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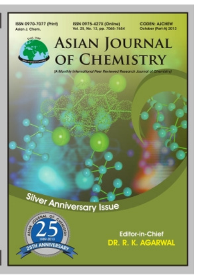

NOTE

Effective Permittivity of Alcohol + Alcohol Mixtures as Influenced by Concentration

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Dielectric properties of alcohol-alcohol (methanol + *n*-propanol and methanol + ethanol) mixtures were measured at the selected microwave frequency (5.65 GHz) by a sensitive sensor method using a network analyzer. The effects of concentration in terms of molar fractions on dielectric properties were investigated.

Key Words: Methanol, Ethanol, *n*-Propanol, Permittivity.

The solvent mixtures of water and alcohol have special importance because of their unique physical and chemical[1] properties. With respect to the chemical properties, the formation of water-alcohol mixtures varies with the magnitude of the concentration of methanol for methanol + *n*-propanol and methanol + ethanol mixtures[2]. Such as density, viscosity, refractive index[3-5] permittivity and surface tension show positive deviations from ideality. The solvation of alcohol (such as methanol, ethanol and *n*-propanol) and other organics in several one component solvents has been a subject of detailed investigations, both theoretically and through simulations, for a considerably long time. Molecular dynamical simulation studies on methanol in the presence of model[6-9] polar solvents, water, NaCl and ethanol have been reported.

To our best of knowledge, dielectric study for this purpose commonly used organic solvents (methanol, ethanol, *etc.*) has less been reported in mixed solvents such as water-methanol[10]. The objectives of the present work were to study the dielectric properties of methanol in mixtures of ethanol and *n*-propanol as a function of concentration. The information on dielectric properties of alcohol mixtures would be helpful to process industries to develop alcohol mixtures based polar solvents by using microwave technology.

Methanol, ethanol and *n*-propanol were purchased from the Chengdu Kelong Chemical Factory. A vector network analyzer Agilent 3734 A, with a sensitive sensor was employed to measure S-parameters of methanol + ethanol and methanol + *n*-propanol mixtures. The two sets of mixtures are provided with different concentrations in terms of molar fractions (x_m). x_m is methanol mol fraction of mixtures, where, x_m = 0.0, 0.1, 0.5, 0.7, 0.9,1.

The sensitive sensor is composed by two ways: one is the material of test branch while the other is reference (reference) branch. The material of test and reference material is placed on the two branches respectively. During testing, the sensor is connected to the Agilent 3734 A network analyzer through standard SMA connectors. A full two-port calibration procedure is conducted before measurements. Then, the reference and material under test will be placed on the two branches of the sensor. In this work, the reference is always deionize water and the material under test is methanol + ethanol and methanol + *n*-propanol mixtures with different concentrations in terms of molar fractions (x_m). The S-parameters are measured for these samples. Finally, complex permittivity of material of test is reconstructed by using a back propagation neural network procedure matching the measured S-parameters.

The experiment effective permittivity data are listed in Tables 1 and 2. It has been observed that dielectric constant e' increases with concentration of methanol of mixtures and it is probably due to a decrease in relaxation time of solvent molecules. From Tables 1 and 2, we also know the information about the dielectric loss of mixtures. That is, the bigger that the concentration of methanol, the larger that the dielectric loss of the two sets of mixtures. This means that two different alcohol molecules behave as the same molecule and the same chainlike cluster is formed in the mixture as that of pure alcohol. Therefore, dielectric relaxation of alcohol-alcohol mixtures is of the Debye type. The mixture permittivity variation with convention of methanol is shown in Figs. 1 and 2.

Conclusion

Dielectric properties of alcohol-alcohol mixtures dispersions were studied as function of concentration in the microwave frequency (5.65 GHz). Results indicated that dielectric parameters were influenced by concentration. Both dielectric constant and loss factor was increased with concentration of methanol of mixtures. This study provides new information related to concentration dependence of alcohol-alcohol mixtures dispersions dielectric properties that may be useful in product development applications. Alcohol + alcohol mixtures also include ethanol + *n*-propanol, methanol + iso-propanol, *etc.* However, the effect permittivity of these mixtures is still not elucidated and deserves further investigations.

TABLE-1
REAL AND IMAGINARY PARTS OF THE EFFECTIVE PERMITTIVITY (DIELECTRIC CONSTANT) FOR METHANOL + *n*-PROPANOL MIXTURES (at 5. 65 GHz) WITH DIFFERENT CONCENTRATION

x_m	ε'	ε''
0.0	3.165	1.698
0.1	3.238	1.998
0.5	4.926	4.859
0.7	6.252	6.039
0.9	7.826	8.623
1	11.226	10.941

TABLE-2
REAL AND IMAGINARY PARTS OF THE EFFECTIVE PERMITTIVITY (DIELECTRIC CONSTANT) FOR METHANOL +ETHANOL MIXTURES (AT 5.65 GHz) WITH DIFFERENT CONCENTRATION

x_m	ε'	ε''
0.0	3.986	3.026
0.1	5.026	4.389
0.5	5.748	6.241
0.7	7.321	7.956
0.9	10.120	10.428
1	11.226	10.941

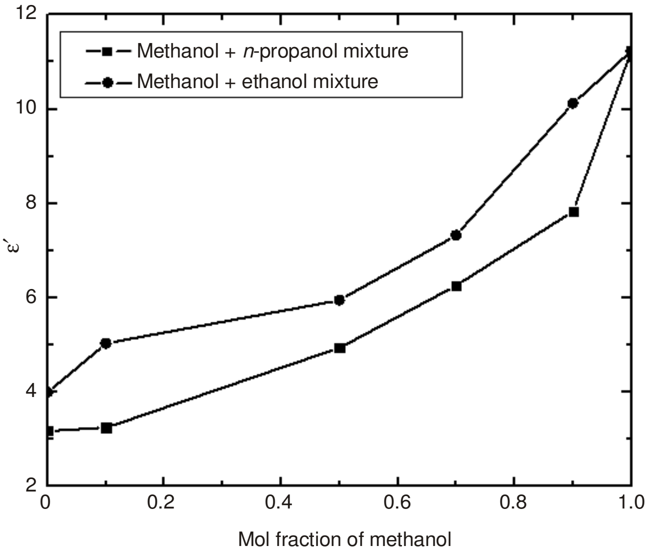

Fig. 1. Real parts of the effective permittivity of alcohol-alcohol mixtures at 5.65 GHz

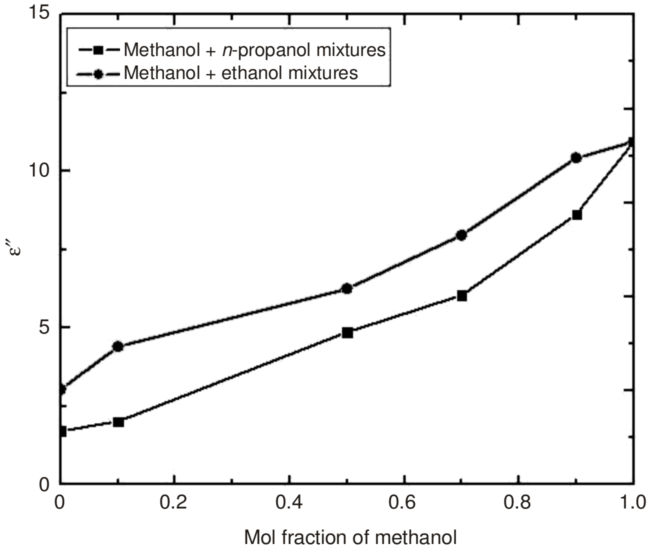

Fig. 2. Imaginary parts of the effective permittivity of alcohol-alcohol mixtures at 5.65 GH

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