# 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.

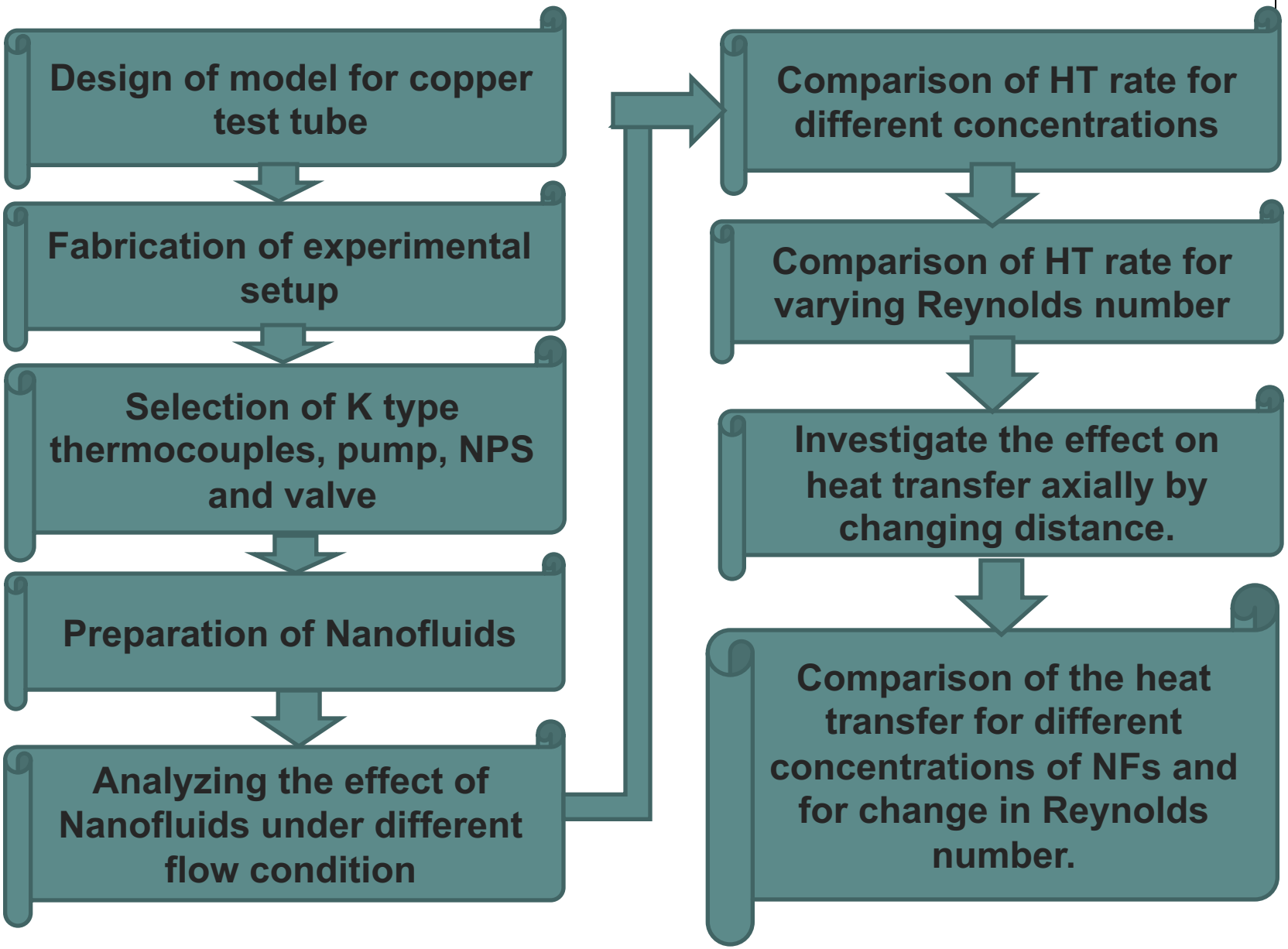
# Introduction

- 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.

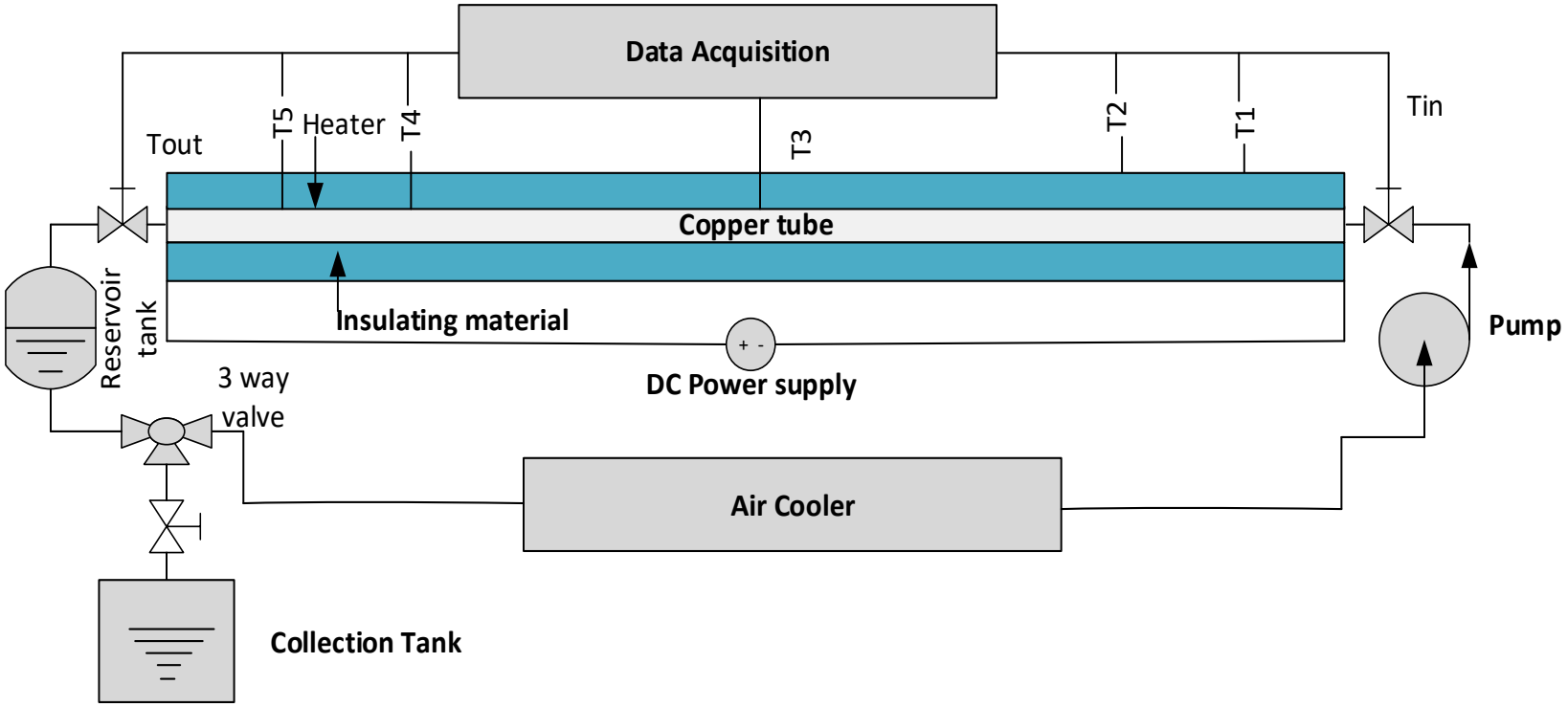
# Introduction cont……

- 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



# Experimental Setup



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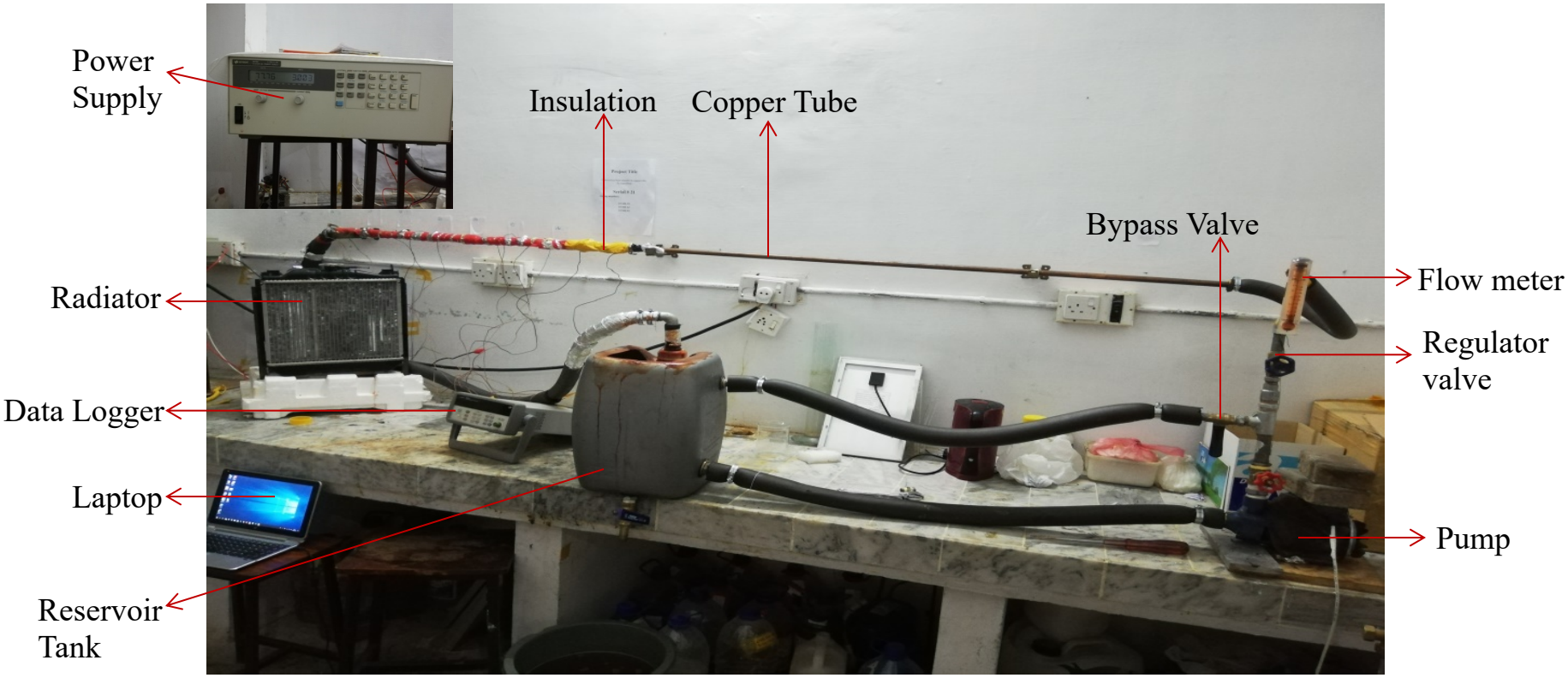


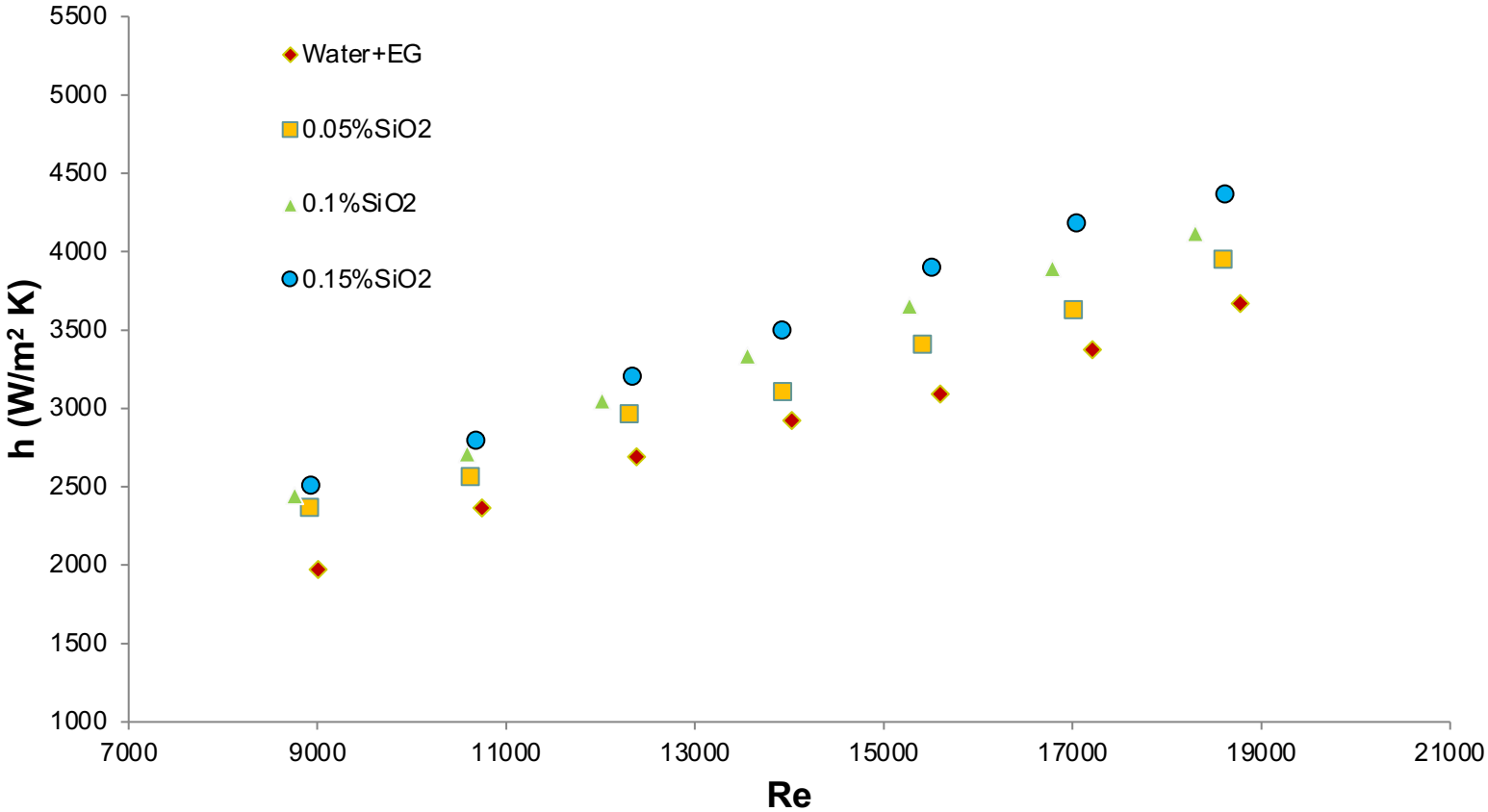
# Nanoparticles

| Purity | Size | Morphology | Specific heat | Thermal Conductivity (TC) | Density ($\rho$) |
|---|---|---|---|---|---|
| **99%** | 20nm | Spherical | 745 j/Kg.K | 1.4 W/m.K | 5240.Kg/$m^3$ |

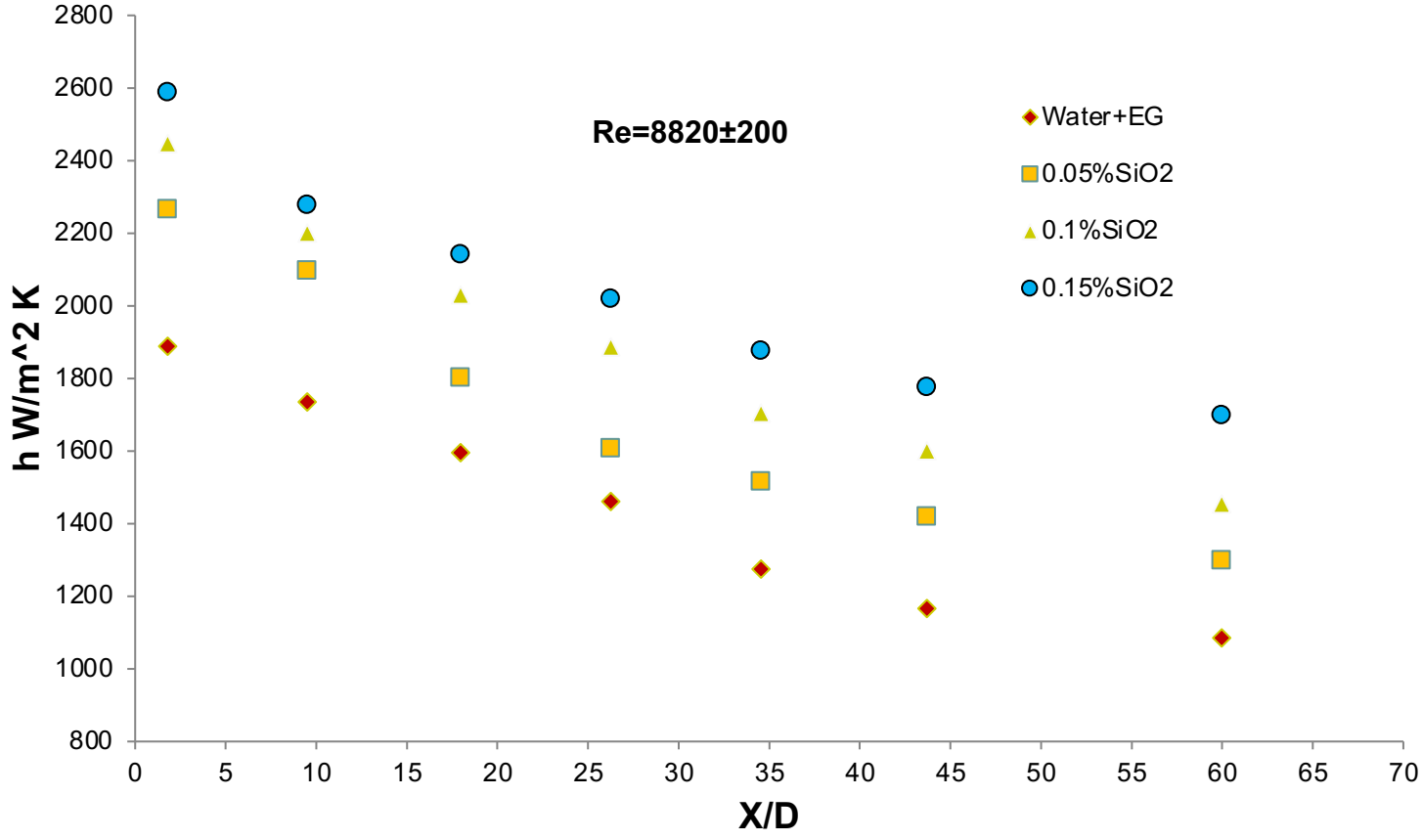
# Results and Discussion

- 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%.

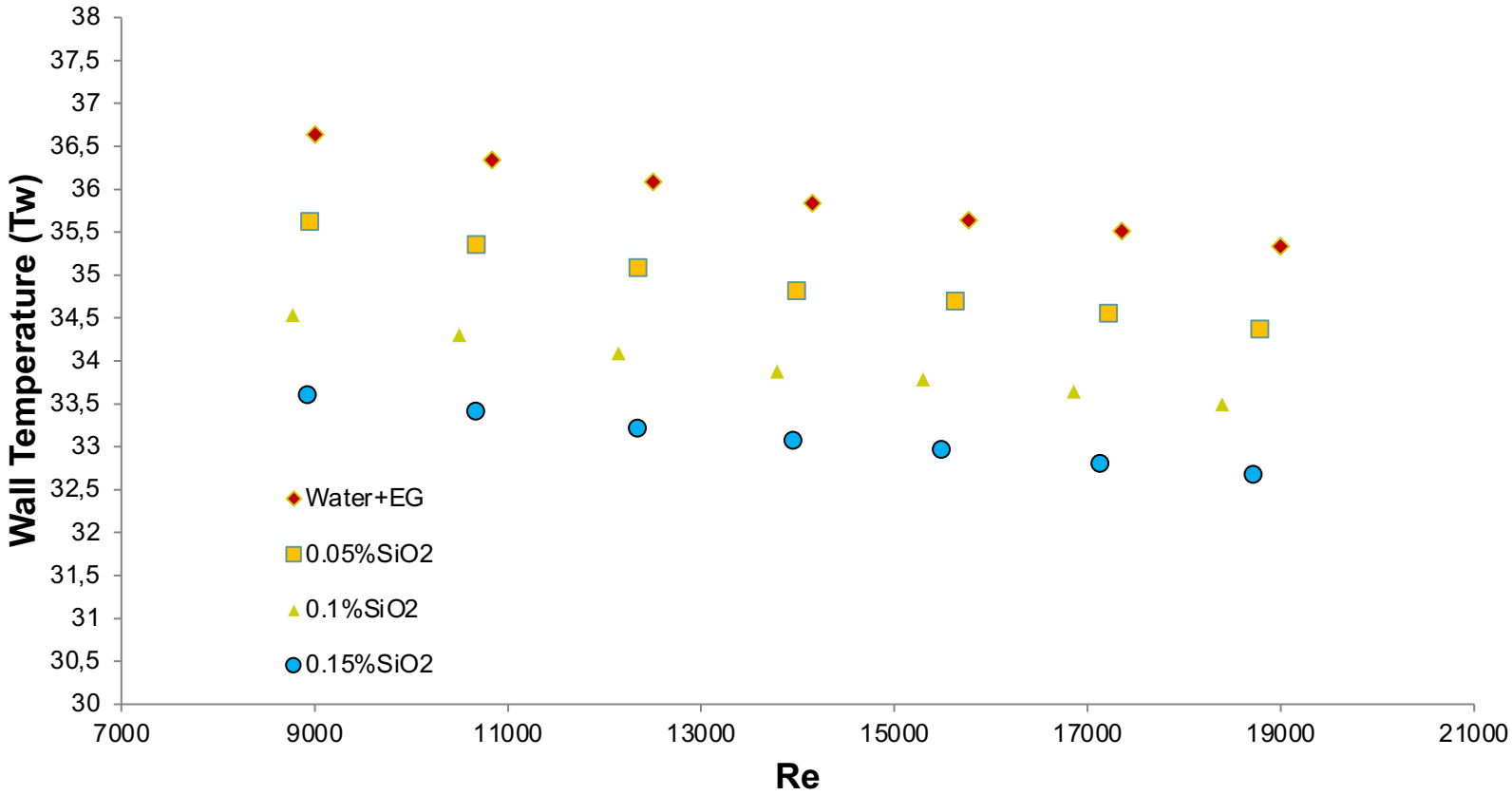
# Reynolds number vs Convective heat transfer coefficient



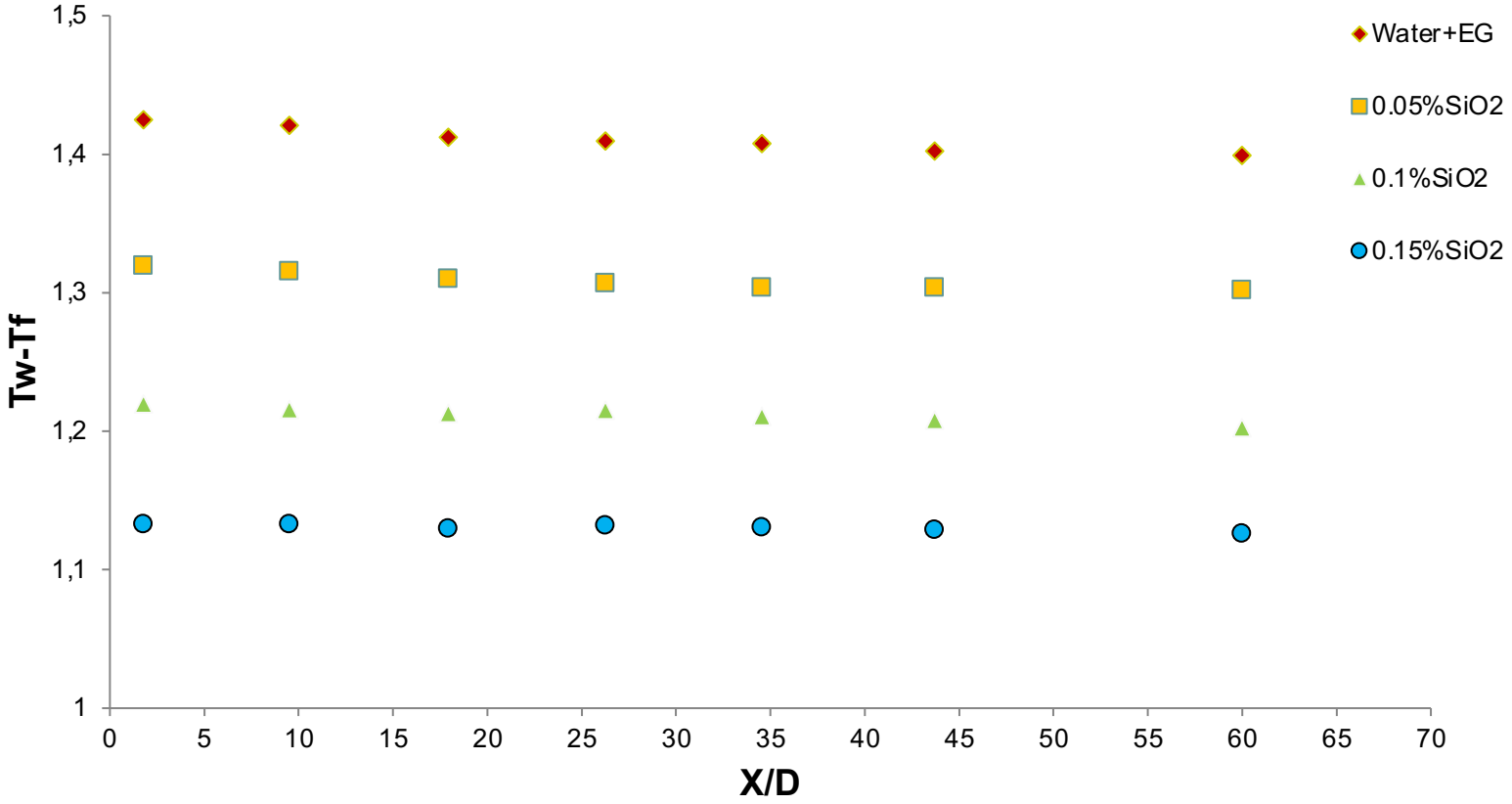
# Axial distance vs heat transfer coefficient



# Variation in wall temperature against Reynolds number



# Variation in Tw-Tf by changing axial distance



# 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% $Si0_2$ 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


- R. Mohebbi, M.M. Rashidi, M. Izadi, N.A.C. Sidik, H.W. Xian, Forced convection of nanofluids in an extended surfaces channel using lattice Boltzmann method, Int. J. Heat Mass Transf. 117 (2018) 1291–1303.
- Y. Ma, R. Mohebbi, M.M. Rashidi, Z. Yang, Study of nanofluid forced convection heat transfer in a bent channel by means of lattice Boltzmann method, Phys. Fluids. 30 (2018) 32001.
- Y. Vermahmoudi, S.M. Peyghambarzadeh, S.H. Hashemabadi, M. Naraki, Experimental investigation on heat transfer performance of Fe 2 O 3/water nanofluid in an air-finned heat exchanger, Eur. J. Mech. B/Fluids. 44 (2014) 32–41. doi:10.1016/j.euromechflu.2013.10.002.
- M. Jafari, M. Farhadi, K. Sedighi, Convection heat transfer of SWCNT-nanofluid in a corrugated channel under pulsating velocity profile, Int. Commun. Heat Mass Transf. 67 (2015) 137–146.
- L. Chola, K.K. Sharma, R. Kumar, AN EXPERIMENTAL THERMAL ANALYSIS FOR PERFORMANCE IMPROVEMENT OF CIRCULAR PIPE, 1 (n.d.).
- J.C. Maxwell, A treatise on electricity and magnetism, Oxford: Clarendon Press, 1873.

# References


- S.U.S. Choi, D.A. Singer, H.P. Wang, Developments and applications of non-Newtonian flows, Asme Fed. 66 (1995) 99–105.
- H.M. Ali, H. Babar, T.R. Shah, M.U. Sajid, M.A. Qasim, S. Javed, Preparation techniques of TiO2 nanofluids and challenges: A review, Appl. Sci. 8 (2018). doi:10.3390/app8040587.
- S.M.S. Murshed, C.A.N. De Castro, Forced convective heat transfer of nanofluids in minichannels, in: Two Phase Flow, Phase Chang. Numer. Model., IntechOpen, 2011.
- S.U.S. Choi, Z.G. Zhang, W. Yu, F.E. Lockwood, E.A. Grulke, Anomalous thermal conductivity enhancement in nanotube suspensions, Appl. Phys. Lett. 79 (2001) 2252–2254. doi:10.1063/1.1408272.
- M.M. Ali, M.A. Alim, S.S. Ahmed, Numerical Simulation of Hydromagnetic Natural Convection Flow in a Grooved Enclosure Filled with CuO–Water Nanofluid Considering Brownian Motion, Int. J. Appl. Comput. Math. 4 (2018) 1–24. doi:10.1007/s40819-018-0563-1.
- N.T. Ravi Kumar, P. Bhramara, B.M. Addis, L.S. Sundar, M.K. Singh, A.C.M. Sousa, Heat transfer, friction factor and effectiveness analysis of Fe3O4/water nanofluid flow in a double pipe heat exchanger with return bend, Int. Commun. Heat Mass Transf. 81 (2017) 155–163. doi:10.1016/j.icheatmasstransfer.2016.12.019.

# Thank you