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Performance Analysis Flow and Heat Transfer Characteristics of Secondary Refrigerant Based SiO_2 Nanofluid

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Abstract

Nanofluids have arisen as a technically and economically credible compounds due to their remarkable thermal conducting properties. Here, we report the stability and silicon dioxide/propanol nanofluid suspension stability and heat transfer abilities. The thermal conductivity of the silicon dioxide/propanol/CNT based nanofluid is studied at different temperatures and concentrations. The results indicate that there is a significant rise in thermal conductivity of silicon dioxide/propanol/CNT based nanofluid at 0.3 volume percentage of carbon nanotube.

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Keywords: Nanofluid, Resistance Temperature Detector, SDBS, surfactants

1. Introduction

Global demand for energy is predicted to increase in the future. The fast depleting fossil fuels, global warming, growing energy have motivated researchers all around the world to investigate on more efficient ways of energy generation, storage and consumption. Performance enhancement of heat-exchange processes is a major challenge of present day industrial thermal applications. Usually in power installations and industrial thermal equipment's, a process of intense heat removal is required, and this involves several types of heat-exchange equipment. Various research groups have carried immense research in the domain of thermal engineering and developed several techniques for improving heat transfer.

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Nomeclature
SDBS sodium dodecy i benzene sulphate
IPA Isopropelene Alcohol

Common liquids have poor heat transfer behaviors when compared to most solid particles. This is a major road block to develop a highly efficient heat transfer system. Suspended metal or nonmetal nanoparticles were found to change the transport properties and, especially, the heat transfer of the base liquid and thus nanofluids have started replacing common heat-transfer media [1-5] as shown in below Fig 1 and Fig 2 (a-d).

2. Methods and materials

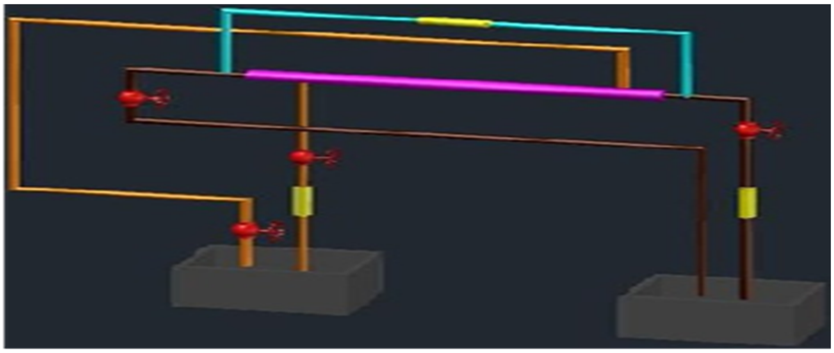
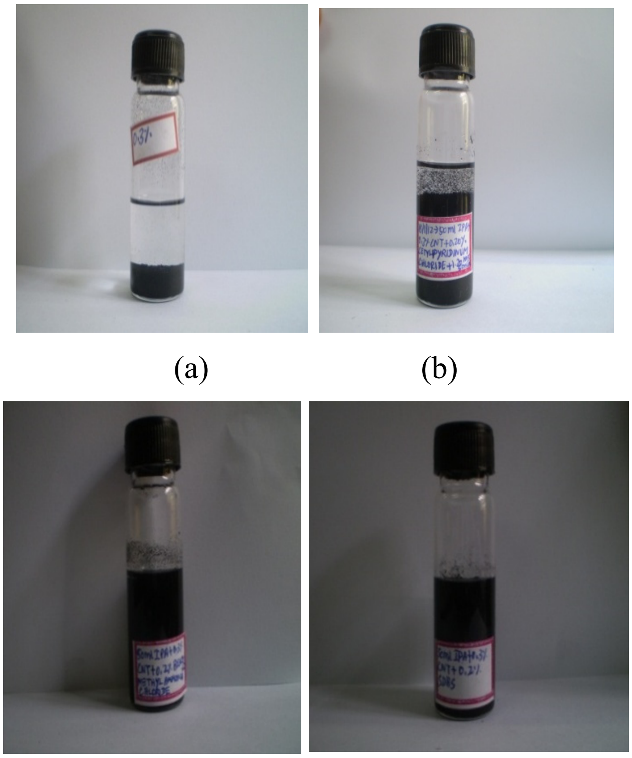


Fig. 1 Laboratory setup for thermo physical studies of nanofluid

The laboratory setup includes a test section, mass flow meter, constant temperature baths, mechanical agitators, pumps, Resistance Temperature Detector, AC unit and a data acquisition system (DAS). The test section under investigation was about 1.5 m long concentric tube heat exchanger. The Resistance Temperature Detectors are kept in the test section at different intervals temperature measurement. In order to measure the pressure drop of nanofluid a differential pressure transmitter is placed across the test section. Flow of water is on the annular side of the counter flow concentric tube heat exchanger while the nanofluid flows in the inner tube. Both fluids are flowing in opposite direction for better enhancement unlike parallel flow arrangement.

2.1 Sample preparation

There are two distinct methods for nanofluid preparation. Calculated amount of base fluid, IPA and nanofluid with surfactant are taken and then stirred in a flask using magnetic stirrer and then ultrasonicated for 30 minutes. Several surfactants like cetylpyridinum chloride, benzyl trimethyl ammonia chloride and SDBS were used as capping agents to prevent nanoparticles agglomeration.



(a) (b)

(c) (d)

Fig. 2 Nanofluids synthesized using different surfactants

From the stability test conducted it was observed that among the various surfactants SDBS is the best one for nanofluid synthesis in the present case.

3. Results and Discussion

3.1. Effect of Reynolds number with pressure drop

The Pressure drop is directly proportional to Reynolds number. From fig 3, it is clear that the variation of concentration of nanofluids, the pressure drop increase with respect to Reynolds number. As the flow rate and concentration increase there is increase in pressure drop.

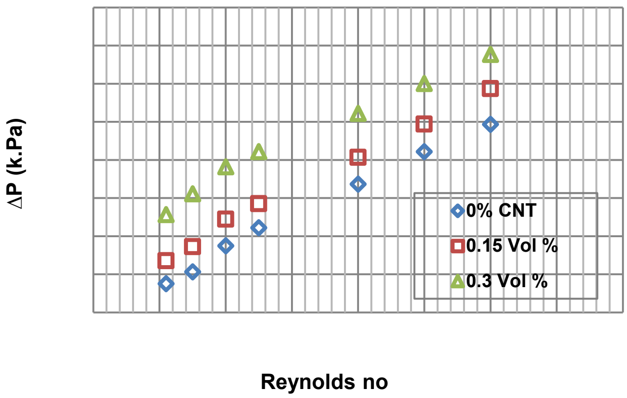


Fig. 3 Reynolds Number vs Pressure drop

3.2. Effect of temperature

The graph (fig.4) clearly reveals that the heat transfer ability improves significantly with increasing temperature and percentage volume of carbon nanotub

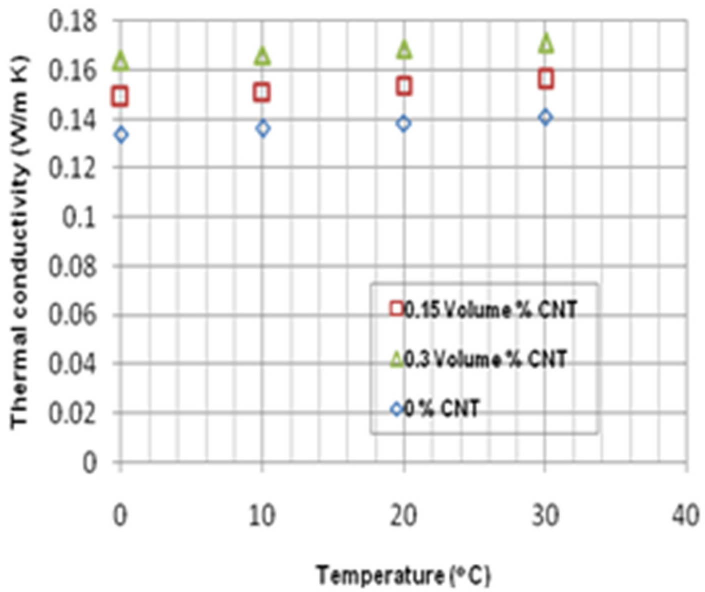


Fig. 4 Temperature vs Thermal Conductivity

3 .3 Effect of change in flowing conditions

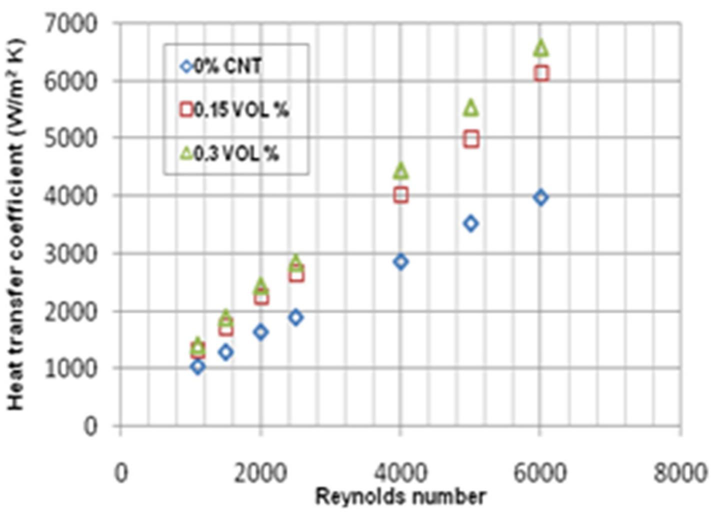


Fig. 5 Change in heat transfer coefficient with flow conditions

Fig.5 indicates that as the flowing conditions vary the thermal conductivity behavior of silicon dioxide/propanol/CNT based nanofluid show a remarkable increase with increase in nanofluid concentration at various Reynolds number.

4. Conclusions

From present investigation we conclude that with increasing temperature, there is an increase in heat transfer ability of **silicon dioxide**/propanol based nanofluids containing 0.15 and 0.30 volume percentage of carbon nanotube. There is considerable enhancement in the thermophysical properties which can be benefit many devices which demand efficient heat transfer fluids.

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