

TEMPERATURE DEPENDENCE OF DIELECTRIC RELAXATION OF SOLVENT MIXTURES

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Microwave heated process design and implementation requires quantitative data on chemicals dielectric properties or at least methods for their prediction. There have been several investigations on the dielectric behaviors of solvent mixtures [1-3] in which dielectric relaxation spectra were used to examine molecular orientations, hydrogen bonded networks and microdynamics of these systems.

In this paper, we report the temperature dependent dielectric relaxation of nitrotoluene and p-xylene mixtures at microwave frequency (2450 MHz). The dielectric relaxation spectra of those solutions have been measured in the temperature range $20^{\circ}\text{C} \leq T \leq 80^{\circ}\text{C}$ and in the concentration range $0 \leq x \leq 1$, x being the mole fraction of p-xylene and T the temperature. In a recent paper [4], we present a brief survey of our measuring equipment. Complex permittivity spectra and resulting relaxation parameters were carried out by the method of small perturbations in resonant cavity.

The relaxation times, τ , depend on the nature of the functional groups and the volume of the molecule. Functional groups capable of hydrogen bonding have a particularly strong influence on the relaxation times. For these reasons, studies on the relaxation properties of mixtures of solvents have provided some interesting insights into the volumes implicated by the Debye expression and the nature of the mixing process. If the solvents are chemically similar and mix well at the molecular level then the mixture will often exhibit a single relaxation time at an average position which reflects the molar ratios of the two components. However, if the solvents do not mix well at the molecular level, then two distinct relaxation times are observed and they do not differ greatly from those of the pure solvents. This suggests that the molecules do not experience average environments, but form aggregates which are micro assemblies of like molecules. Therefore, the relaxation times resemble those of the pure solvents and the relaxation volumes are significantly larger than the molecular volumes, indicating that the relaxation processes are occurring within an aggregate of molecules.

So it may be appreciated that the relaxation times of molecules have a large influence on the dielectric parameters which influence the rate of heating in a microwave cavity. The relaxation times may involve the whole molecule or a functional group anchored to a large molecule and they depend on the intermolecular forces between the molecules and the size of the molecule. It is hoped the ready access to the data presented in this review will lead to the design of microwave heating experiments which are based more soundly on the relevant dielectric parameters.

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