

## Comparative Study of Viscosity Behaviour of Novel 1-Furyl-3-(substituted phenyl)-2-propene-1-one in Different Percentages of Solvents

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The viscosities and densities of 1-furyl-3-(substituted phenyl)-2-propene-1-one (I–VI) in different percentages of dioxane-water, ethanol-water and acetone-water mixtures have been measured. The data have been used to calculate the relative viscosities and to measure molecular interactions in the solutions to compare the viscosity behaviour of 1-furyl-3-(substituted phenyl)-2-propene-1-one (I–VI) depending upon the presence of different substituents.

**Key Words:** Viscosity, 1-furyl-3-(substituted phenyl)-2-propene-1-one, Mixed solvents.

### INTRODUCTION

Viscosity is one of the important physical properties of liquids. Like other transport properties of electrolytes, viscosity measurement provides a useful information about solute-solute as well as solute-solvent interactions in aqueous and non-aqueous solutions<sup>1–5</sup>. Molecular interactions of binary mixtures have been the subject of interest for many workers<sup>6–9</sup>. Number of attempts have been made to study viscosities of binary liquid mixtures, but no satisfactory results seem to have been obtained<sup>10</sup>. In the present communication, the study of molecular interactions of 1-furyl-3-(substituted phenyl)-2-propene-1-one (I–VI) in different percentages of dioxane-water, ethanol-water and acetone-water mixtures at (30 ± 0.1°C) and their viscosity behaviour depending upon the presence of different substituents have been reported.

### EXPERIMENTAL

1-Furyl-3-(4-dimethylaminophenyl)-2-propene-1-one (I), 1-furyl-3-(phenyl)-2-propene-1-one (II), 1-furyl-3-(2-nitrophenyl)-2-propene-1-one (III), 1-furyl-3-(4-methoxyphenyl)-2-propene-1-one (IV), 1-furyl-3-(3-hydroxyphenyl)-2-propene-1-one (V) and 1-furyl-3-(2-furyl)-2-propene-1-one (VI) were prepared in the laboratory<sup>11</sup> and confirmed by elemental analysis, IR and PMR spectral data. The densities of ligand solutions and solvents were determined by

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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 ( $\pm 0.1^\circ\text{C}$ ). The solvents used were of AR grade and doubly distilled water was used. Weighing was made on Shimadzu Japan BL-2204 balance ( $\pm 0.001 \text{ g}$ ). Solutions were prepared in different percentages (85, 90, 95 and 100%) of dioxane-water, ethanol-water and acetone-water mixtures. For each measurement sufficient time was allowed to maintain constant temperature by attaining thermal equilibrium in a thermostat.

## RESULTS AND DISCUSSION

The relative viscosities of ligands 1-furyl-3-(substituted phenyl)-2-propene-1-one (I–VI) in different percentages of dioxane-water, ethanol-water and acetone-water mixture are determined by using the empirical formula

$$\eta_r = \frac{d_s \times t_s}{d_b \times t_b}$$

where  $\eta_r$  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 flow for ligand solution and  $t_b$  is time flow for respective solvent.

The data of relative viscosity for ternary mixtures in different percentages of solvents are presented in Tables 1 to 3. It can be seen that relative viscosity increases with decrease in the percentage of dioxane, ethanol and acetone, which may be due to the increase in molecular interactions. Also as a result of hydrogen bond formation or disruption, there is change in the structure of solvent or solution leading 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<sup>12, 13</sup>. Relative viscosities follows the order



which 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  
RELATIVE VISCOSITY DATA FOR 1-FURYL-3-(SUBSTITUTED PHENYL)-  
2-PROPENE-1-ONE (I–VI) DIOXANE-WATER MIXTURES

Percentage of dioxane	Compounds (I–VI)/Relative viscosity ( $\eta_r$ ) (at $30 \pm 0.1^\circ\text{C}$ )					
	I	II	III	IV	V	VI
100	0.8222	0.8568	0.8640	0.8115	0.8478	0.8081
95	0.8779	0.8754	0.9053	0.8672	0.8995	0.8657
90	0.9118	0.9688	0.9737	0.9068	0.9343	0.9018
85	0.9503	1.0018	1.0137	0.9455	0.9788	0.9410

TABLE-2  
RELATIVE VISCOSITY DATA FOR 1-FURYL-3-(SUBSTITUTED PHENYL)-2-PROPENE-1-ONE (I-VI) ETHANOL-WATER MIXTURES

Percentage of ethanol	Compounds (I-VI)/Relative viscosity ( $\eta_r$ ) at ( $30 \pm 0.1$ °C)					
	I	II	III	IV	V	VI
100	1.0230	1.0425	1.0423	0.9976	1.0340	1.0425
95	1.0955	1.0846	1.1004	1.0370	1.0694	1.0846
90	1.0873	1.1226	1.1324	1.0544	1.1125	1.1226
85	1.1051	1.1495	1.1611	1.0800	1.1293	1.1495

TABLE-3  
RELATIVE VISCOSITY DATA FOR 1-FURYL-3-(SUBSTITUTED PHENYL)-2-PROPENE-1-ONE (I-VI) ACETONE-WATER MIXTURES

Percentage of acetone	Compounds (I-VI)/Relative viscosity ( $\eta_r$ ) at ( $30 \pm 0.1$ °C)					
	I	II	III	IV	V	VI
100	1.0619	1.0997	1.1154	1.0472	1.0687	1.0328
95	1.1029	1.1452	1.1576	1.0581	1.1244	1.0839
90	1.1188	1.1855	1.1944	1.1175	1.1451	1.1117
85	1.1809	1.2246	1.2321	1.1719	1.1992	1.1707

From Table 1 to 3, it can also be seen that the order of relative viscosities in compounds is  $\text{III} > \text{II} > \text{V} > \text{I} > \text{IV} > \text{VI}$ . The increase in relative viscosity of compound III as compare to II may be due to the presence of electron withdrawing substituent  $-\text{NO}_2$  on phenyl ring, which undergoes dipole-dipole interaction with solvent resulting in ionic dissociation and increases the number of free ions across the fluid stream. The decrease in relative viscosity of compounds I, IV and V as compared to II may be due to the presence of electron donating substituents  $-\text{N}(\text{CH}_3)_2$ ,  $-\text{OCH}_3$  and  $-\text{OH}$  respectively. In compounds I and IV no dipole-dipole interaction is there between the substituents and solvent due to steric hindrance but to a lesser extent ion-dipole bonding may occur because of electron donating effect of  $-\text{CH}_3$  groups, causing ionic association. In compound V there is strong dipole-dipole interaction between electron donating substituent  $-\text{OH}$  and solvent, which again results in ionic association and decreases number of free ions across the fluid stream. Free ions present across the fluid stream always tend to rotate and absorb the energy, resulting in increase in the relative viscosity.

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