M_1 , M_2 and M_3 are the molecular weights of dioxane, water and solute respectively. 'd' is the density of solution. The molar refraction of ligand was calculated by $R_{Lz} = R_{Mz} - R_{D-W}$ And the polarizability constant (α) of the ligand was calculated by using the relation $R_{Lz} = \frac{4}{3}\pi \cdot N_0 \cdot \alpha$. Where, N_0 is Avogadro's constant

RESULT AND DISCUSSION

The values of molar refraction and polarizability constants of some ligand systems at different concentrations are presented in Table 1.

It is observed that molar refractivity and polarizability constants increase with increasing the concentration of ligands. The values of molar refraction and polarizability constants of ligands in different percentage of dioxane-water mixtures are presented in Table 2.

**Table 1: Molar refraction and polarizability constants
Of sulphonic acids at different concentration**

Conc. (M)	6,7-DHN-SA		4A-3N-SA		O-ABSA	
	[R] cm ³ mole ⁻¹	$\alpha \cdot 10^{-23}$ cm ³	[R] cm ³ mole ⁻¹	$\alpha \cdot 10^{-23}$ cm ³	[R] cm ³ mole ⁻¹	$\alpha \cdot 10^{-23}$ cm ³
0.01	10.4523	0.7369	8.0254	0.5658	6.1254	0.4318
0.008	10.0254	0.7068	7.89654	0.5567	5.7542	0.4057
0.006	9.6521	0.6805	7.46521	0.5263	5.2685	0.3714
0.004	8.2154	0.5792	6.5241	0.4600	4.8695	0.3433
0.002	7.8754	0.5552	6.2695	0.4420	4.4785	0.3157

**Table 2: Molar refraction and polarizability constants
Of sulphonic acids in different percentage of dioxane**

Conc. (M)	6,7-DHN-SA		4A-3N-SA		O-ABSA	
	[R] cm ³ mole ⁻¹	$\alpha \cdot 10^{-23}$ cm ³	[R] cm ³ mole ⁻¹	$\alpha \cdot 10^{-23}$ cm ³	[R] cm ³ mole ⁻¹	$\alpha \cdot 10^{-23}$ cm ³
40	5.6154	0.3959	3.5984	0.2537	3.0521	0.2152
45	6.2365	0.4397	4.0569	0.2860	3.6582	0.2579
50	6.9754	0.4918	4.7251	0.3331	4.1352	0.2915
55	7.8695	0.5548	5.3584	0.3778	4.5698	0.3222
60	8.6521	0.6100	6.3214	0.4457	4.9752	0.3508
65	9.5362	0.6723	7.2154	0.5087	5.3652	0.3783
70	10.2541	0.7229	7.9856	0.5630	5.9185	0.4173

Agarwal *et al.*,⁷ have done studies on molar refraction and polarizability constants at 30°C and observed the same results. It shows that with increase in percentage of dioxane, the molar refraction (true molar volume) as well as the polarizability constant of ligand increase. This may be attributed to the fact that the dipole in ligand lies perpendicular to the longer axis of the molecules and with increase in the percentage of dioxane causing decrease in dielectric constant of medium, considerable dipole association (intermolecular attraction) takes place which would be accompanied by increase in polarizability as well as molar refraction because of the mutual compensation of the dipoles.

The values of molar refraction and polarizability constants of ligands in different percentage of acetone-water and dioxane-water mixtures are presented in Table 3.

With increase in percentage of acetone the molar refraction as well as the polarizability constant of ligand decreases.

Table 3: Molar refraction and polarizability constants of 6, 7-dhn-sa in different solvents

% Solvent	Acetone-Water		Dioxane- Water	
	[R] cm ³ mole ⁻¹	α 10 ⁻²³ cm ³	[R] cm ³ mole ⁻¹	α 10 ⁻²³ cm ³
40	8.4691	0.5971	5.6154	0.3959
45	7.5365	0.5313	6.2365	0.4397
50	6.7154	0.4734	6.9754	0.4918
55	6.0315	0.4252	7.8695	0.5548
60	5.3584	0.3778	8.6521	0.6100
65	4.6521	0.3280	9.5362	0.6723
70	3.6542	0.2576	10.2541	0.7229

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