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Journal of Geography and Natural Disasters

Short Communication

Leverage the environmentally friendly nanoparticles on the thermal stability and electrical conductivity of Polyp-Phenylenediamine

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ABSTRACT

Eggshell is a biomaterial containing 95% by weight of calcium carbonate in the form of calcite and 5% by weight of oxides (Mn, Si, Al, Fe, Cr, Cu and Ca) and organic substances. Para-phenylenediamine was polymerized by oxidation in aqueous acidic solution with potassium persulfate as an oxidant. Poly (p-phenylenediamine) and their nanocomposites with nano eggshell, carbon nanotube and nano eggshell with carbon nanotube were prepared and compared with ground eggshell. All prepared samples were characterized using FT-IR, Raman and UV-spectra. The morphology has been studied by SEM and TEM. The thermal stability of the prepared polymer nanocomposites was analyzed using TGA, the results showed high thermal stability compared to the net polymer. The electrical conductivity properties were studied the results showed efficiency in the improvement of electrical properties, which form a better composite with higher conductivity, so can be used as a semiconductor.

Introduction:

Heat-exchange processes are of major importance for almost all industrial processes, and thus their efficiency is of paramount significance. In the last few decades, a new class of heat-transfer fluids was developed and intensively studied, namely nanoparticle-enhanced fluids. This new class of fluids actually consists of regular heat-transfer fluids enhanced with solid nanoparticles, generally termed as nanofluids. As base fluids, both conventional and non-conventional fluids were considered, and a few examples are: water, ethylene glycol, oils, ionic liquids, basic lubricants and also molten salts. On the other hand, nanoparticles consist of metals, oxides, carbon nanotubes, graphene and several composites. The combination of these two phases raised a lot of interest in the published literature also due to their intrinsic applications in heat exchangers used for different industries as: automobile, coolers, radiators, refrigerators, in the oil and gas industries, solar collectors, electronic industries, aeronautics, etc. Nevertheless, unlike the properties of regular mixtures that can be predicted very easily by averaging the properties of the pure phases, the thermophysical properties of nanofluids do not respect this rule, as was outlined intensively in the open literature. If the electrical conductivity is considered, this author believes that this is a less studied property, even if it is of tremendous relevance for several industrial applications. For example, commonly, fluids are poor conductors of electricity while several liquids are good conductors. In the last few years, an abundant consideration was received by the study of conducting fluids, especially because of their numerous applications in engineering, as for example: plasma jet, controlled thermo-nuclear reactor, shock tubes, pumps, magneto hydrodynamic generators. Many gaps still exist in the science describing the flow of electrically conducting fluids and such gaps are most frequent with regard to magneto hydrodynamic (MHD) subjects like flows of inhomogeneous and multiphase fluids and turbulent flows.

On the other hand, as one of the most relevant applications of nanofluids is electronic cooling,

the increased electrical conductivity over the base fluid constitutes a major advantage, especially

when it is coupled with higher thermal conductivity. Consequently, recommended in their comprehensive review the use of nanoparticles in heat exchangers under the influence of electrical fields, and thus the investigation of electrical behavior of nanofluids is of major importance. Concluding, this review's scope is to summarize research on electrical conductivity that is a very important property, especially for applications in mineral processing systems, fuel cells, electric field heat transfer applications etc. As far as this author is aware, a complex review on electrical conductivity is not available at this moment and interest in measuring this property has been relatively limited so far. The purpose of this article is not only to describe the available experimental and theoretical studies, but also to gain a better awareness of the nanofluids behavior while evaluating and relating recent results on electrical conductivity measurements. Thus, this review's starting point will be to summarize the theoretical models available for electrical conductivity, followed by the experimental research performed by now in regard to the influence of base fluid type, nanoparticle selection and temperature on electrical conductivity variation.

Methods:

A very good review on electrical conductivity of dispersions, summarizing some models that are used for the estimation of electrical properties. They described the available equations and provided a distinct consideration of models which consider volume concentration, shape and size distribution of the solid dispersed phase, specifically the models of Maxwell, Bruggeman and Fricke, discussing the limitations of each approach. In this sense, a short outline of theoretical models will be the start point of this review and a few aspects will be discussed further in correlation with experimental results. The importance of electrical conductivity estimation was more intensively outlined about 3–4 years ago when the research on this topic clearly increased, thus not much experimental work was identified in the archived literature. This review is fully dedicated to electrical conductivity of nanofluids, being initially to try to summarize and discuss experimental outcomes on this property. Outlines the most recent and relevant researches related to electrical conductivity, containing details about the base fluid, nanoparticles type and also about the equipment used for experiments, can over a very good start point for future research, summarizing some preoccupations and contains all the available data, as far as this author is aware.

Discussion:

Studies on temperature variation influence over electrical conductivity are summarized. The overall conclusion was that the temperature increase leads to a linear increase in the electrical conductivity which is a logical phenomenon with major occurrence in the physics of suspensions. Some details are already presented in both Table 1 and Section 3 and a discussion will be undertaken below. From a state of the art review, it can clearly be noticed that most of the experimental studies on this topic concluded that temperature influence is not as major as concentration and the increase is linear. Anyhow, some exceptions were noted in the literature, as stated that temperature influences the electrical conductivity but no pattern was noticed an Arrhenius type equation that better describe their experimental outcomes. On the other hand, some explanations for the low enhancement explained that the low enhancement in electrical conductivity at heating occurs due to the fact that aggregation is a time-dependent phenomena and the aggregation time is greatly reduced when temperature is increasing. A drawback noticed, even if there are several studies of temperature influence on electrical conductivity, is the absence of correlations that can describe the heating influence. Even if temperature was considered as an important parameter, most of the equations are connecting both concentrations and temperature.

Conclusion:

In this article, a complex review was performed on electrical conductivity results. Even if the

other nanofluids properties received greater attention, studies on electrical conductivity can also over valuable information about these new fluids behavior in different real-life applications. As the conductivity of the polyp-phenylenediamine is almost insulating, the addition of environmentally friendly materials as natural calcium carbonate which obtained from waste chicken eggshell has an effect in improving properties as well as adding nanomaterials such as carbon nanotubes. We have successfully prepared poly through oxidative chemical polymerization. Poly nanocomposites were prepared by adding nanoeggshell, carbon nanotube and nanoeggshell with carbon nanotube and compared with ground eggshell.