Journal of Nanoscience and Nanoengineering
Vol. 6, No. 2, 2020, pp. 8-12
http://www.aiscience.org/journal/jnn
ISSN: 2471-8378 (Print); ISSN: 2471-8394 (Online)

Experimental Evaluation of Physical Characteristics of Nano Oil in the Pilot Plant of Laboratory Well Column

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Abstract

This is more important especially about the new type of oil which contains nano particle. In this study, the dimensionless groups and thermo physic parameters of the nano oil are considered to determine the nano oil behaviour. The increase or decrease trend in values are the same for both nano oil and simple oil. Flowing in the adiabatic tube increases the oil temperature and changes the value of physical parameters. Maximum deviation between values of simple and nano oil belongs to the kinematic viscosity which the nano oil values are 28% lower than values obtained for simple oil. Results state, the decrease in the value of heat capacity despite of increase in the temperature due to the friction may relate to the structural properties of the simple and nano oil. In addition, the difference between values of heat capacity of simple and nano oil is averagely about 0.6%. the presented results show, the somwhat increase in the amount of Pr can be seen for both simple and nano type. Addition of nano ferric oxide decreases the value of Pr. The average deviation between values of Pr number of simple and nano oil is about 5.4%. also, the nano addition in oil increases the value of shear stress. Changes in value of shear stress for nano oil is higher than that is obtained for simple oil. According to the experimental results, changes in Reynolds and Prantle number, the changes in peclet number can be considered.

Keywords

Crude Oil, Nano Oil, Pilot Plant, Well Column, Physical Characteristics

Received: October 5, 2020 / Accepted: October 23, 2020 / Published online: November 23, 2020

1. Introduction

In recent years, development in the miniaturization technologies results in fabrication of micro-scale electronic devices which is used in various industries such as aerospace and automotive [1-4]. For maximum performance of these micro devices which is known as MEMS (Micro Electromechanical Systems), the temperatures should be in a certain range [5-9]. Micro channel as Compact and efficient cooling devices have been developed for the thermal control of MEMS [10-15]. Utilizing nano fluid as working fluid could improve the cooling and heating performance [16-18]. Because of more stable nature of nano fluid compared with its pioneer generation (including micro and millimetre particles) and exceptional thermal conductivity of nanoparticles, it could considerably enhance the convective heat transfer coefficient in micro channel. During the last decade, many studies on convective heat transfer with nano fluids have been considered [19]. Some researchers revealed that the heat transfer coefficients of the nano fluids increase with increasing the volume fraction of nanoparticles and the Reynolds number. Scientifics studied the laminar mixed convection of an Al_2O_3/water nano fluid in a horizontal tube numerically using a two-phase mixture model [20]. They

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showed that the nanoparticle concentration did not have significant effects on the hydrodynamics parameters, but its effects on the thermal parameters were important for the fully developed region. The other Scientifics considered the laminar forced convection of an Al_2O_3 /water nano fluid flowing in an annulus [21]. Their results indicate that the friction coefficient depends on the nanoparticle concentration when the order of magnitude of heating energy is much higher than the momentum energy. Thermal transport of nano fluid flow in micro channels has also attracted a few investigators due to its promising applications [22]. In a study in previous literature the cooling performance of the micro channel was significantly improved by the significant reduction in the temperature difference between the heated wall and the nano fluids. The other researchers experimentally assessed forced convective cooling and heating performance of a copper micro channel heat sink with Al_2O_3/water nano fluid as a coolant. Their results show that the nano fluid cooled heat sink outperforms the water-cooled one, having significantly higher average heat transfer coefficient and thereby markedly lower thermal resistance and wall temperature at high pumping power, in particular. Meanwhile, in an experiment using SiO_2–water nano fluids in an aluminium heat sink consisted of an array of 4 mm diameter circular channels with a length of 40 mm. The experimental results showed that dispersing Al_2O_3 and SiO_2 nanoparticles in water significantly increased the overall heat transfer coefficient while thermal resistance of heat sink was decreased up to 10%. Also they numerically investigated corresponding configuration. The results revealed that channel diameter, as well as heat sink height and number of channels in a heat sink have significant effects on the maximum temperature of heat sink. Regarding numerical aspects, Scientifics demonstrated when the commonly used assumption of constant heat flux boundary condition is applicable in heat and fluid flow analysis in microfluidic systems. Also a general Nusselt number correlation for fully developed laminar flow was developed as a function of two dimensionless parameters, namely, Biot number and relative conductivity, to take the conduction effects of the solid substrate on heat transfer into account. Fluids are classified by their rheological behaviour American Petroleum Institute. All fluids are classified as either Newtonian or Non-Newtonian, the clearest distinction between different types of fluids. Fluid mechanics is the study of the forces involved in both still and flowing fluids. Reynolds introduced a dimensionless number in order to compare fluid flow independent of which medium surrounded them and other variables. The Reynolds number is the ratio of inertial forces to viscous forces in fluid flow.

2. Materials and Method

The researchers showed that Fe_2O_3 is highly active for reforming isooctane via partial oxidation. This process is exothermic ($\Delta H°= -582.2$ kJ/mol) and in the presence of Fe_2O_3 proceeds to full conversion at 630°C and 1 atm. The catalytic activity shown by Fe_2O_3 can be explained in terms of the Mars-van Krevelen mechanism. Despite its interesting catalytic properties, a very limited number of studies have been conducted examining the potential of Fe_2O_3 as a catalyst for reforming processes. Such studies were carried out using commercial Fe_2O_3, with particle sizes in the range of a few micrometres and Brunauer, Emmett, and Teller (BET) surface areas <10 m2/g. By utilizing nanoparticles, we have shown that it is possible to significantly increase the total reactive surface area and thus achieve reforming processes with much higher efficiency levels than those of commercial Fe_2O_3. Nanoparticle Fe_2O_3 was synthesized by reduction of ferric trioxide (Fe_2O_3) powder in a 1:3 volume ratio of ethylene glycol to distilled water16. The mixture was combined in a 45 ml Teflon-lined general-purpose vessel, which was subsequently sealed and heated to 180°C for 12h. After cooling, the dark coloured Fe_2O_3 was filtered and air dried at 100°C. Figure 2 shows scanning electron microscope (SEM) and transmission electron microscope (TEM) images of nanoparticle Fe_2O_3.

3. Results and Discussion

Experiments are held to investigate the properties and behaviour of nano oil comparing with simple oil. Thermo-physical properties like density, viscosity, thermal conductivity, thermal diffusivity with changes in temperature and amount of nano particle are surveyed.

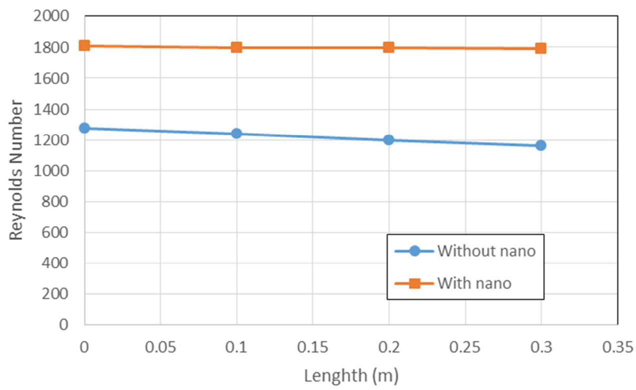

Figure 1. Reynolds number versus length.

Changes in the values of Reynold number through the length by addition of 1% nano ferric oxide is shown in the Figure 1. The Reynolds number of fluid decreases through the tube flowing. The flow is considered in laminar flow. The friction loss may decrease the velocity and consequently decraese the Reynolds number. For simple oil without nano particel the value of Reynolds decraeses from 1276 to 1164 and for nano oil the value of Reynolds decreases from 1807 to 1789. The increase in the value of Reynolds of nano oil in comparison with those are obtained for simple oil is since of combination of parameters, changes in kinematic viscosity, velocity and density. The Reynolds number increases averagely about 48% by addition of 1% nano ferric oxide.

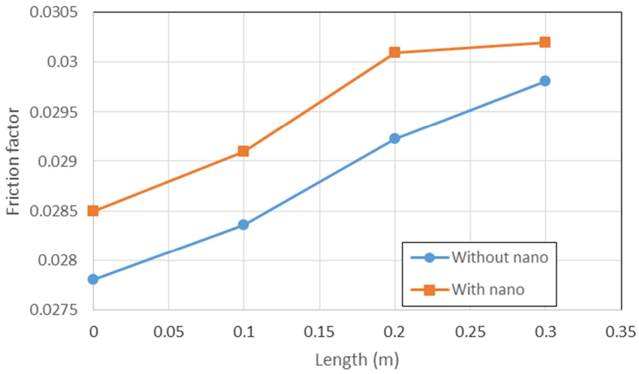

Figure 2. Friction factor versus length.

Value of frictoin factor of both simple and nano oil through the tube is shown in the Figure 2. The increase in the value of friction factor for both simple and nano oil is not considerable. However, this trend can be explained by the realtion between reynolds and friction factor in laminar flow regiem. Nano presence in the oil increases the amount of friction factor about 2.3%.

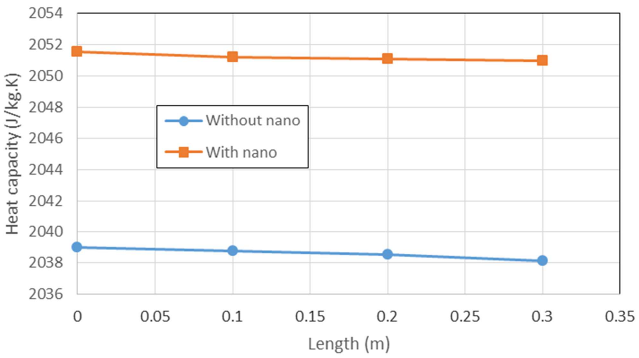

Figure 3. Heat capacity versus length.

Values of heat capacity of both oil and nano oil through the length of tube are shown in the Figure 3. Through the 0.3 m of tube, the amounts of heat capacity decreases for both simple and nano oil. The decrease in the value of heat capacity despite of increase in the temperature due to the friction may relate to the structural properties of the simple and nano oil. The difference between values of heat capacity of simple and nano oil is averagely about 0.6%.

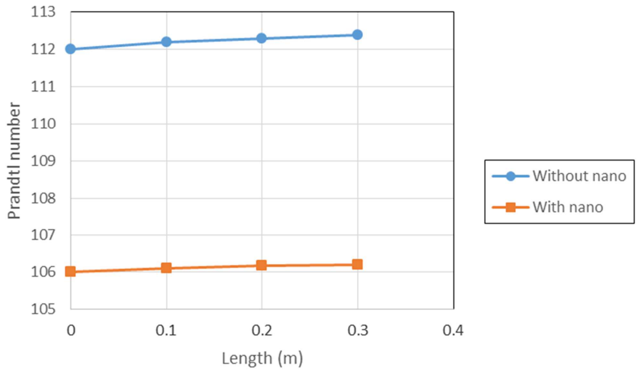

Figure 4. Prandtle versus length.

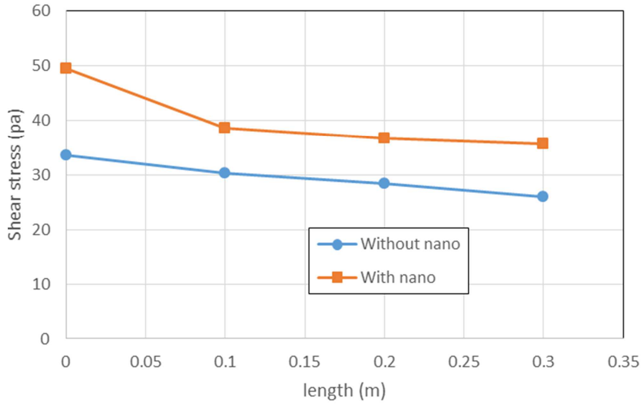

Figure 5. Shear stress versus length.

The values of prandtle number through the 0.3 m length of the tube is shown in the Figure 4. Changes in the value of Pr for both simple and nano oil is presented here. The somwhat increase in the amount of Pr can be seen for both simple and nano type. Addition of nano ferric oxide decreases the value of Pr. The average deviation between values of Pr number of simple and nano oil is about 5.4%. The values of shear stress versus length in vertical tube for both simple and nano oil is shown in the Figure 5. The decrease trend is obtained for both simple and nano types. Nano addition in oil increases the value of shear stress. Changes in value of shear stress for nano oil is higher than that is obtained for simple oil.

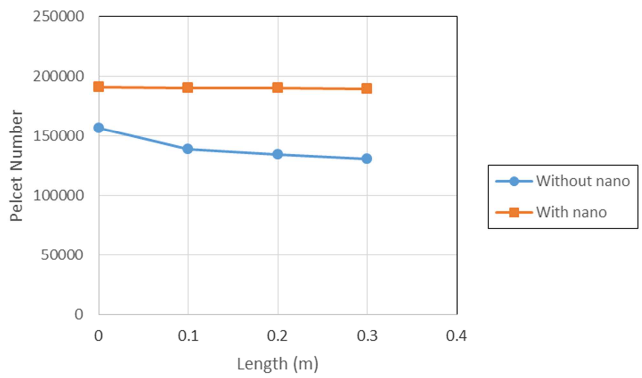

Figure 6. Peclet versus length.

Another important dimensionless number is peclet number.

This number is important to evaluate the thermal and fluid mechanic effects on the fluid. According to the changes in Reynolds and Prantle number, the changes in peclet number can be considered. The Figure 6 shows the changes in values of Peclet versus length.

4. Conclusions

Application of nano ferric oxide in oil is studied in this manuscript. The effect of addition of different weight percentage of nano particle into the oil which flows vertically under different temperatures (ranges from 30-70°C, 25-85°C, 30-90°C) in a tube section is investigated, experimentally. The experimental results show, the Reynolds number of fluid decreases through the tube flowing. The flow is considered in laminar flow. The friction loss may decrease the velocity and consequently decraese the Reynolds number. For simple oil without nano particel the value of Reynolds decraeses from 1276 to 1164 and for nano oil the value of Reynolds decreases from 1807 to 1789. The increase in the value of Reynolds of nano oil in comparison with those are obtained for simple oil is since of combination of parameters, changes in kinematic viscosity, velocity and density. The Reynolds number incraeses averagely about 48% by addition of 1% nano ferric oxide. Moreover, the obtained results show, increasing in the value of friction factor for both simple and nano oil is not considerable. However, this trend can be explained by the realtion between reynolds and friction factor in laminar flow regiem. Nano presence in the oil increases the amount of friction factor about 2.3%. Results state, the decrease in the value of heat capacity despite of increase in the temperature due to the friction may relate to the structural properties of the simple and nano oil. In addition, the difference between values of heat capacity of simple and nano oil is averagely about 0.6%. the presented results show, the somwhat increase in the amount of Pr can be seen for both simple and nano type. Addition of nano ferric oxide decreases the value of Pr. The average deviation between values of Pr number of simple and nano oil is about 5.4%. also, the nano addition in oil increases the value of shear stress. Changes in value of shear stress for nano oil is higher than that is obtained for simple oil. According to the experimental results, changes in Reynolds and Prantle number, the changes in peclet number can be considered.

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