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Usage Areas and Thermal Performance of Nanofluids and Nanoparticles

[1]Edip Taşkesen, [2]Khandan Roshanaei, [3] Mehmet ÖZKAYMAK

[1,2,3] Energy Systems Engineering Department, Karabuk University, Karabuk, Turkey

Corresponding author: First A. Author (e-mail: ediptaskesen@karabuk.edu.tr).

ABSTRACT In the study, it has been observed that there are many alternatives for the usage areas of nanofluids formed by dispersing solid particles of nanometric size (1-100 nm) in a basic fluid, as well as these fluids are efficient in both solar energy systems and other thermal systems. In this study, widely used nanofluids in heating and cooling systems and their application areas were investigated. It was observed that when nanofluids with different parameters are used, it affects thermal conductivity efficiency.

KEYWORDS: Nanofluids, Heat Transfer, Nanoparticles

1. INTRODUCTION

Improving thermal conductivity efficiency is one of the ways to use energy efficiently. Nanofluids, with their improved thermo physical properties and heat convey performances with contrast to conventional substances heat transfer; attract the attention of researchers to be used in many different heat transfer applications. Nanofluids have several techniques used to boost and improve and speed up the heat transfer. The heat transfer rate changeable to flow in geometry, boundary conditions, or improving thermo-physical properties. nanofluids usually have a median size<100 nm and also various dimensions, formations and structure [1]. As seen in Fig1 and Fig2, nanofluid basic fluid consists of a nanoparticle and a nanolayer [2].

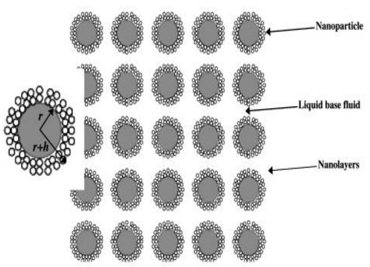

Figure 1. Nanofluid schematic view [2].

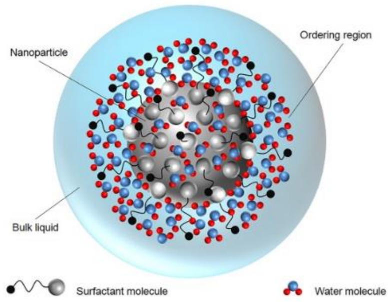

Figure 2. Nanoparticle-fluid structure [3].

Nanofluids have boosted heat transport shifting and better productivity as a higher energy in a variety of thermal altercation systems for mentioned industrial demands; shipment, electronic cooling, energy storage, applications etc. Nanofluids can be applied in various application and s such as commercial cooling, heating constructions, decreasing contamination, nuclear applications cooling, space engineering, friction depletion, magnetic sealing, antibacterial undertaking, nano drug systems, biological fuel cells [4,5]. Various nano particle materials are used to obtain nanofluids, for example, metals (Al, Cu, Ag), metal oxide (Al_2O_3, CuO, MgO), Nitrides (AlN, SiN), carbide ceramics (SiC, TiC), thermal resistors and semiconductor units (TiO_2, SiO_2) [6].

As can be noticed and visible in Fig3., the heat conduction of nanofluids varies depending on the nanoparticle concentration, size, shape, thermal conductivity, basic fluid type, nanofluid temperature and preparation technique, which are different parameters [7].

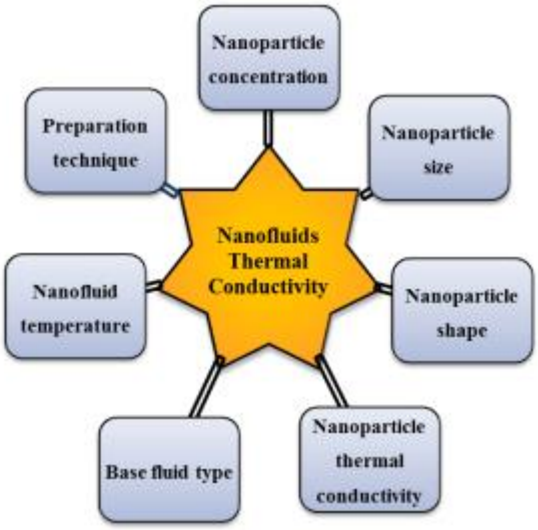

Figure 3. The reaction of different parameters on the heated dynamism of nanofluids [7].

In this study; nanofluids, their application areas and elements influencing the change of heated conductivity were investigated.

2. MATERIALS METHOD

Recently, there has been an increasing interest in studies on the heated conductivity of nanofluids. The first experimental study on nanofluids was carried out by Choi and in this study, by adding nanoparticles into the basic fluid, the thermal conductivity and heat transfer performance of the fluid was investigated [8]. Heris has experimentally investigated the change of boiling heat transfer in automotive cooling systems using an ethylene-glycol-water based (60%: 40%) nanofluid consisting of 0.5% and 40 nm sizes CuO nanoparticles. He stated that there is a 55% increase in heat transfer compared to the basic fluid [9]. Abbassi et al. Analytically considered the heat removal of 10 nm TiO2/water nanofluid at different volumetric concentrations (0.25%, 0.5%, 1.0% and 1.5%) at different Reynolds numbers. It has been found that the heat transfer coefficient of nanofluid higher than the basic fluid water [10]. Ali et al. Conducted an experimental study using ZnO/water nanofluid at different volumetric concentrations (0.01%, 0.08%, 0.2% and 0.3%) to improve the heat transfer performance of a car radiator. They observed a 46% increase in heat transfer at 0.2% volumetric concentration compared to the basic fluid, water [11]. In their work, Li et al. Created an experimental system to investigate the convective heat transfer and flow properties of nanofluid in a tube. They measured both the convective heat transfer coefficient and the friction factor of the Cu/water nanofluid for laminar and turbulent flow. They discussed in detail the effects of factors such as volume fraction and Reynolds numbers of suspended nanoparticles on heat transfer and flow properties. Compared to the base fluid, for example, with amount of 2.0% Cu as nanoparticles in volumetric concentration at the identical Reynolds number, they observed that the coefficient of convective heat transfer for the nanotechnology increased by approximately 60%. Taking the considering the elements altering the convective heat transfer coefficient of nanofluid, they established a new convective heat transfer interaction for nanofluid under mono-phase motion in ducts and pipelines. In the contrast of the middle of the experimental data and the deliberated outcomes, they showed that the association accurately describes the energy transport of the nanofluid [12]. Tekir et al., examine experimentally the forced convection heat transfer of Fe_3O_4/water nanofluid flow at different volumetric concentrations ($0 \leq \phi \leq 0.05$) in laminar flow ($1122 < Re < 2124$) in a straight pipe under the influence of a constant magnetic field (B= 0.3T). Experimental results have shown that the fixed magnetic field provides 13% increase in convective heat transfer compared to the absence of the magnetic field [13]. Baskar et al experimentally investigated the heat transfer by using MWCNT/water-Ethylene Glycol (EG) nanofluid in a 2500 mm long, 10.7 mm inner diameter and 12.7 mm outer diameter copper pipe. The increase in the heat transfer coefficient was found respectively 30% and 34.74%, and in volumetric concentrations of MWCNT at 0.15% and 0.3%. However, for the same nanofluids, they observed that the heat transfer coefficient increased significantly as flow conditions changed (from laminar to turbulent flow) [14].

As shown in Fig4. And Table1. it is seen that the ones with the highest thermal conductivity are inorganic metals (Melamine-formaldehyde), basic fluid (water), metals (Cu) and metal oxides (ZnO) [15].

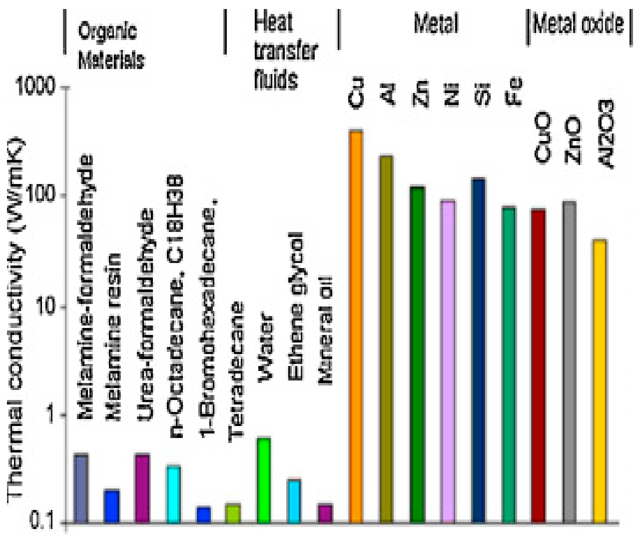

Figure 4. Thermal conductivity comparison [15].

Table 1. Thermal conductivity of nanoparticles [16].

Sl.no	Nanopowders	Thermal conductivity (W/m° K)
1	Aluminum Oxide (Al_2O_3)	40
2	Zinc Oxide (ZnO)	29
3	Tin Oxide (SnO_2)	36
4	Iron Oxide (Fe_2O_3)	7
5	Gold nanopowder (Au)	315
6	Titanium Dioxide (TiO_2)	8.5
7	Copper Oxide (CuO)	76
8	Carbon nanotubes	3000–6000
9	Zirconium (IV) Oxide (ZrO_2)	2
10	Silicon nitride (Si_3N_4)	29–30
11	Boron nitride (BN)	30–33
12	Aluminum nitride (AlN)	140–180
13	Diamond nanopowder (C)	900
14	Silver nanopowder (Ag)	424

As can be seen in Fig. 6 and Fig. 7, various application areas of nanofluids are emphasized to use energy more efficiently.

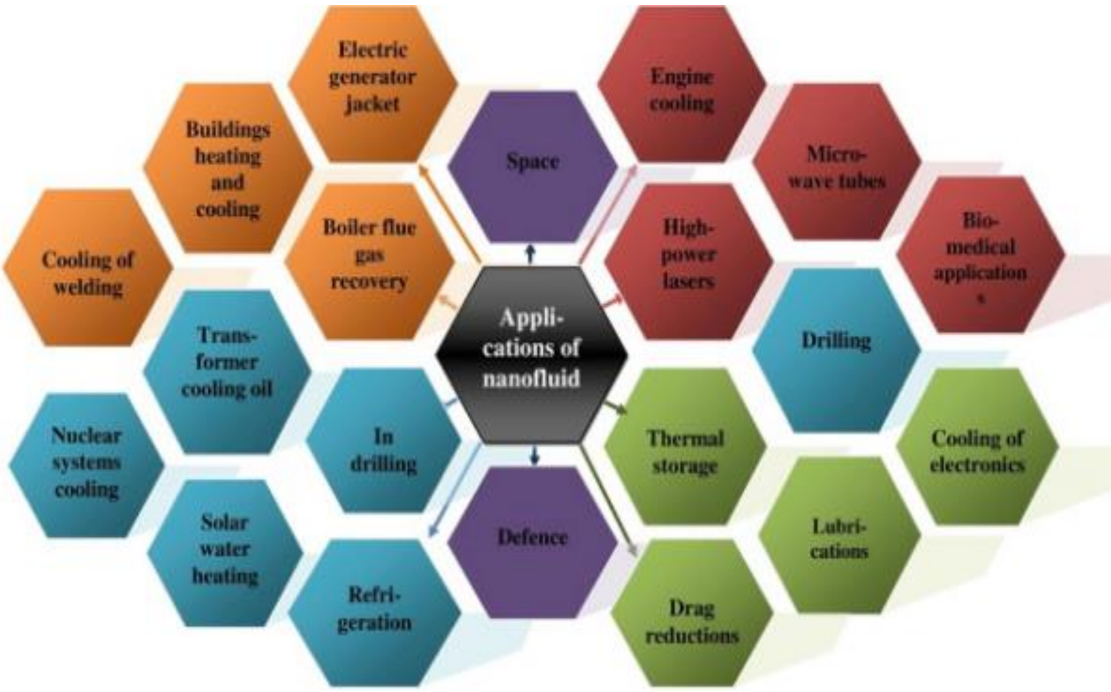

Figure 5. Application areas of nanofluid [6].

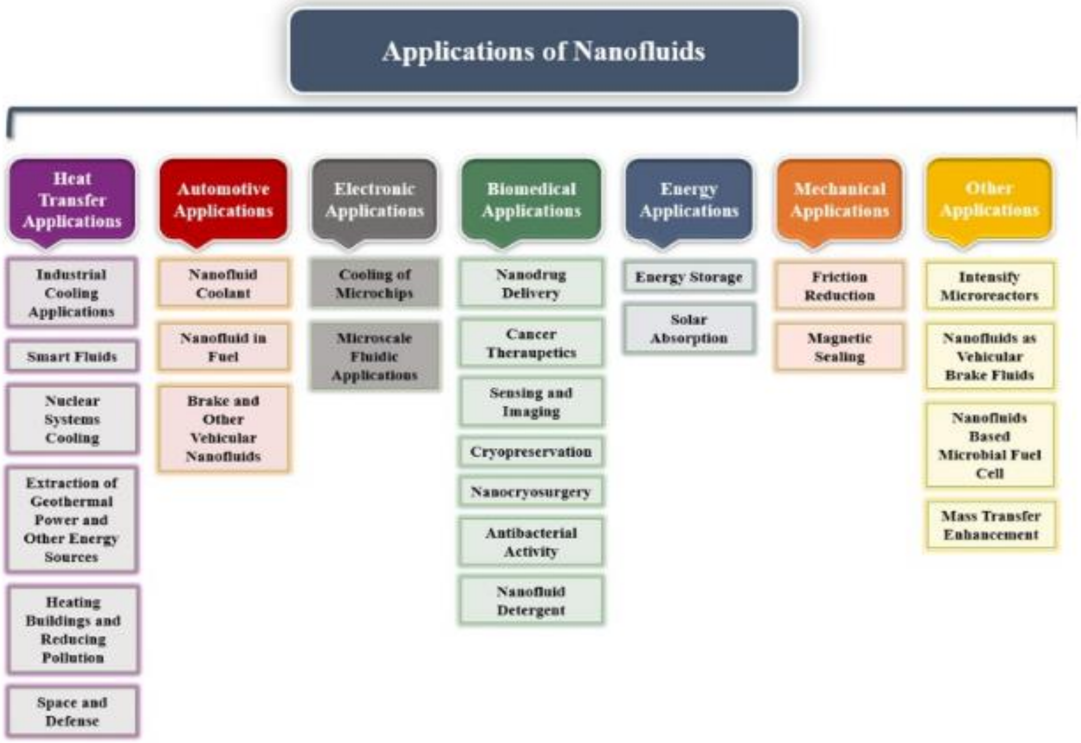

Figure 6. Implementation of nanofluids [17].

3. CONCLUSION

In this study; Research was done on nanofluids and their application areas. More efficiency is obtained in heating and cooling systems by using nanofluids. It has been observed that the thermal efficiency of nanofluids varies depending on different parameters (nanoparticle concentration, size, shape, thermal conductivity, bases of fluid type, nanofluid temperature, and preparation technique) and the nanoparticle with the highest thermal conductivity is the Carbon nanotube.

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