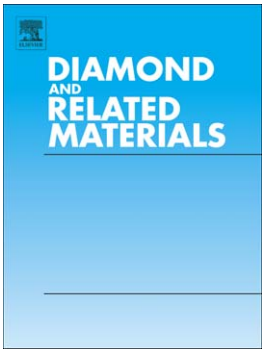

The influence of ash content on thermophysical properties of ethylene glycol based graphite/diamonds mixture nanofluids

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The influence of ash content on thermophysical properties of ethylene glycol based graphite/diamonds mixture nanofluids

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Abstract

Since the second half of the twentieth century, nanofluids are very promising engineering materials that can find numerous applications in the processes of heat exchange. Scientist and engineers are developing new and more advanced nanosuspensions which may differ from their physical properties, production costs and practical use. The aim of this paper is to study the differences between two nanofluids containing a mixture of graphite and nanodiamonds with various ash content. Here, ethylene glycol was used as a base fluid. Rheological properties, thermal and electrical conductivities at a constant temperature 298.15 K were investigated for nanoparticle volume content ranging from 0.004 to 0.023. It was presented that ash content in nanofluids changes significantly rheological properties of nanofluids containing graphite/nanodiamonds mixture nanoparticles. While the variation in ash content does not affect thermal conductivity of nanofluids, a big impact on electrical conductivity is reported.

Keywords: nanofluid, rheology, thermal conductivity, electrical conductivity, nanodiamonds, ash content

1. Introduction

In an era of ever-increasing demand for energy, scientists and engineers compete in the design of materials with sophisticated properties. One undoubtedly important groups of materials are suspensions of nanoparticles called nanofluids. At the end of the last century, first experimental studies showing that the addition of the nanoparticles to liquid causes an increase in the thermal conductivity of such material has been introduced. Since then many publications on the thermal conductivity of nanofluids has been presented [1, 2, 3, 4, 5, 6]. Increasing the thermal conductivity of the fluid results in the enormity of possible applications of these materials in many fields of industries [7, 8]. Particularly noteworthy are the possibilities of using these materials in the building industry [9], green energy [10, 11, 12] and the wider automotive industry [13].

Nanofluids apply not only in industry, but also are promising materials in medical drug delivery systems. Especially interesting here are harmless to the organism gold nanoparticles that can be used in a targeted therapy [14, 15, 16].

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However, the addition of nanoparticles to the liquid does not remain without effect on its mechanical properties. Increasing concentration of nanoparticles leads to an increase in dynamic viscosity of the suspension [17, 18, 19, 20]. It must be taken into consideration when designing systems using nanofluids.

One of the most popular groups of nanoparticles used in the research on thermal conductivity of nanofluids are oxides [21, 22, 23, 24, 25, 26]. Note, however, that in addition to oxides widespread is the use of metals [27, 28, 29], nitrides [30, 31, 32, 33] and carbon nanotubes [34, 35, 36]. More recently, graphene was also considered due to high intrinsic thermal properties [37, 38, 39, 40, 41]. A relatively new study group of nanofluids are so-called hybrid nanofluids which contain different types of nanoparticles, in suitable ratios [42, 43, 44, 45, 46].

Nanodiamonds (ND) based nanofluids are also very interesting and promising. Branson et al. [47] investigated two types of nanofluids containing nanodiamonds in which the liquid base were poly(glycidol) polymer brush:EG and oleic acid:mineral oil. They showed that the thermal conductivity of these systems is growing much more than the prediction of Maxwell model. In addition, they showed that the increase in thermal