

A Comparative Study of Effect of Solvents on Relative Viscosities of Some Substituted Benzo-1,2,5-Thiadiazines

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The viscosities and densities of benzo-(3,4-c)-6-phenylimino-1,2,5-thiadiazine (I), benzo(3,4-c)-6-*o*-tolylimino-1,2,5-thiadiazine (II), benzo-(3,4-c)-6-*m*-tolylimino-1,2,5-thiadiazine (III), benzo-(3,4-c)-6-*p*-tolylimino-1,2,5-thiadiazine (IV), benzo-(3,4-c)-6-*o*-chlorophenylimino-1,2,5-thiadiazine (V), benzo-(3,4-c)-6-*p*-chlorophenylimino-1,2,5-thiadiazine (VI) and benzo-(3,4-c)-6-*t*-butylimino-1,2,5-thiadiazine (VII) in different percentages of acetone-water, ethanol-water and dioxane-water mixtures have been measured. From the data the relative viscosities have been calculated which are used to measure the molecular interactions in the solutions and to compare the viscosity behaviour of substituted benzo-1,2,5-thiadiazines on the basis of presence of different substituents.

Key Words: Viscosity, Substituted Benzo-1,2,5-thiadiazines.

INTRODUCTION

Viscosity is one of the important properties of liquids. It implies resistance to flow. Viscosity measurement, like other transport properties of electrolytes, provides useful information about solute-solute and solute-solvent interactions in non-aqueous and aqueous solutions¹⁻³. Molecular interactions of binary mixtures are also studied by many workers⁴⁻⁷. Many attempts have been made to study viscosities of binary liquid mixtures, but no satisfactory result seems to have been obtained⁸. The present work deals with a comparative study of molecular interactions of substituted benzo-1,2,5-thiadiazines (I–VII) in different percentages of acetone-water, ethanol-water and dioxane-water mixtures at $(29 \pm 0.1^\circ\text{C})$ and also with a comparison of their viscosities on the basis of presence of different substituents.

EXPERIMENTAL

Benzo-(3,4-c)-6-phenylimino-1,2,5-thiadiazine (I), benzo-(3,4-c)-6-*o*-tolylimino-1,2,5-thiadiazine (II), benzo-(3,4-c)-6-*m*-tolylimino-1,2,5-thiadiazine (III), benzo-(3,4-c)-6-*p*-tolylimino-1,2,5-thiadiazine (IV), benzo-(3,4-c)-6-*o*-chlorophenylimino-1,2,5-thiadiazine (V), benzo-(3,4-c)-6-*p*-chlorophenylimino-1,2,5-thiadiazine (VI) and benzo-(3,4-c)-6-*t*-butylimino-1,2,5-thiadiazine (VII) were prepared by the basification of some substituted benzo-(3,4-c)-6-aryl/alkylimino-1,2,5-thiadiazine dihydriodides, which were prepared initially by the oxidative cyclization of substituted 1,3-diaryl/aryl-alkyl thiocarbamides by ethanolic iodine. Their structures were established on the basis of elemental

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analysis, equivalent weight determination, IR and PMR spectral data. The solvents used were of AR grade and doubly distilled water was used. Weighing was made on Shimadzu Japan BL-2204 balance (± 0.0001 g). The densities of ligand solutions and solvents were determined by a bicapillary pycnometer ($\pm 0.2\%$). The viscosities were measured by means of Ostwald's viscometer ($\pm 0.11\% \text{ kg m}^{-1} \text{ s}^{-1}$) which was kept in equilibrium with Elite thermostatic water bath ($\pm 0.1^\circ\text{C}$). Solutions were prepared in different percentages (70, 80, 90 and 100%) of acetone-water, ethanol-water and dioxane-water mixtures. For each measurement sufficient time was allowed to maintain the constant temperature by attaining thermal equilibrium in thermostat.

RESULTS AND DISCUSSION

The relative viscosity of each of the ligand solutions is determined by using the empirical formula

$$\eta_r = d_s \times t_s / d_b \times t_b$$

where η_r is relative viscosity of ligand solution; d_s is density of ligand solution and d_b is density of respective solvent; t_s is time of flow for ligand solution and t_b is time of flow for respective solvent.

The relative viscosities for ternary mixtures in different percentages of solvents are tabulated in Tables 1 to 3. It can be seen that the relative viscosity increases with decrease in the percentage of acetone, ethanol and dioxane, which may be due to increase in molecular interactions. Also change in the structure of solvent or solution as a result of hydrogen bond formation or disruption leads to decrease or increase in interactions. Solutes can occupy interstitial spaces in the solvent. The increase in viscosity arises from the fact that solute particles lie across the fluid stream lines and are subjected to torsional force^{9,10}. Relative viscosities follow the order:

Acetone-Water > Ethanol-Water > Dioxane-Water.

This may be due to the effect of greater polarity of acetone as compared to the less polar ethanol and non-polar dioxane solvent.

TABLE-1
VISCOSITY DATA FOR SUBSTITUTED BENZO-1,2,5-THIA DIAZINES (I-VII)
ACETONE-WATER MIXTURES

Percentage of acetone	Compounds/Relative viscosity (η_r) at ($29 \pm 0.1^\circ\text{C}$)						
	I	II	III	IV	V	VI	VII
70	1.0471	1.0181	1.0133	0.9872	1.0696	1.0551	0.8229
80	1.0192	0.9637	0.9985	0.9759	1.0363	1.0342	0.7994
90	0.9706	0.9232	0.9360	0.8956	0.9994	0.9536	0.7643
100	0.9222	0.8958	0.9062	0.8749	0.9741	0.9568	0.6978

TABLE-2
 VISCOSITY DATA FOR SUBSTITUTED BENZO-1,2,5-THIADIAZINES (I-VII)
 ETHANOL-WATER MIXTURES

Percentage of ethanol	Compounds/Relative viscosity (η_r) at (29 \pm 0.1°C)						
	I	II	III	IV	V	VI	VII
70	1.0005	0.9512	0.9766	0.9592	1.0322	1.0205	0.7904
80	0.9837	0.9252	0.9585	0.9256	1.0036	0.9935	0.6519
90	0.9407	0.9082	0.9664	0.8953	0.9716	0.9559	0.5360
100	0.9050	0.8688	0.8940	0.8758	0.9137	0.91391	0.4533

TABLE -3
 VISCOSITY DATA FOR SUBSTITUTED BENZO-1,2,5-THIADIAZINES (I-VII)
 DIOXANE-WATER MIXTURES

Percentage of dioxane	Compounds/Relative viscosity (η_r) at (29 \pm 0.1°C)						
	I	II	III	IV	V	VI	VII
70	0.9083	0.8751	0.8800	0.8706	0.9432	0.9317	0.7488
80	0.8641	0.8365	0.8415	0.8314	0.9034	0.8984	0.7030
90	0.8291	0.7969	0.8075	0.7953	0.8350	0.8050	0.6233
100	0.7774	0.7411	0.7518	0.7377	0.7936	0.7866	0.6203

It can also be seen from Tables 1 to 3 that the order of relative viscosities in compounds is: **V > VI > I > III > II > IV > VII**. The increase in viscosity of compounds **V** and **VI** may be due to the presence of more number of free ions across the fluid stream which is because of the interaction between the electron withdrawing substituent —Cl and solvent resulting in ionic dissociation, while that of decrease in viscosity of compounds **II**, **III**, **IV** and **VII** is due to the presence of electron donating substituents like —CH₃ and —C(CH₃)₃, where no such interaction is there but to a lesser extent ion-dipole bonding may occurs resulting in ionic association and decrease in number of free ions across the fluid stream. Free ions present across fluid stream always tend to rotate and absorb the energy, resulting in increase in the relative viscosity.

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