Experimental Investigations on the Influence of Base fluid on the Heat Transfer Performance of Silicon Carbide Suspensions

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Abstract-

Energy conservation is obtained through energy savings. One such method to attain energy conservation is the use of nanofluids in place of conventional fluids. In the present paper, the effect of working fluid on the thermophysical properties of Silicon Carbide (SiC) suspensions is determined experimentally. The thermohydraulic performance of these suspensions is investigated using a Double pipe heat exchanger (DPHE). Three different working fluids, viz., Distilled Water (DW), a mixture of Ethylene glycol and water in the ratios of 20:80 and 40:60 (20:80 EG-Water and 40:60 EG-Water) are considered to prepare SiC nanofluid in the volume concentration ranging from 0.02% to 0.08%. The experiments are conducted in the turbulent regime. For the same volume concentration of SiC suspensions, a significant enhancement in thermophysical properties, particularly in viscosity and thermal conductivity and hence in the thermo-hydraulic performance is observed for both EG-Water based SiC nanofluids, compared to that of DW based nanofluid. The heat transfer coefficient of DW based nanofluid is 1.21 times that of 40:60 EG-Water based nanofluid and 1.05 times than that of 20:80 EG-Water based nanofluid for a volume concentration of 0.08%, over the range of flow rates considered in the analysis. Even, the Thermal Performance Factor values of three nanofluids also vary by marginal difference. This shows that for the three different base fluids considered in the analysis, the effect of base fluid is observed to be less significant when a high thermal conductivity nanoparticles like SiC are used to prepare the corresponding nanofluids.

Keywords: Heat transfer performance, turbulent flow, nanofluid, thermophysical properties, volume concentration

1. Introduction

In the past few decades, nanofluids have gained significance as the new class of working fluids with superior thermophysical as well as transport properties. The properties of nanofluids are affected by the type of nanoparticles used for suspension and its volume concentration, the working fluid, size and shape of nanoparticles, operating temperature, etc., Vasu et al. [1, 2] conducted analytical research to develop correlations for the thermophysical properties and Nusselt number of water based Al_2O_3, Cu, CuO and TiO_2 nanofluids. Researchers have conducted studies to determine the effect of base fluids like Glycerol-water [3], Propylene glycol-water [4-6] on the heat transfer performance of different nanofluids. In order to improve the heat transfer enhancement most of the researchers have conducted study on the improvement in the design of heat exchangers [7-10].

Huminic et al. [11] experimentally investigated the thermo-physical properties and heat transfer enhancement of SiC/Water nanofluid in a two-phase closed-loop thermosyphon for volume concentrations of 0.5% and 1% within the temperature range of 20°C to 50°C. Maximum relative thermal conductivity was found to be 17.62% for 1% volume concentration at a higher operating temperature of 50°C, while the maximum enhancement in dynamic viscosity was 40.89% at 1% volume concentration and at 20°C. Maximum heat transfer enhancement of 24.4% was reported at a 1% volume concentration for the maximum temperature difference. Li et al.[12] experimentally investigated the thermo-physical properties of 40:60 EG-Water based SiC nanofluids in the volume concentrations ranging from 0.1 to 0.5% under the temperature range of 10 to 50°C. They reported a maximum enhancement of 53.81% in thermal conductivity at 0.5% volume concentration and at 50°C. Based on the relative viscosity and relative thermal conductivity the overall effectiveness of the nanofluid (C_μ/C_k should be less than 4) reported was around 1.6. Karimi et al. [13] experimentally investigated the convective heat transfer and pressure drop of SiC/Water nanofluid in a shell and tube heat exchanger with nanofluid flowing in the tube section and hot fluid flowing in the shell for volume concentrations ranging from 0.25% to 1% under the temperature range of 35 to 55°C with the Reynolds number varying from 350 to 1000. A maximum heat transfer enhancement of 19.8% was reported at 55°C for a 1% volume concentration at a Reynolds number of 1000. Ghanbarpour et al. [14] experimentally investigated the thermal performance of heat pipes using SiC/Water nanofluid at mass concentrations of 0.35%, 0.7% and 1%. Experimental results revealed that the maximum heat removal capacity of heat pipe was increased by up to 29%, while the average thermal resistance of the heat pipe is reduced by 40% for a 1% mass concentration of SiC nanoparticles. Nikkam et al. [15] experimentally investigated the thermophysical properties of water-based and 50:50 EG-Water based SiC nanofluids for weight percentage of 3%, 6% and 9% concentrations at 20°C. They reported a maximum enhancement of 15.2% and 20% in thermal conductivity and maximum enhancement of 22.7% and 14% in viscosity for SiC/Water and SiC/50:50 EG-Water nanofluids respectively at 9% concentration. They concluded that due to high thermal conductivity and low viscosity enhancement of SiC/50:50 EG-Water, compared to that of SiC/Water nanofluid, 50:50 EG-Water based SiC nanofluid at 9% concentration was considered for heat transfer coefficient tests in the Reynolds number range of 500 to 1800. Results revealed that the average enhancement in the heat transfer coefficient was about 13% for SiC/50:50 EG-Water nanofluid, compared to that of the base fluid. Timofeeva et al. [16] experimentally determined the effect of temperature and base fluid on the heat transfer characteristics of SiC/50:50 EG-Water and SiC/Water nanofluids. The experiments were carried out in the Reynolds number range of 4500 to 7500 for a volume concentration of 4% in the temperature range of 57°C to 71°C for particle sizes varying from 16nm to 90nm. They reported that the thermal conductivity of the nanofluids increases with the increase in temperature and particle size and the enhancement of thermal conductivity of EG-Water based SiC nanofluid is 4-5% higher than that of Water-based SiC nanofluids for the same temperatures and particle sizes considered, due to the lower value of interfacial thermal resistance of EG-Water. They reported that viscosity decreases with the increase in particle size for both nanofluids and also stated that the enhancement in the viscosity is more pronounced for smaller particle sizes. This phenomenon is related to the difference in the structure and thickness of the fluid layer around the nanoparticle for various base fluids which affects the viscosity. They reported that nanofluid to base fluid viscosity ratio shows a slight increase followed by a stronger decrease as the temperature rises above

50°C, this effect is more significant at low particle sizes due to the highest solid/liquid interface. Their results

reported a maximum enhancement of 14.2% in the heat transfer coefficient for 90 nm SiC/50:50 EG-Water at 71°C whereas the enhancement of water-based SiC nanofluid is very less compared to EG-Water based SiC nanofluid. They reported that the heat transfer coefficient increases with the increase in particle size and also reported that the heat transfer coefficient of 16 nm and 28 nm size nanofluid has a low heat transfer coefficient than the base fluid.

Azmi et al. [17] experimentally investigated the forced convection heat transfer of Al_2O_3 nanoparticles suspended in Water and Ethylene Glycol mixture in the volume ratio 60:40, 50:50, and 40:60. They conducted experiments for the volume concentrations ranging from 0.2% to 1% at an operating temperature of 30, 50 and 70°C under the Reynolds number range of 3000 to 25000. They reported that at the higher operating temperature of 70^0C, the maximum heat transfer enhancement obtained was 24.6% for 60:40 W-EG based Al_2O_3 nanofluid, 24.2% for 40:60 W-EG based nanofluid and 19% for 50:50 W-EG based Al_2O_3 nanofluid. The overall thermal performance of 40:60 W-EG based nanofluid was reported to be higher at lower operating temperatures of at 30 and 50°C, while the performance of 60:40 W-EG nanofluid was found to be higher than the other two nanofluids at 70°C. They concluded that the variation in temperature and thermophysical properties of the base mixtures greatly influence the heat transfer coefficient of nanofluids and also indicated that detailed investigations on the effect of base fluid need to be carried out.

In the present study, three different base fluids, viz., Demineralized Water (DW) and a mixture of Ethylene Glycol and Water in the volume ratio of 20:80 and 40:60 (20:80 EG-Water and 40:60 EG-Water) are used to prepare nanofluid using SiC nanoparticle suspensions in the volume concentration range of 0.02% to 0.08%. For the same volume concentration of SiC nanoparticles, the effect of base fluid on the thermophysical properties of resulting nanofluids and on the thermo-hydraulic performance is studied.

2. Preparation of Nanofluids

SiC nanoparticles are procured from Nanoamor Texas USA. The properties of these nanoparticles are presented in Table1.

Table 1. Properties of Nanoparticles

Properties	**Fe_3O_4**
Density(ρ, kg/m^3)	3227.87
Specific Heat(J/kgK)	675
Thermal Conductivity(W/mK)	350
Purity	99%
Size	20-30nm

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The SiC nanoparticles are mixed in three different base fluids viz., Distilled water, 20:80 EG-Water, and 40:60 EG-water in the volume concentration of 0.02%, 0.04%, 0.06% and 0.08%. Surfactant is not used in the preparation of nanofluid as its presence affects the original properties of nanofluids. The weight of nanoparticles to be mixed in a given base fluid is evaluated using Eq. (1), where, ϕ is the volume concentration of the nanofluid.

$$\phi = \frac{\dfrac{Wnp}{\rho np}}{\left(\dfrac{Wnp}{\rho np} + \dfrac{Wbf}{\rho bf}\right)} \times 100 \qquad (1)$$

Nanofluid at various volume concentrations is prepared using the two-step method. In order to avoid the sedimentation of the nanoparticles, the mechanical stirrer is used continuously for 24-48 hours depending on the volume concentration. Experiments are performed after obtaining stable nanofluids.

To measure the stability of nanofluids Zeta potential of SiC/DW, SiC/20:80 EG-Water and SiC/40:60 EG-Water nanofluids is tested using Nanoparticle Analyser (Horiba, Japan). For the three different base fluids, the Zeta potential values are observed to be greater than ±30mV, when dispersed with SiC nanoparticles, showing the stability of these colloidal solutions. The values of Zeta potential are given in Table.2

Table 2. Zeta potential of SiC Nanofluids

Nanofluid	Zeta Potential (mV)
SiC/DW	-48.6
SiC/20:80 EG-Water	-50.4
SiC/40:60 EG-Water	-38.6

Figure 1 shows the TEM images of SiC nanoparticles at a magnification of 50nm, which clearly indicates that these particles are of spherical shape.

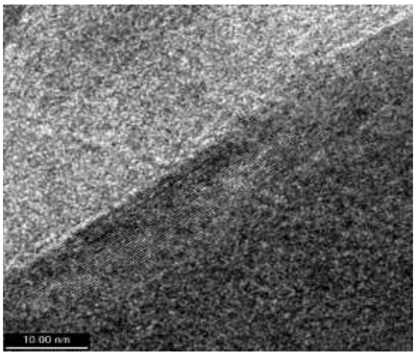


Figure 1. TEM image of SiC Nanoparticles at 10 nm Scale

3. Experimental

3.1 Measurement of Thermophysical Properties

The density of the nanofluids is measured using Antonpaar Density Measuring Instrument. It works on the principle of Oscillating U-tube, which is a technique used to determine the density of liquids or gases based on the electronic measurement of the frequency of oscillation.

The specific heat of the nanofluid is measured using Mentos Heat Capacity Apparatus. It consists of a water bath with a heater to raise the temperature of the fluid under test. The data is logged for every 0.1°C of temperature rise. The Specific heat of the test fluid is calculated using the Eq. 2.

$$c_p = (W_s - P_{av} / \Delta) / m \qquad (2)$$

Where W_s is the specific heat equivalent of water, P_{av} is the average power consumed in watts to raise the temperature of the fluid for a given time. $\Delta = (T_1 - T_2) / t$. Where T_1 and T_2 are the temperatures for a given time t.

The viscosity of SiC nanoparticle suspensions in DW, 20:80 EG-Water, and 40:60 EG-Water is measured using the DV2T Viscometer, for different volume concentrations ranging from 0.02 to 0.08%. The viscosity of these nanofluids is measured at a temperature of 45^0C.

The thermal conductivity of SiC/DW, SiC/ 20:80 EG-Water, and SiC/40;60 EG-Water nanofluids are measured using Tempos thermal property analyzer at 45°C.

3.3 Experimental Setup and Procedure

The test section consists of a Double Pipe Heat Exchanger (DPHE) with U bend. Hot fluid (test fluid) flows through the inner tube and water at room temperature passes through the annulus at a constant flow rate. The inner pipe of the heat exchanger is made of stainless steel with a 19mm inner diameter and 25mm outer diameter. The outer pipe is made up of galvanized iron with a 56mm outer diameter and 50mm inner diameter. The outside of the outer pipe is insulated using a double-layered asbestos rope. The total length of the pipe is 4.52m. The other parts of the setup include two reservoirs for hot and cold water, a temperature controller and a data logger for the measurement of all relevant parameters, viz., flow rate, temperature and pressure drop. The detailed data analysis is presented in Kanthimathi et al. [20]. The pressure drop is directly measured, based on which friction factor is evaluated.

Based on the accuracy of the measuring devices, viz., K type thermocouples, flowmeter and pressure transducer, the uncertainties in the estimation of Reynolds number, heat transfer coefficient and friction factor are calculated using Eqs. (3) to (5)

$$\frac{U_{\mathrm{Re}}}{\mathrm{Re}} = \sqrt{\left(\frac{U_\rho}{\rho}\right)^2 + \left(\frac{U_V}{V}\right)^2 + \left(\frac{U_\mu}{\mu}\right)^2} \tag{3}$$

$$\frac{U_{hi}}{h_i} = \sqrt{\left(\frac{U_{Ui}}{U_i}\right)^2 + \left(\frac{U_{kp}}{k_p}\right)^2 + \left(\frac{U_{ho}}{h_o}\right)^2} \tag{4}$$

$$\frac{U_{fi}}{f_i} = \sqrt{\left(\frac{U_{\Delta P}}{\Delta P}\right)^2 + \left(\frac{U_\rho}{\rho}\right)^2 + \left(\frac{2\times U_V}{V}\right)^2} \tag{5}$$

The maximum percentage uncertainty in Reynolds number, heat transfer coefficient and friction factor is found to be 0.2816%, 0.91%, 0.4506% respectively.

4. Results and Discussion

4.1 Thermophysical Properties of DW, 20:80 EG-Water and 40:60 EG-Water based SiC Nanofluids

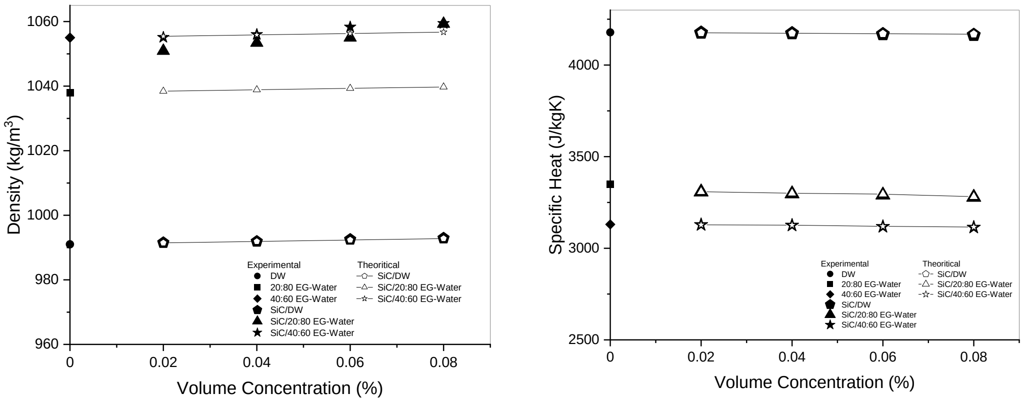
4.1.1 Density and Specific Heat

Figure 2(a) shows the variation of density of SiC/DW, SiC/20:80 EG-Water, and SiC/40:60 EG-Water nanofluids with volume concentration. Among the three different SiC-based nanofluids, SiC/DW nanofluid exhibited a lower density and SiC/40:60 EG-Water nanofluid exhibited higher density. For the three different base fluid-based SiC nanofluid, the variation of density with the volume concentration is not significant from that of the corresponding base fluid, for the range of volume concentrations considered in the analysis. The measured values of density are compared with Pak and Cho [21] correlation, given by Eq. (6). The average percentage deviation of the theoretical correlations from that of measured values is observed to be 0.0085%, 1.49% and 0.11% for SiC/DW, SiC/20:80 EG-Water and SiC/40:60 EG-Water nanofluids respectively, thus showing that the Pak and Cho [21] correlations predicted the experimental data with good agreement, for all the three different base fluid-based SiC nanofluids.

$$\rho_{\mathrm{nf}} = (1-\phi)\rho_{\mathrm{bf}} + \phi\rho_{\mathrm{p}} \tag{6}$$

The variation of specific heat of nanofluids with the volume concentration is shown in Figure 2(b). The specific heat of DW based SiC nanofluid is the highest and that of 40:60 EG-Water based SiC nanofluid is the lowest among three different nanofluids, for the range of volume concentrations considered in the analysis. The percentage decrease in specific heat compared to that of corresponding base fluid is observed to vary from 0.04% to 0.33% for SiC/DW, 1.28% to 2.14% for SiC/ 20:80 EG-Water nanofluid and 0.06% to 0.51% for SiC/40:60 EG-Water nanofluid respectively, as the volume concentration varies from 0.02% to 0.08%. This shows that the variation of specific heat with volume concentration is not significant for the SiC-based nanofluids considered in the analysis. The measured values of specific heat are compared with that of Pak and Cho [21] correlation, given by Eq. (7). The theoretical values are observed to match the measured values in good agreement with less than 0.2% deviation

$$. \; c_{\mathrm{p}} = \frac{(1-\phi)\,\rho c_{\mathrm{p}} + \phi \rho_{\mathrm{p}} c_{p_p}}{\rho_{\mathrm{nf}}} \qquad (7)$$



(a) Density (b) Specific Heat

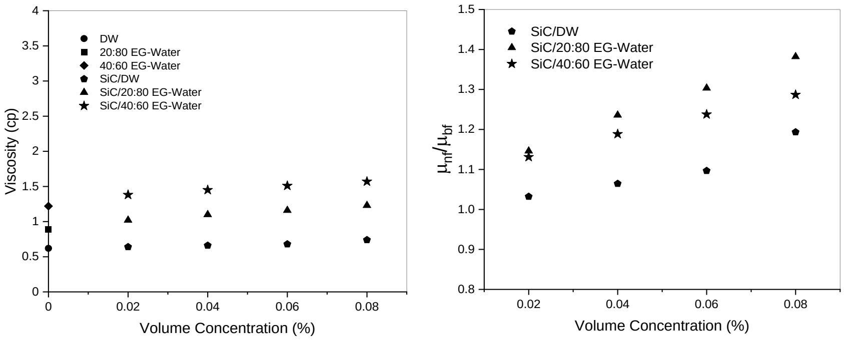
Figure 2. Density and Specific Heat of SiC Naofluids

4.1.2 Viscosity , Thermal Conductivity and Prandtl Number

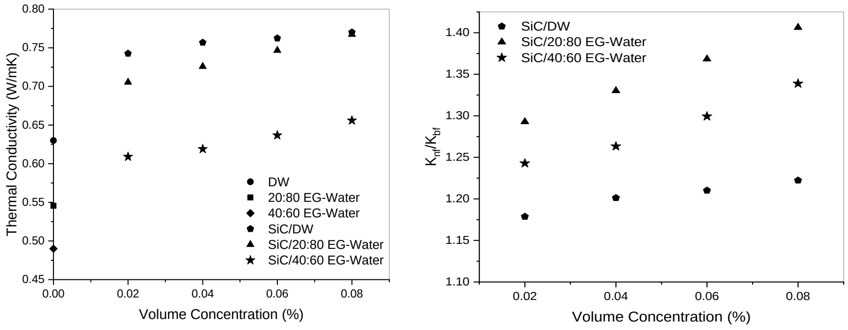
Figures 4(a) to 4(d) represent the viscsotiy and thermal conductivity of nanofluids along with their relative values. Both EG-Water based nanofluids have exhibited higher viscosity than that of water-based nanofluid, with the viscosity being increased with the increase of EG percentage in the base fluid. The percentage increment in the viscosity of DW, 20:80 EG-Water and 40:60 EG-Water based SiC nanofluids compared to that of their respective base fluid varies from 3.22% to 19.35%, 14.6% to 38.2%, 13.11% to 28.68% respectively as the volume concentration varies from 0.02% to 0.08%. The viscosity of SiC/40:60 EG-Water nanofluid is 2.12 times higher than SiC/DW and 1.27 times higher than SiC/20:80 EG-Water nanofluid for 0.08% volume concentration and at the operating temperature of 45^{0}C.

DW based SiC nanofluid has exhibited higher thermal conductivity whereas 40:60 EG-Water based nanofluid exhibited lower thermal conductivity among the nanofluids considered. The percentage increment in the thermal conductivity of DW, 20:80 EG-Water and 40:60 EG-Water based SiC nanofluid vary from 17.87% to 22.23%, 29.28% to 40.63% and 24.28% to 33.87% respectively compared with their respective base fluids as the volume concentration varies from 0.02% to 0.08%. The thermal conductivity of DW based SiC nanofluid is 1.005 times that of 20:80 EG-Water and 1.17 times that of 40:60 EG-Water based SiC nanofluids.

For the same volume concentrations considered, the relative viscocity and the relative thermal conductivity of DW based nanofluid has exhibited a lower enhancement compared to the EG-Water based SiC nanofluid as shown in Figures 4(b) and (d) respectively. 20:80 EG-Water based SiC nanofluid has exhibited a higher enhancemnet compared to that of 40:60 EG-Water based nanofluid.



(a) Viscosity of Nanofluids (b) Relative Viscosity of SiC



(c) Thermal Conductivity of Nanofluids (d) Relative Thermal Conductivity Nanofluids

Figure 4. Viscosity and Thermal Conductivity of SiC Nanofluids

These results matched with other works reported in the literature, viz., Nikkam et al. [5], and Timofeeva et al. [6] who reported that the higher enhancement in properties is observed for EG-Water based nanofluids compared to that of water-based nanofluids.

Based on the measured thermophysical properties of the three different SiC-based nanofluids, their Prandtl number is calculated and the same is shown in Figure 5. The Prandtl number of three base fluids is observed to sharply decrease with the addition of 0.02% SiC nanoparticles and then gradually increase with volume concentration, with a minute rate of change. 40:60 EG-Water based Fe_3O_4 nanofluid has exhibited higher Prandtl number, while that of DW based nanofluid has exhibited lower Prandtl number for all the volume concentrations considered in the analysis.

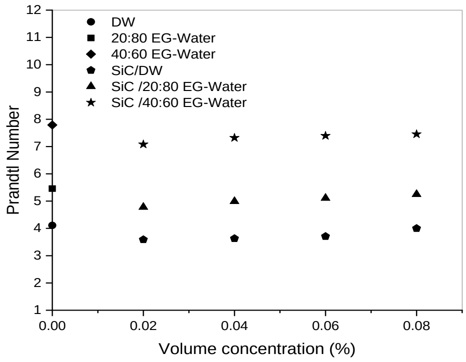


Figure 5. Prandtl Number of the Nanofluids

4.2 Comparison of Thermal Performance of SiC Nanofluids

4.2.1 Nusselt Number & Heat Transfer Coefficient

Figure 6 indicates comparison of Nusselt number of nanofluids in the analysis at 0.08% volume concnetration with the correlations given by Pak & Cho [21], Dittus Boelter [22], Vajjha et al. [23] and Sharma et al. [24] given by Eqs. (8) to (11).

$$Nu=0.021Re^{0.8}\,Pr^{0.5} \tag{8}$$

$$Nu = 0.023\,Re^{0.8}\,Pr^{0.4} \tag{9}$$

$$Nu=0.065(Re^{0.65}-60.22)(1+0.0169\O^{0.15})Pr^{0.542} \tag{10}$$

$$Nu=0.023\,Re^{0.8}Pr_w{}^{0.4}(1+Pr_{nf})^{-0.012}(1+\O)^{0.23} \tag{11}$$

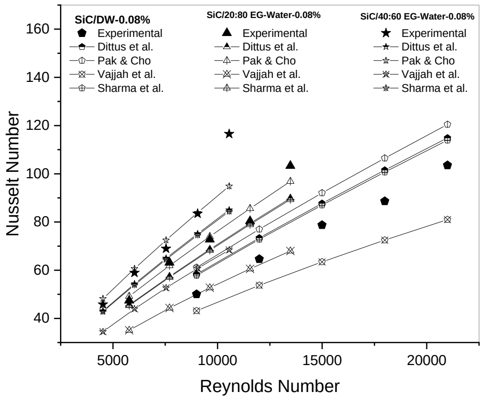


Figure 6. Comparison of Nussel Number with Correlations for Volume Concentrations of 0.08%

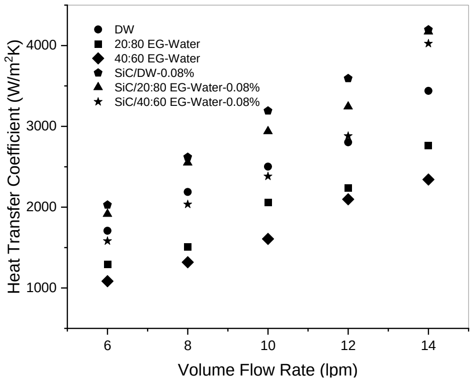


Figure 7. Heat Transfer Coefficient of Nanofluids

All the correlations predicted the experimental data well with a deviation varying from 0.65% to 28%. The average percentage enhancement in Nusselt number is 0.83%, 7.48%, and 13.16% respectively for SiC/DW, SiC/20:80 EG-Water and SiC/40:60 EG-Water nanofluid at 0.08% volume concentration compared to that of corresponding base fluid. The minor enhancement of Nusselt number shows that the dominant mode of heat transfer in these nanofluids is Brownian motion induced diffusion, as the contribution of convection in enhancing the heat transfer in nanofluids is almost the same as that in their corresponding base fluids. Among the three different base fluid-based SiC nanofluids considered in the analysis, DW based nanofluid has a comparatively higher component of diffusion, for the same volume concentration.

The variation of heat transfer coefficient of base fluids and nanofluids considered in the analysis at 0.08% volume concentration with the volume flow rates is shown in Figure 7. The results show that the enhancement in heat transfer coefficient is higher at higher flow rates due to the combined effect of enhanced thermo-physical properties and turbulence associated with higher flow rates for all the three different base fluid-based SiC nanofluids. SiC/40:60 EG-Water nanofluid has exhibited a maximum enhancement of 71.8% in the heat transfer coefficient at 0.08% volume concentration at 14 lpm. DW based SiC nanofluid has exhibited an enhancement of 23.25% at 0.08% volume concnetration at 14 lpm. This is due to the thermophysical properties of DW based SiC nanofluid, which did not exhibit a significant enhancement in the properties, though the thermal conductivity of DW based nanofluids is higher than other two types of nanofluids.

The DW based nanofluid has a higher heat transfer coefficient, due to its higher thermal conductivity and lower viscosity compared to the other two base fluids. Though the viscosity of 20:80 EG-Water based nanofluid is significantly higher than that of DW based nanofluid, because of the minor difference in the corresponding Prandtl number as shown in Figure 5, both the fluids offered similar resistance to heat transfer. The 40:60 EG-Water based SiC nanofluid has exhibited a lower heat transfer coefficient, due to its higher Prandtl number, comparatively. The heat transfer coefficient of DW based nanofluid is 1.21 times that of 40:60 EG-Water based nanofluid and 1.05 times than that of 20:80 EG-Water based nanofluid for a volume concentration of 0.08%, over the range of flow rates considered in the analysis.

4.3 Friction Factor & Thermal performance Factor

Figure 8. shows the comparision of experimental friction factor of the nanofluids in the analysis at 0.08% volume concentration with the correlations given by Vajjah et al. [23] and Sharma et al. [24], given by Eqs. (12) and (13).

$$f_{nf}= f_{bf}((\rho_{nf}/\rho_{bf})^{0.797}(\mu_{nf}/\mu_{bf})^{0.108}) \qquad (12)$$

$$f_{nf}= f_{bf}((\rho_{nf}/\rho_{bf})^{1.3}(\mu_{nf}/\mu_{bf})^{0.3}) \qquad (13)$$

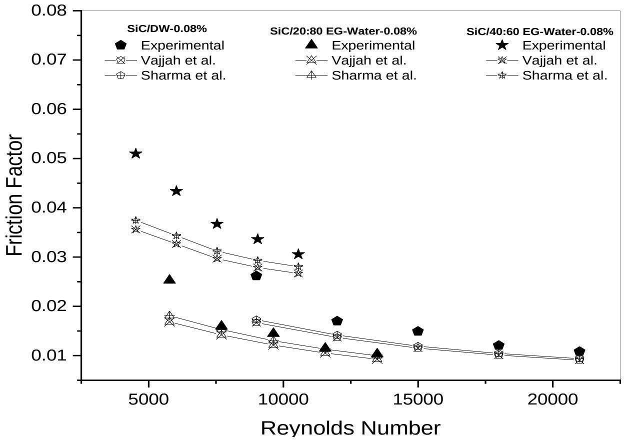


Figure 8. Comparison of Friction Factor with Correlations for 0.08% Volume Concentration

Both the correlations have predicted the experimental data of EG-Water based nanofluid with a deviation of 1.63% to 29.65%, while the experimental data of DW based nanofluid is predicted by 6.76% to 22.27% deviation, on an average over the range of flow rates considered in the analysis. Both the correlations and experimental data of three different base fluid-based nanofluids followed the same trend, viz., in experimental as well as correlations, the friction factor of 20:80 EG-Water based nanofluid has exhibited a lower friction factor and the higher friction factor is exhibited by 40:60 EG-Water based nanofluid, at 0.08% volume concentrations.

To compare the overall performance of the nanofluids the Thermal Performance Factor (TPF) represented by η given by Eq. (14) is evaluated and the same is represented in Figure 9.

$$\eta = \frac{\left(\frac{Nu_{nf}}{Nu_{bf}}\right)}{\left(\frac{f_{nf}}{f_{bf}}\right)^{\frac{1}{3}}}$$

(14)

The average TPF over the range of flow rates considered in the analysis is 0.92, 0.997, and 1.036 respectively for DW, 20:80 EG-Water and 40:60 EG-Water based SiC nanofluids for a volume concentration of 0.08%. This shows the effect of base fluid becomes less significant when high thermal conductivity nanoparticle suspensions like SiC is used for the preparation of nanofluid. Due to higher enhancement in the heat transfer coefficient compared to the corresponding increment in the friction factor, the TPF of 40:60 EG-Water based nanofluid is slightly higher than the other two types of nanofluids.

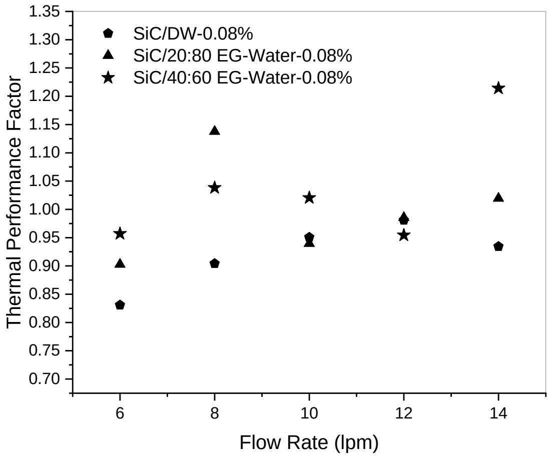


Figure 9. Thermal performance of Nanofluids at 0.08%

5. CONCLUSIONS

The thermo-hydraulic performance of DW, 20:80 EG-Water, and 40:60 EG-Water based SiC nanofluids is experimentally investigated in a double pipe heat exchanger for low

volume concentrations of up to 0.08% under turbulent conditions. The following inferences are drawn from the analysis.

- The effect of base fluid is clearly observed on the thermo-physical properties of SiC nanofluids. The relative enhancement in viscosity and thermal conductivity is observed to be higher for 20:80 EG-Water based SiC nanofluid, compared to the other two types of SiC nanofluids.
- The most widely used Pak and Cho correlations for density and specific heat has predicted the experimentally measured properties with good agreement.
- The heat transfer coefficient of DW based nanofluid is 1.21 times that of 40:60 EG-Water based nanofluid and 1.05 times than that of 20:80 EG-Water based nanofluid for a volume concentration of 0.08%, over the range of flow rates considered in the analysis.
- The Vajjaha et al. [23] and Sharma et al. [24] correlations have predicted the experimental data of both EG-Water based SiC nanofluids better than DW based nanofluid, with less than 30% error in heat transfer coefficient and friction factor.
- For the same volume concentration of SiC suspensions considered in the analysis, significant enhancement in the thermo-hydraulic performance is resulted in both EG-Water based nanofluids, compared to that of DW based SiC nanofluid.
- Higher enhancement in heat transfer coefficient and thus comparatively higher Thermal Performance Factor is observed for 40:60 EG-Water based SiC nanofluid.
- A maximum enhancement of 71.8% is obtained for SiC/40:60 EG-Water nanofluid at 0.08% volume concentration at 14 lpm.
- Based on the analysis of three different base fluids considered in the present work, the effect of base fluid is observed to become less significant when high thermal conductivity nanoparticle suspensions like SiC is used for the preparation of nanofluid.

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