



# IJRASET

International Journal For Research in  
Applied Science and Engineering Technology



---

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

---

**Volume: 5      Issue: VI      Month of publication: June 2017**

**DOI:**

**[www.ijraset.com](http://www.ijraset.com)**

**Call:  08813907089**

**E-mail ID: [ijraset@gmail.com](mailto:ijraset@gmail.com)**

# The Experimental Study of Heat Transfer Coefficient of $\text{Al}_2\text{O}_3$ /Water Nano Fluid by Using Double Pipe Heat Exchanger

Tharoon T<sup>1</sup>

<sup>1</sup>UG Scholar, Department of Mechanical Engineering, SNS College of Technology, Coimbatore-35, Tamilnadu, India.

**Abstract:** The heat transfer coefficient of  $\text{Al}_2\text{O}_3$ /Water nanofluid is investigated experimentally in this paper. This Experiment is done with the help of double pipe heat exchanger. The  $\text{Al}_2\text{O}_3$  nanofluid is prepared by dispersing an  $\text{Al}_2\text{O}_3$  nanoparticle in deionized water.  $\text{Al}_2\text{O}_3$  /Water nanofluid with a nominal diameter 20nm at different volume concentration (0.4&0.8 vol %) at room temperature was used for this investigations. The result of this experiment proves that the convective heat transfer coefficient increases with an increase in time and also the Nusslet number increases with increasing the liquid flow rate.

**Keywords:**  $\text{Al}_2\text{O}_3$  nanofluid, Nusslet number, the coefficient heat transfer.

## I. INTRODUCTION

The rate of heat transfer is considered as a necessary parameter for the design of any mechanical, electrical or electronic component. The heat transfer rate of the element is obtained by the surface area, surface roughness, thermal conductivity of the element and the temperature gradient. Many of the researches have tried to increase the thermal conductivity of the fluid in order to increase the heat transfer rate [5,17]. The thermal conductivity of the fluid can be increased by the nanofluids. Fluids with nano particles suspended in them are called as nanofluids, a term coined by Choi in 1995 of the Argonne National Laboratory, U.S.A. The higher the Nusslet number will tend to increase the heat transfer coefficient and also increases the heat transfer rate of the nanofluid. Nanofluids [1] can be used for the wide variety of industries, ranging from transportation to energy production and in

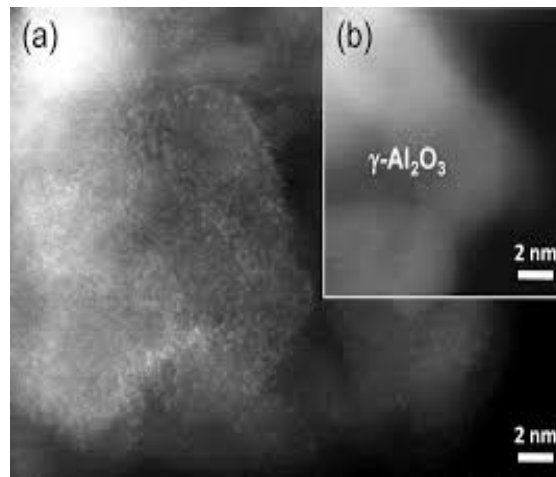


Figure 1.  $\text{Al}_2\text{O}_3$  Nano particle

electronics systems like a microprocessor. Considering the heat transfer point of view, one of the most important challenges faced by the experts is the necessity to increase the heat flux and to reduce the size of the heat exchanger for the efficient use of the energy. The conventional heat transfer fluids like water, ethylene glycol, propylene glycol etc. are widely used to remove the heat from the mechanical systems. However, these conventional fluids have very poor heat transfer properties. So we prepare nanofluids which mean special kinds of heat transfer fluids are named as “Nano fluids”. Nano fluids are relatively new class of fluid containing suspension of nanometer-sized particles in the base fluids like water, ethylene glycol, propylene glycol, oil etc. The main objectives of nanofluid are Heat transfer rate increases due to large surface area of the nanoparticles in the base fluid, Nanofluids are most suitable for rapid heating and also cooling systems, higher thermal conductivity of nanoparticles will increase the heat transfer rate,

## International Journal for Research in Applied Science & Engineering Technology (IJRASET)

where pressure drop is minimum[3,8].

### II. METHODOLOGY

In this study, the following methodology to be used.

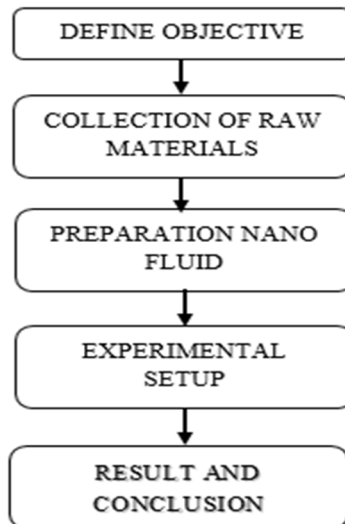


Figure 2. Methodology

### III. PREPARATION OF NANOFLUID

The two-step method is used because it's a simple technique and cost efficient than the one-step method. The  $Al_2O_3$ /water nanofluid was prepared [6, 7]. The following steps are followed to prepare the  $Al_2O_3$  nanofluid to weigh a certain amount of nanoparticles, SDBS and distilled water obey their proportions. By adding the nanoparticles and the SDBS into the distilled water slowly to make the nanoparticles suspended better, and the nanoparticles suspensions were obtained. Place the beaker containing the suspension on a magnetic stirrer and stir it for 30 minutes. Then make the suspension take ultrasonic vibration for 2 hours to get the nanofluids. The magnetic stirring and ultrasonic vibration are physical methods to make the fluids more corresponding which affected by the time of stirring and vibration, but the time has not gotten consistent recognition. During the initial experiments, many bubbles appeared on the surface of nanoparticles suspensions after magnetic stirring, these bubbles can adhere to the beaker wall when we shift the suspension from a beaker to colorimetric tubes, which affected the mass fractions of the suspension in colorimetric tubes. This is because SDBS has high surface activity and the air is easy to dissolve into the fluid in the stirring process, where bubbles are formed easily. To solve this problem, the stirring speed was reduced from 1150r/min to 850r/min, and the stirring time was extended from 15min to 25min. It was confirmed that this method is effective to reduce the formation of bubbles, and improves the quality of the obtained nanofluids.

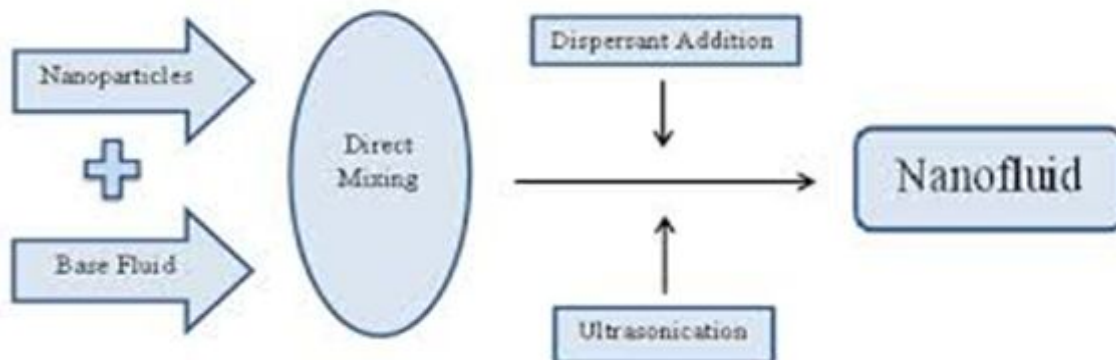


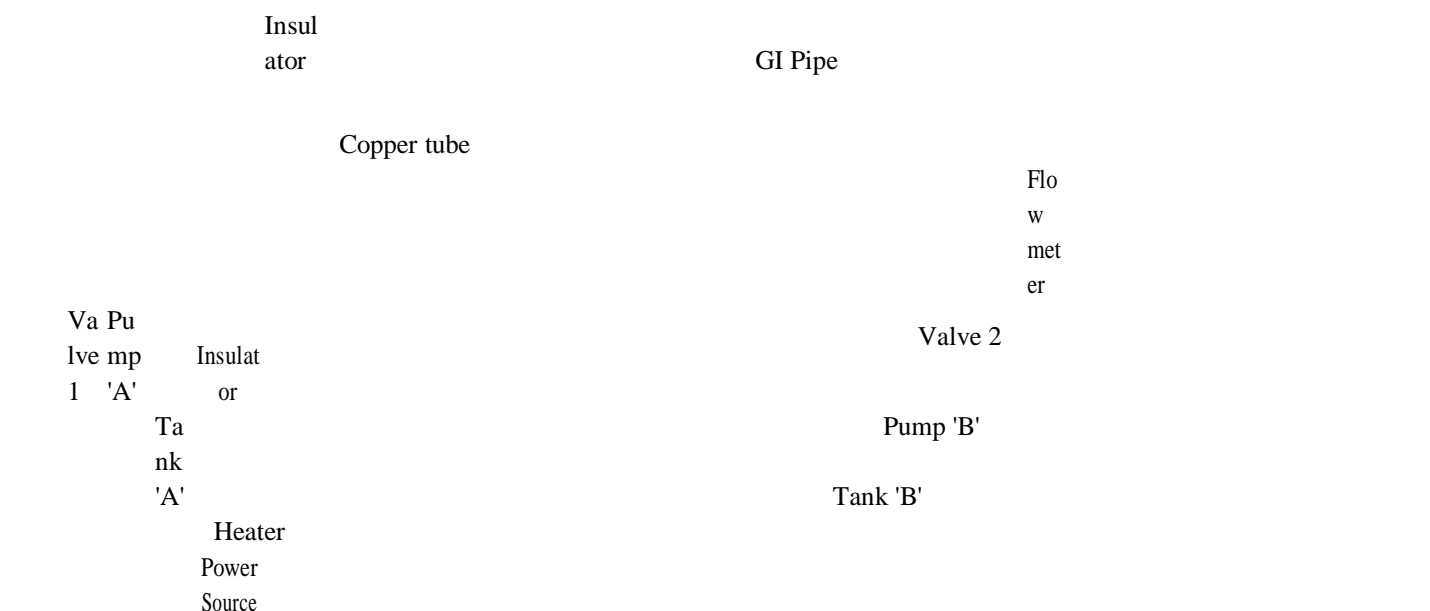
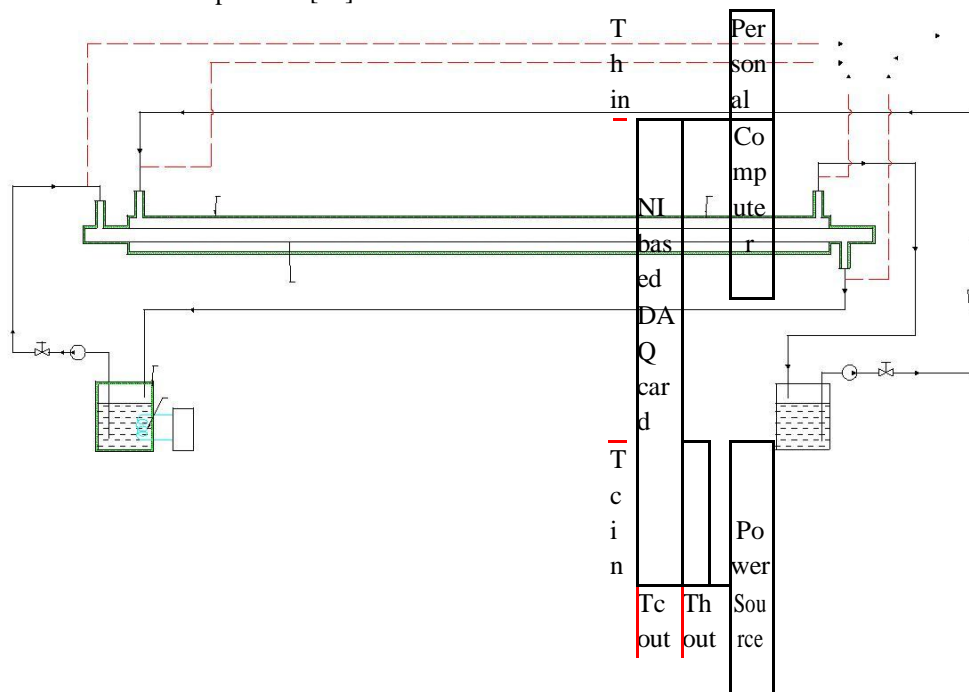
Figure 3. Preparation process

## International Journal for Research in Applied Science & Engineering Technology (IJRASET)

### IV. EXPERIMENTAL SETUP

The experiment setup is as shown in Fig.3. This experimental setup consists of two tanks namely tank A and tank B with a capacity of 10 litres were used to store the water. The 2kW immiscible heater is fitted in the tank A to heat the water. Two centrifugal pumps were used to circulate the water into the test section.

One pump is used to circulate the cold water in the outer tube and the other pump is used to circulate the hot water in the inner tube. The outer pipe of the test section is made of Galvanized Iron (GI), 42mm outside diameter and 34.2mm inner diameter with a heat exchange length of 1m. The inner tube is made from smooth copper tubing with 9.53mm outer diameter and 8.13mm inner diameter and 1.5m length. To reduce the heat loss from the system the test section is perfectly insulated by using Rockwool. Here K-type thermocouples are used to measure the temperature [18].



# International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Figure 4. Schematic diagram of the experimental setup.

## V. RESULT AND DISCUSSIONS

The  $Al_2O_3$ /water nanofluid is prepared by two step method the properties of the  $Al_2O_3$  and water are given below:

Table 1 Properties of Substances

S. No	Particle/ Fluid	Mean Diameter (nm)	Density ( $kg/m^3$ )	Thermal Conductivity ( $w/m-k$ )	Specific Heat ( $J/kg-K$ )
1.	$Al_2O_3$	20	3700	46	880
2.	Water	-	998	0.628	4178

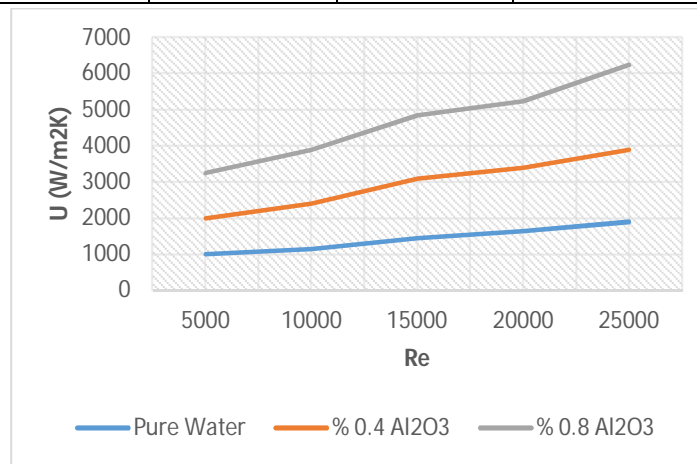


Figure 5. The relationship between the convective heat transfer coefficient and the Reynolds number of  $Al_2O_3$ /water nanofluid

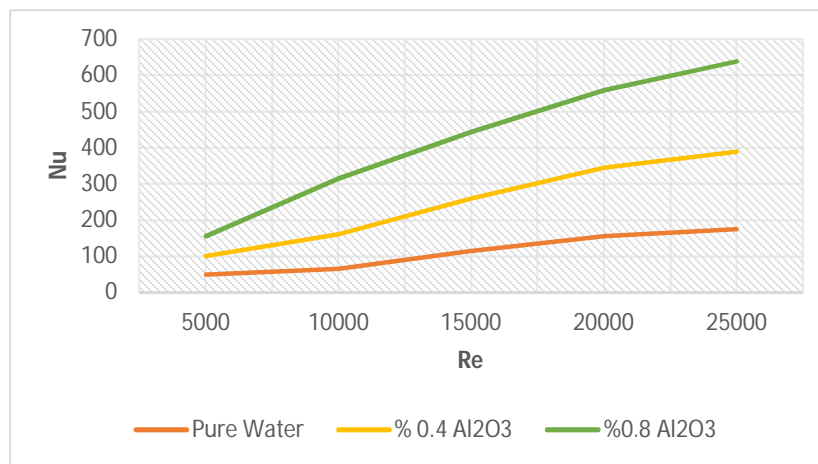


Figure 6. The relationship between the Reynolds number and Nusselt number of  $Al_2O_3$ /water nanofluid.

The graph is plotted between the convective heat transfer coefficient and the Reynolds number. This figure shows that the convective heat transfer coefficient increases with an increasing Reynolds number also the heat transfer coefficient of the  $Al_2O_3$ /water nanofluid is higher that of water at a given Reynolds number.

## VI. CONCLUSION

The heat transfer coefficient of  $Al_2O_3$ /Water nanofluid is investigated experimentally in this paper. This Experiment is done with the help of double pipe heat exchanger. The  $Al_2O_3$  nanofluid is prepared by dispersing an  $Al_2O_3$  nanoparticle in deionized water.  $Al_2O_3$

## International Journal for Research in Applied Science & Engineering Technology (IJRASET)

/Water nanofluid with a nominal diameter 20nm at different volume concentration (0.4&0.8 vol %) at room temperature was used for this investigations. In this study, the convective heat transfer coefficient of an  $\text{Al}_2\text{O}_3$ /water Nano fluid was investigated. The  $\text{Al}_2\text{O}_3$ /water nanofluid was prepared by dispersing  $\text{Al}_2\text{O}_3$  particles in deionized water. This experimental result showed that the convective heat transfer coefficient and the Nusselt number of nanofluids was increased compared to base fluid (water).

### REFERENCES

- [1] Abbasian Arani.A.A, Amani.J (2012), "Experimental study on the effect of  $\text{TiO}_2$ -water nanofluid on heat transfer and pressure drop", *Experimental Thermal and Fluid Science* 42 107-115.
- [2] Akhavan-Behabadi.M.A, Fakoor Pakdaman.M, Ghazvini.M (2012), "Experimental investigation on the convective heat transfer of nanofluid inside vertical helically coiled tubes under uniform wall temperature condition", *International Communication in Heat and Mass Transfer* 39 556-564.
- [3] Anoop.K.B, Sundarajan.T, Sarit K. Das (2009), "Effect of particle size on the convective heat transfer in the nanofluid developing region," *International Journal of Heat and Mass Transfer* 52 2189-2195.
- [4] Choi.S.U.S (1998), *Nanofluid technology: current status and future research*. Vienna, VA, US: Korea-U.S. Technical Conference on Strategic Technologies.
- [5] Das.S.K, Choi.S.US, Wenhua Yu, T. Pradeep (2007) *Nanofluids: Science and Technology*. 1 edition. Hoboken, NJ: John Wiley & Sons, Inc.
- [6] Ho.Z.W.Li.C.J, Wei.L.C, (2010), "An experimental investigation of forced convective cooling performance of a micro channel heat sink with  $\text{Al}_2\text{O}_3$ /water nanofluid." *Applied Thermal Engineering* 30, PP 96-103.
- [7] Jongwook Choi and Yuwen Zhang (2012), "Numerical simulation of laminar forced convection heat transfer of  $\text{Al}_2\text{O}_3$ -water nanofluid in a pipe with return bend", *International Journal of Thermal Science* 55 90-102.
- [8] Lee.S,Choi.S.U.S, Eastman.S.Li.J.A, Measuring thermal conductivity of fluid containing oxide nanoparticles, *ASME Journal of Heat Transfer*, 121, PP 280-289.
- [9] Massimo Corcione, Marta Cianfrini, Alessandro Quintino (2012), "Heat transfer of nanofluids in turbulent pipe flow", *International Journal of Thermal Science* 56 58-69.
- [10] Masuda.H, Ebata.A, Teramae.K, andHishinuma.N, (1993) "Alteration of Thermal conductivity and Viscosity of Liquid by Dispersing Ultra-fine Particles." *NetsuBussei (Japan)*, 7(4), PP 227-233.
- [11] .Murshed.S.M.S, Leong.K.C, and Yang.C, (2005), "Enhanced thermal conductivity of  $\text{TiO}_2$ -water based nanofluids." *International Journal of Thermal Sciences*, 44(4), PP 367- 373.
- [12] .Prasher.R, Bhattacharya.P, and Phelan.P.E, (2005), "Thermal Conductivity of Nano scale Colloidal Solutions (Nanofluids)." *Physical Review Letters*, 94(2), 025901.
- [13] .Ravikanth.S, Debendra K. Das, Praveen K. Namburu, (2010), "Numerical study of fluid dynamic and heat transfer performance of  $\text{Al}_2\text{O}_3$  and CuO nanofluids in the flat tubes of a radiator." *International Journal of Heat and Fluid Flow* 31, PP 613-621.
- [14] .Saeedinia.M, Akhavan-Behabadi.M.A, Nasr.M(2012) "Experimental study on heat transfer and pressure drop of nanofluid flow in a horizontal coiled wire inserted tube under constant heat flux", *Experimental Thermal and Fluid Science* 36 158-168.
- [15] .Senthilraja.S,KCK.Vijayakumar, "Analysis of Heat Transfer Coefficient of CuO/Water Nanofluid using Double Pipe Heat Exchanger", *International Journal of Engineering Research and Technology* ISSN 0974-3154 Volume 6,Number 5(2013),pp. 675-680.
- [16] .Sharjeel Tahir, Manu Mital(2012), "Numerical investigation of laminar nanofluid developing flow and heat transfer in a circular channel", *Applied Thermal Engineering* 39 8-14.
- [17] .Syam Sundar.L, Sharma.K.V (2010), "Heat transfer enhancements of low volume concentration  $\text{Al}_2\text{O}_3$  nanofluid and with longitudinal strip inserts in a circular tube" *International Journal of Heat and Mass Transfer* 53 4280-4286.
- [18] .Zeinali Heris.S, Nasr.S. Esfahany, EtemadS.Gh(2007), "Experimental investigation of convective heat transfer of  $\text{Al}_2\text{O}_3$  / water nanofluid in circular tube", *International Journal of Heat and Fluid Flow* 28 203-210.



10.22214/IJRASET



45.98



IMPACT FACTOR:  
7.129



IMPACT FACTOR:  
7.429



# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24\*7 Support on Whatsapp)