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:

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The Experimental Study of Heat Transfer Coefficient of Al_2o_3/Water Nano Fluid by Using Double Pipe Heat Exchanger

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Abstract: 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 /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: Al_2O_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 inorder 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 1955 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

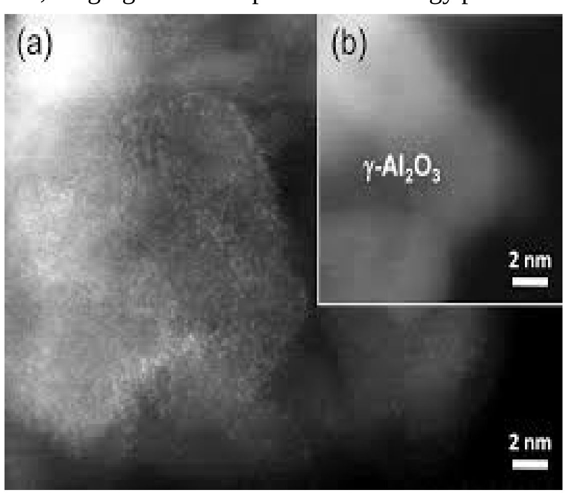

Figure 1. Al_2O_3 Nano particle

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, where pressure drop is minimum[3,8].

II. METHODOLOGY

In this study, the following methodology to be used.

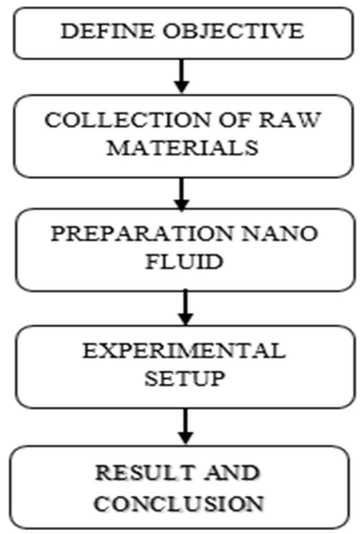

Figure 2. Methodology

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.

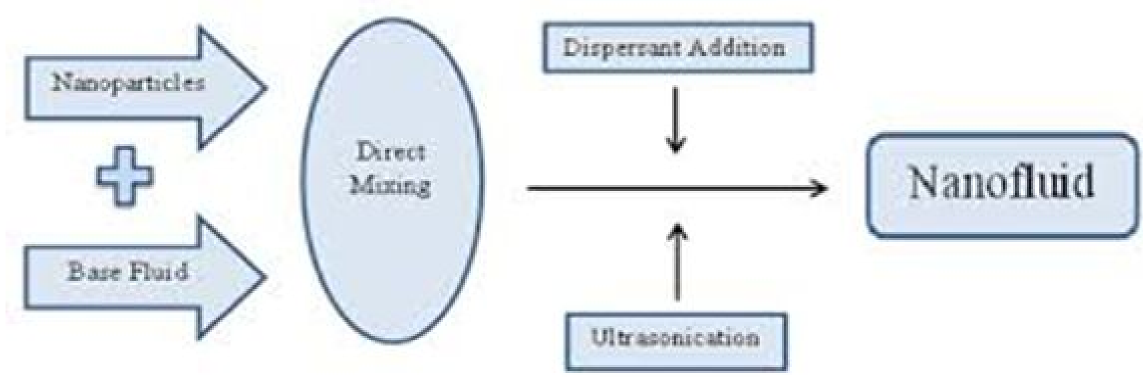

Figure 3. Preparation process

Volume 5 Issue VI, June 2017
ISSN: 2321-9653

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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].

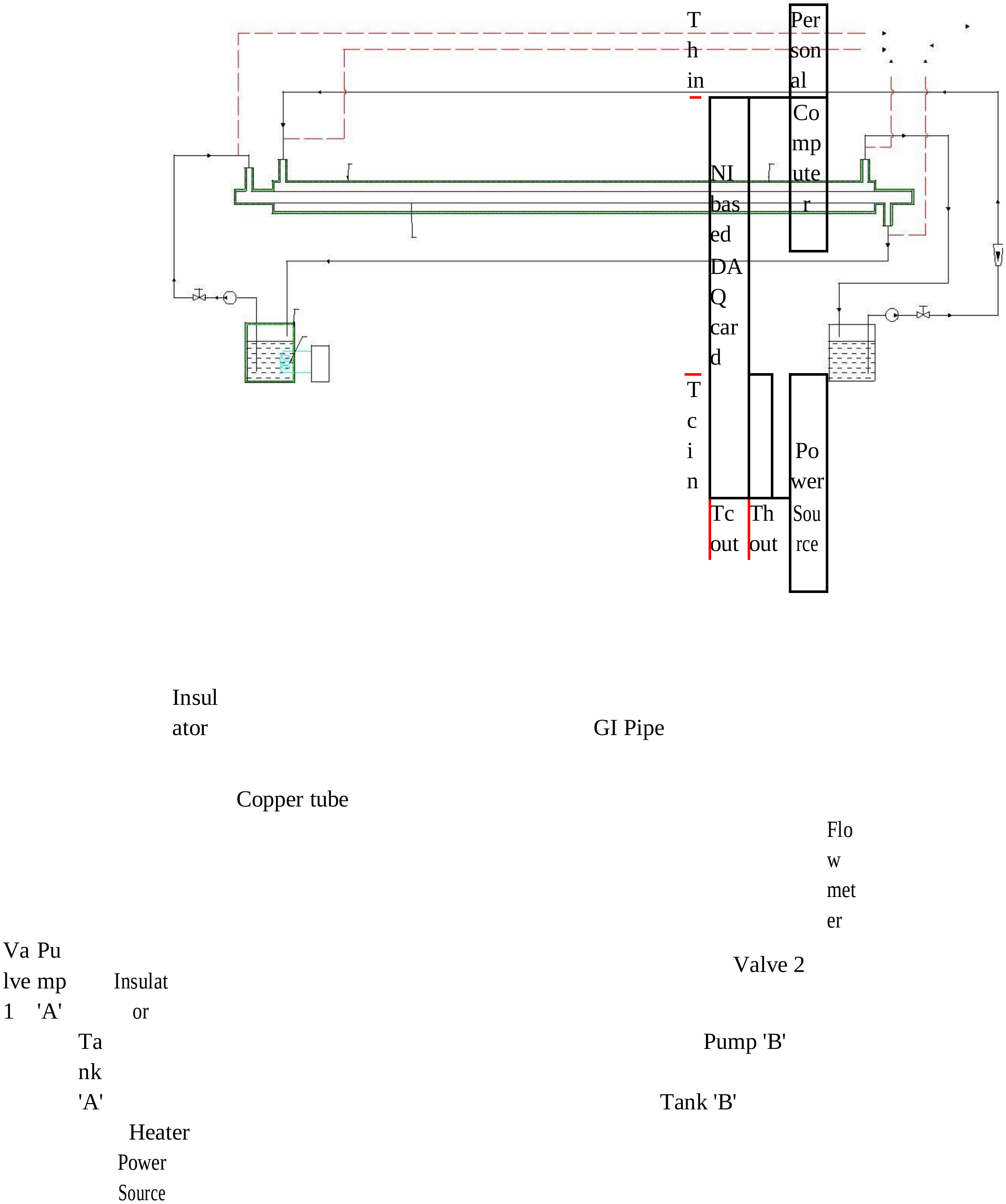

Figure 4. Schematic diagram of the experimental setup.

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

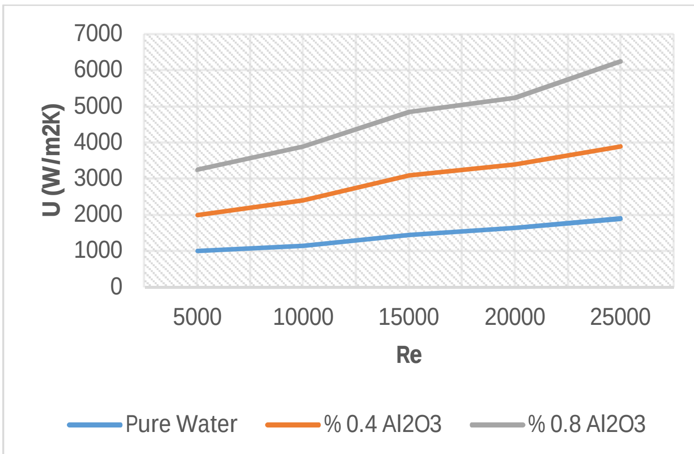

Figure 5.The relationship between the convective heat transfer coefficient and the Reynolds number of Al_2O_3/water nanofluid

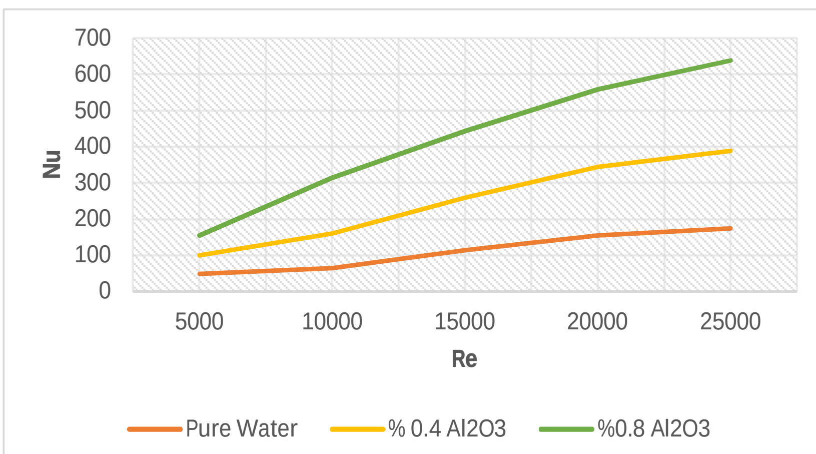

Figure 6. The relationship between the Reynolds number and Nusselt number of Al_2O_3/water nanofluid.

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

/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 Al_2O_3/water Nano fluid was investigated. The Al_2O_3/water nanofluid was prepared by dispersing Al_2O_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).

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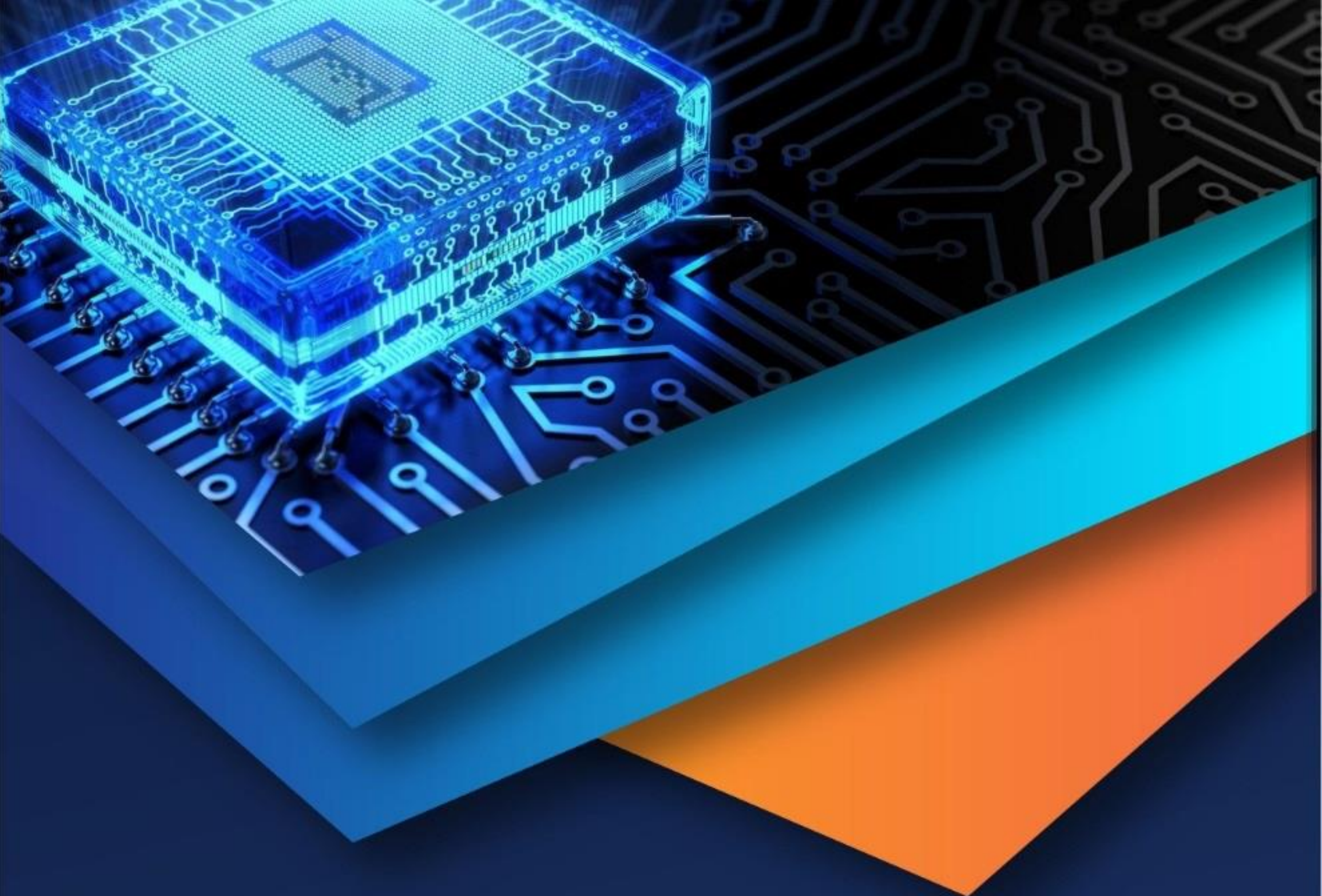

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