**International Journal of Mechanical Engineering and Technology (IJMET)**
Volume 10, Issue 01, January 2019, pp. 564–570, Article ID: IJMET_10_01_058
Available online at http://www.iaeme.com/ijmet/issues.asp?JType=IJMET&VType=10&IType=1
ISSN Print: 0976-6340 and ISSN Online: 0976-6359



# HEAT TRANSFER ENHANCEMENT IN MINI COMPACT HEAT EXCHANGER BY USING ALUMINA NANOFLUID

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## ABSTRACT

*In the recent research activities, the nanofluids have involved a great deal attention since their superior report in thermal performance and many other applications. Now a days cooling process is a great challenge in most of the chemical process, Nuclear reactor, automobile radiator, micro electronics systems. To meet out this, a novel coolant (Nano fluids) was developed by choi.S.U.S 1995 at Argonne National lab. USA. In continuation to his work, water based alumina Nano fluids was prepared and applied in shell and tube heat exchanger to analyze the heat transfer rate. The same analysis is discussed with conventional base fluid of water and alumina nanofluid also this presents the characterization of Alumina Nano particle by means of XRD and SEM.*

**Keywords**: Nano fluids, Overall Heat Transfer, Alumina Nano particles.
**Cite this Article:** V.Vijayan, S. Saravanan, A.Godwin Antony, M.Loganathan and S. Baskar, Heat Transfer Enhancement in Mini Compact Heat Exchanger by using Alumina Nanofluid, International Journal of Mechanical Engineering and Technology, 10(01), 2019, pp. 564–570.
http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&IType=1

# 1. INTRODUCTION

The water acting as conventional heat transfer fluid and engine oil, ethylene glycol are poor heat transfer fluid. Here it is a string need to expand advanced heat transfer fluids with considerably more thermal conductivities and better heat transfer characteristics as compared to the conventional fluids which are available. When comparing the thermal conductivities of fluids, metal, non – metal, ceramics, oxide, nitride, and carbide particles, the higher thermal conductivities have in Metals in solid than other. Even $Al_2O_3$ are acting as good thermal conductivities.

In view of this, Choi S.U.S, Argonne National lab the USA dispersed the $Al_2O_3$ Nano powders in the range of 1 – 100 nm with water and named the suspended $Al_2O_3$ in water, Nano fluids. On testing the $Al_2O_3$ Nano fluids show better properties relation to these of conventional heat transfer fluid. Because the suspended Nano particles have more surface effect suitable to the surface area – to volume ratio and more stable in base fluids due to the Nano Size.

**Table 1** Thremo-physical properties of liquid phase (base fluids) and solid phase (particles) at 300 K

| Property | Ethylene glycol | Water | Al2O3 | Cuo | Tio2 |
|---|---|---|---|---|---|
| k | 0.63 | 0.523 | 42.34 | 18 | 6.531 |
| p | 997 | 1109.04 | 3880 | 6210 | 4230 |
| Cp | 4170 | 2428 | 729 | 540 | 711.62 |
| Molecular weight | 18 | 62 | 101 | 143.09 | 79.9 |

In most of Nano fluids applications the mechanism of effective thermal conductivities, is still under debate and has more uncertainty. While applying Nano fluids the short comings of sedimentation, stability and aggrementation of Nano particles in Nano fluids is not clear even now and how to overcome them.

Several research group proposed different concepts regarding enhancement in Heat transfer using Nano fluids. Lee et al 1 studied the thermal conductivity enhancement in Nano fluids using $Al_2O_3$ Nano particle with water by experimentation. Xuan and Li 2 studied the thermal conductivity enhancement of Al2O3 Nano fluids of different volume fraction.

The major parameter that affect the effective thermal conductivity are volume fraction or particles concentration, shape of the particles temperature of the Nano fluids , pH value of Nano fluids, viscosity, density and fluids preparation method, reported by many research groups.

K.P.Kumar et al [4] reported and proposed that the Sisal Nano fluids can be applied in shell and coil Heat Exchanger for augmenting the effective Heat Transfer and concludes that the Sisal / Silicon particles can be replaced by some particles such as oxide, Nitride, carbide Nano particles of Metals.

The main objective of the experimental work is to analyze the overall heat transfer coefficient of $Al_2O_3$ water based Nano fluids and water and at different at different temperature of hot working medium, when Nanofluids passes through the shell and coil Heat Exchanger. In analysis effective thermal conductivity of nanofluids is taken into account and pH value, Nano fluid layer thicknesses are not considered.

# 2. PREPERATION AND CHARACTERIZATION OF NANO FLUIDS

$Al_2O_3$ Nano powder was supplied by Alfa Aeasar, USA. The particles is to 40-50nm and on delivery under atmosphere conditions, there was no agglomerations. The Nano particles were analyzed by XRD to study the $Al_2O_3$ Nano particles were BCC and showed the crystal size

1.72nm. Scanning Electron Microscope (SEM) showed the surface temperature of the Nano Particles

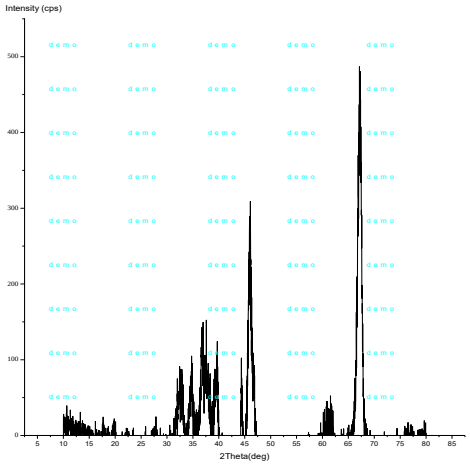



**Figure 1** XRD pattern of $Al_2O_3$ nano particle

## 2.1. SEM IMAGE OF $Al_2O_3$ NANO PARTICLES

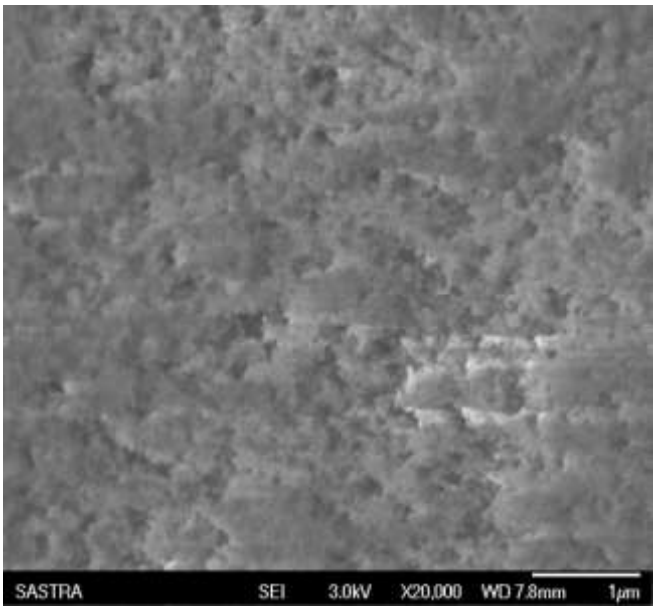



**Figure 2** SEM image

It is assumed that the Nano particle sizes are uniform no sedimentation, No agglomerations, No additive during preparation of nanofluids, pH value maintained Uniform and well dispersion of $Al_2O_3$ Nano particle.

The dispersion of $Al_2O_3$ Nano particles was done by mixing the required volume in water using, initially by vigorous mechanical making and then by ultrasonic agitator about 6 hours. After dispersion, no sedimentation is observed.

## 3. EXPERIMENTAL SETUP

The $Al_2O_3$ Nano fluids is passed through the double pipe heat exchanger of brass with 10mm D and GI with 20mm D with one pass and the Hot working medium is filled with ordinary water. J type thermocouples are placed to measures the temperatures of the two medium.

Heater is immersed to raise the temperature of base fluid and agitator is provided to gain the uniform heating of the water.

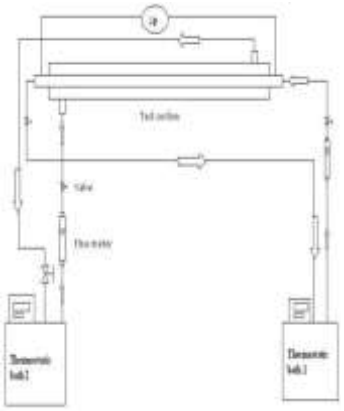


**Figure 3** Experimental setup

## 4. MEASUREMENT OF HEAT TRANSFER FOR NANO FLUIDS

$$Q = \pi NukL\ (\Delta T)$$

$$Nu = 1.86(RePrD/L)^{(1/3)}(\mu/\mu_w)^{0.14}$$

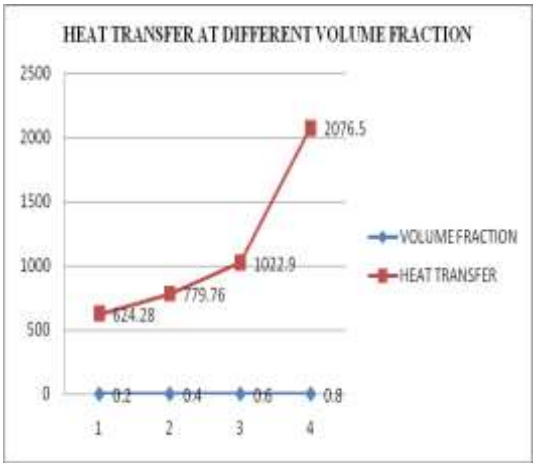
$$Re = \rho vD/\mu$$

$$Pr = Cp\mu/k$$

The following table shows the heat transfer rate of Nano fluids at different volume fraction and water at 40deg C for 1000ml.

**Table 2** Heat transfer rate of Nano fluid

| Medium | Heat Transfer in Watts |
|---|---|
| Water | 86.431 |
| 0.2(6.85g) | 621.39 |
| 0.4(16.8g) | 778.81 |
| 0.6(22.8g) | 1020.81 |
| 0.85(31.13g) | 2074.65 |



## 5. CONCLUSION AND FUTURE WORK

From the above experimental it is concluded that overall heat transfer of Nano fluids improves over the water as a coolant at different volume fraction at different temperature of the hot working medium. Further work is required to explain the theoretical correlations pressure drop of Nano fluid, erosion of tube walls, overall heat transfer co – efficient of different volume fraction, various PH values of Nano fluids at various temperatures of Nano fluids, various sizes of the Nano particles at different Nano particles and different base fluids.

## ACKNOWLEDGMENT

It is my pleasure to express sincere thanks to Mr. R. Krishnamurthy for giving continuous encouragement.

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