Experimental Investigation of Convective Heat Transfer using Ethylene Glycol based Nano-fluid

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Abstract

- Coolant Having importance in automobile industry are being used as thermal fluid to study the heat transfer coefficient performance. The experiment is done by using 50:50 Water Ethylene Glycol based nanofluid through a 1 meter long circular copper tube of 18mm External Diameter and 16.5mm internal Diameter.

- Three volumetric concentration (0.5%,0.10% and 0.15%) of SiO2 are used in nanofluids to find out the total convective heat transfer coefficient by varying Reynold number.

- Maximum enhancement of 29% in CHT coefficient is observed in case of 0.15% SiO2.
Introduction

- Fluid flow and heat transfer (HT) in a channel has been a famous region of specialists because of its generally application.
- Increased turbulence, boundary layer disturbance and increased HT surface area are main input factors involved in increasing HT.
- Choi and his team was first to use Nanofluids.
- After Maxwell research, Nanofluids got importance.
- Sir Ali et al. used Cu-water NFs to investigate effect of Brownian motion and HT in a notched walled in area loaded up with NFS numerically.
Introduction cont......

- Ravi Kumar et al.
- Umar Khan et al.
- Hwang et al. and Eastman et al.
- Leong et al.
- Zakaria et al.
- Sundar et al.
- Reddy and Rao
- Sohaib Usman et al. and many more.
Methodology of Research

- Design of model for copper test tube
- Fabrication of experimental setup
- Selection of K type thermocouples, pump, NPS and valve
- Preparation of Nanofluids
- Analyzing the effect of Nanofluids under different flow condition
- Comparison of HT rate for different concentrations
- Comparison of HT rate for varying Reynolds number
- Investigate the effect on heat transfer axially by changing distance.
- Comparison of the heat transfer for different concentrations of NFs and for change in Reynolds number.
Experimental Setup

[Diagram showing a flowchart with labels for Air Cooler, Data Acquisition, Copper tube, Insulating material, DC Power supply, Collection Tank, Reservoir tank, 3 way valve, Heater, and Tin.]
Experimental Setup

Power Supply

Radiator

Data Logger

Laptop

Reservoir Tank

Insulation

Copper Tube

Bypass Valve

Flow meter

Regulator valve

Pump
## Nanoparticles

<table>
<thead>
<tr>
<th>Purity</th>
<th>Size</th>
<th>Morphology</th>
<th>Specific heat</th>
<th>Thermal Conductivity (TC)</th>
<th>Density ($\rho$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>99%</td>
<td>20nm</td>
<td>Spherical</td>
<td>745 J/Kg.K</td>
<td>1.4 W/m.K</td>
<td>5240 Kg/m³</td>
</tr>
</tbody>
</table>
Results and Discussion

- Convective heat transfer (CHT) co-efficient is used to calculate the HT during convection, fluid flow or change in phase between a fluid and the solid.
- In case of 0.15% SiO$_2$ NPs higher value of CHT is observed because of the ability of NF to absorb more HT as compared to base fluid.
- Increase in Re number also increases the CHT. The observed value of Re is 7500-21000.
- Almost 29% increase in CHT was observed as compared to base fluid at a Re of 20,600 for 0.15% SiO$_2$ NPs. In case of 0.05% SiO$_2$ NPs maximum enhancement observed was 9-11%.
Reynolds number vs Convective heat transfer coefficient
Axial distance vs heat transfer coefficient

Re=8820±200

Water+EG
0.05% SiO2
0.1% SiO2
0.15% SiO2
Variation in wall temperature against Reynolds number
Variation in $T_{w}-T_{f}$ by changing axial distance

![Graph showing variation in $T_{w}-T_{f}$ by changing axial distance with different concentrations of SiO2.](image-url)
Conclusion

- Experimental investigation of the internal CHT of Nanofluid in a copper tube in fully turbulent regime has been conducted.
- At 0.15% SiO$_2$ nanoparticles almost 29% enhancement in heat transfer co-efficient is observed at maximum Re of 19,200 as compared to water-EG.
- At 0.1% SiO$_2$ nanoparticles the maximum enhancement is observed as 9-11%. When concentration is increased, increase in CHT is observed.
- The possible reason for the enhancement of the CHT is not only the increase in the TC of the NF. But also are Particle migration, chaotic movement of the nanoparticles and fluctuations in the fluid which causes turbulence and reduction in the thermal boundary layer which increase heat transfer rate as compare to base fluid.
References


- L. Chola, K.K. Sharma, R. Kumar, AN EXPERIMENTAL THERMAL ANALYSIS FOR PERFORMANCE IMPROVEMENT OF CIRCULAR PIPE, 1 (n.d.).

References

Thank you