Dielectric Constant Measurement In Binary Liquid Mixture (DEA + Butanol) And Hybrid CuO Nanofluid (Cuo + DEA+ Butanol) At Various Temperatures

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Abstract

This present work elucidates the intermolecular interaction and intramolecular interaction of binary base fluids and hybrid CuO nano fluids. Dielectric constant has been computed experimentally for various values of concentrations ranging from 0.01M to 0.06M and for different temperatures from 298K to 318K. The aim of the study to provide the knowledge of interaction of the molecules in hybrid CuO nanofluid compared to its binary base fluid. DEA and alcohol are selected as a solvent because of the special N-H bonding in Diethlyamine and the presence of Hydroxyl group –OH- in butanol plays the vital role in the complex formation in the system. The results of this study clearly discuss about the dipole-dipole interaction as well as the enhancement of dielectric constant during the addition of CuO nanoparticles.

Key words: Dipole-dipole interaction, Hybrid CuO nanofluid, dielectric constant, Diethyl amine.

1. Introduction:

There are two different era of studies has been carried out in this paper, one is dielectric study of binary fluids (Butanol + Diethyl amine) and another one is dielectric study of hybrid Cuo nanofluid (CuO + Diethyl amine + butanol) . Alcohols have wide range of applications in medical fields [1]. A very few workers proposed the dielectric studies on binary fluids that with amines and the results are not clearly explaining the complex formation. With this view, the present study clearly explains the Dielectric studies of binary fluid and hybrid CuO nanofluid. Dielectric constant is a important parameter and it is related to many physical and biological applications[2-3]. It is important for understanding the inter molecular interactions due to their dipole-dipole interaction and also the presence -OH- hydroxyl group and N-H bonding in the diethylamine. Nanomaterial taken for this study is CuO and it has many applications in the field of electronics, magnetic storage media, sensors, catalysis [4-13], and also in solar cells, electro chemical cells, gas sensors [14-16].

2. Experimental details

Pure samples diethyl amine and butanol are procured from Merck Company, AR grade and were used without further purification. CuO Nanoparticle is also commericially purchased with 99.9% purity. The measured binary fluids were kept in the magnetic stirrer for 5 mintues to get uniform suspension. The value of dielectric constant of binary fluid (DEA + Butanol) was measured for the different concentrations ranging from 0.01M to 0.06M and for various temperatures from 298K to 318K. In the same solution CuO nanoparticle was also added from 0.1gm to 0.6gm. After adding the CuO nanoparticle in to the binary fluid it was kept in the ultra probe sonicator for 30minutes. The suspension of the prepared hybrid CuO nanofluid was maintained for more than 12 hours without adding any surfactant. Dielectric measurement process of Hybrid CuO nanofluid(CuO + DEA + Butanol) was also performed like a binary fluid. The dielectric constant (ε) of binary fluid and hyrid CuO nanofluid were calculated by using the following formula.

$$\varepsilon_x = 1 + (C_O - C_X / C_O - C_R)\,[\varepsilon_R - 1]$$

Where,

ε_R - Dielectric constant of reference fluid

ε_x - Dielectric constant of unknown fluid.

C_X - Capacitance of unknown fluid.

C_R - Capacitance of reference fluid.

C_O - Capacitance of air.

Where ε_r is the dielectric constant of the reference liquid ($\varepsilon_{benzene}$= 2.26).

3. Result and discussion

Butanol is the protic solvent and it has the high dielectric constant. When concentration increases from 0.01M to 0.06M the dielectric constant of the binary fluid (Butanol + DEA) is also increases but it decreases with increase in temperature. The linearity occurred in the measurement may be attributed due to the dipole-dipole association arising from the –NH- bond in the DEA and the positive charge on hydrogen of the alcohol molecule [17].

Alcohol based fluids shows the high dielectric constant value while adding the CuO nanoparticle. This is because the presence of –OH- group in the alcohol molecule interacts with the –O- of the CuO nanoparticle. There is the appreciable amount of increment in the dielectric constant after adding the CuO nanoparticle to the binary fluid. The particle-fluid interaction is more dominant compared to the fluid-fluid interaction. The increment in dielectric constant value is not only due to the interaction of the molecules there are the possibility of thermal mechanism in terms of temperature and size of the CuO nanoparticle[18,19].

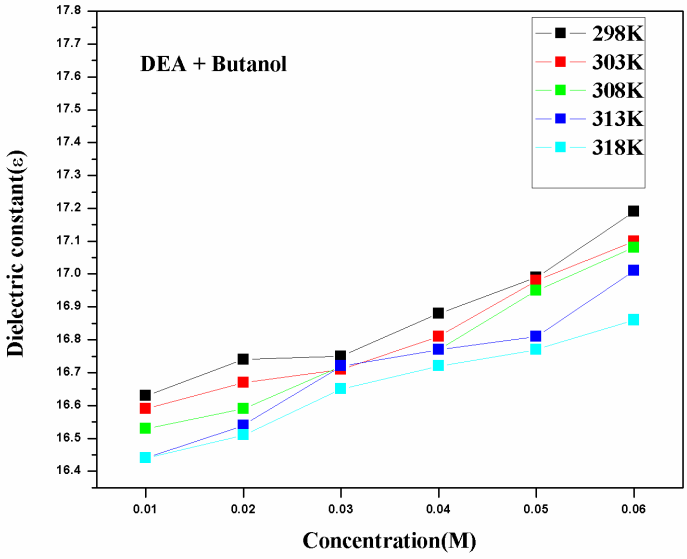

Fig.1. Variation of dielectric constant with the concentration of DEA in Butanol at various temperatures (298K to 318K) .

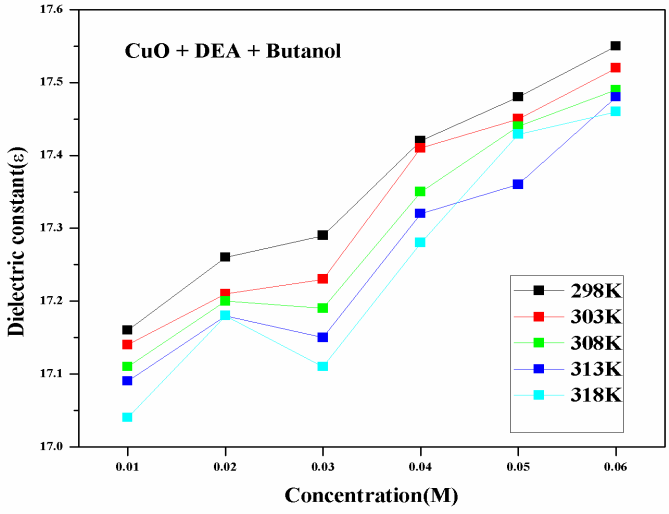

Fig.2.Variation of dielectric constant with the concentration of CuO dispersed in DEA + Butanol at various temperatures (298K to 318K).

4. Conclusion:

The dielectric constant of binary fluid and hybrid CuO nanofluid were investigated with the various concentrations from 0.01M to 0.06M and in the temperature range from 298-318K.The experimental results shows that dielectric constant value of hybrid CuO nanofluid is quite high compared to binary fluid. The enhancement in dielectric constant was achieved through addition of CuO nanoparticle to the binary fluid.

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