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EXPERIMENTAL INVESTIGATION OF ALUMINIUM-WATER NANO FLUID

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Abstract - *Nano fluid research is increased day by day. Literatures shows that research over nano fluid is in heat transfer applications such as condenser, evaporator and refrigeration. Nano fluid is made of liquids and nano particles of solids. With the rapid development of modern nanotechnology, particles of nanometre-size (normally less than 100 nm) are used instead of micrometre-size for dispersing in base liquids, and they are called nanofluids,In our work, we are going to study the heat transfer rate of nano fluid contains water and aluminium nano particle. For this we will manufacture experimental investigation setup, It will resemble a heat exchanger and study the heat transfer rate by nano fluid with different volume fractions of aluminium. Parameters studied are heat transfer rate and volume fraction of nano fluids. Relationship between them is evolved through our research. The purpose of this project is to explore relationship between volume fraction of nano particles of aluminium and heat transfer rate in a water based nano fluid.*

Key Words: **Nano technology, Nano fluid, Aluminium-water, Heat exchanger, Heat transfer rate, volume fraction.**

1. INTRODUCTION

Nano technology is the manipulation of matter on an atomic, molecular, and supra molecular scale. A more generalized description of nano technology was subsequently established by the National nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1to 100 nano metres. Nano technology as defined by size is naturally very broad, including fields of science as diverseas science,organic, molecularbiology, semiconduct or physics, micro fabrication, etc. The associated research and applications are equally diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the Nano-scale to direct control of matter on the atomic scale.

1.1 Nano Fluid

Thermal properties of liquids play a decisive role in heating as well as cooling applications in industrial processes. Thermal conductivity of a liquid is an important physical property that decides its heat transfer performance. Conventional heat transfer fluids have inherently poor thermal conductivity which makes them inadequate for ultra high cooling applications. Scientists have tried to enhance the inherently poor thermal conductivity of these conventional heat transfer fluids using solid additives following the classical effective medium theory (Maxwell, 1873) for effective properties of mixtures. Fine tuning of the dimensions of these solid suspensions to millimetre and micrometre ranges for getting better heat transfer performance have failed because of the drawbacks such as still low thermal conductivity, particle sedimentation, corrosion of components of machines, particle clogging, excessive pressure drop etc.

Downscaling of particle sizes continued in the search for new types of fluid suspensions having enhanced thermal properties as well as heat transfer performance. All physical mechanisms have a critical scale below which the properties of a material changes totally. Modern nanotechnology offers physical and chemical routes to prepare nano-meter sized particles or nano-structured materials engineered on the atomic or molecular scales with enhanced thermo-physical properties compared to their respective bulk forms.

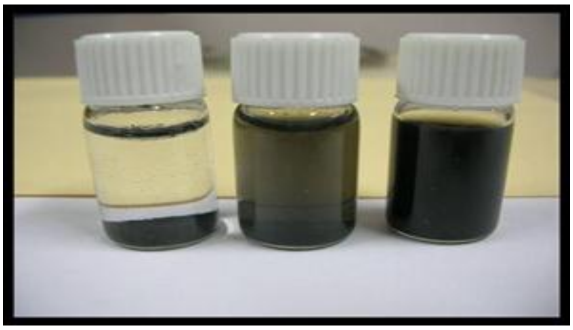

Fig. 1.3 Nano Fluid

1.2 Properties of Nano fluid

It may be noted that particle size is an important physical parameter in nano-fluids because it can be used to tailor the nano-fluid thermal properties as well as the suspension stability of nanoparticles. The key building blocks of nano-fluids are nanoparticles, Thus the nano suspensions show high thermal conductivity possibly due to enhanced convection between the solid particle and liquid surfaces. Since the properties like the thermal conductivity of the nano sized materials are typically an order of magnitude higher than those of the base fluids, nano-fluids show enhancement in their effective thermal properties.

2. METHODOLOGY

The purpose of this project is to explore relationship between volume fraction of nano particles of aluminium and heat transfer rate in a water based nano fluid. To conduct experimental investigation, setup will be fabricated. It will resemble a heat exchanger and consists of hot water pump, copper tubes, flow control valve and temperature measuring devices.

Next step of work is preparation of nano fluid (Water-Aluminium) with different volume fractions of nano particles. This nano fluid is investigated using above setup to find its heat transfer capability at various configurations. The result expected is relationship between volume fractions of nano particles and heat transfer rate and optimum fraction for better heat transfer with this kind of nano fluid.

3. EXPERIMENTAL PROCEDURE

Heat transfer rate is calculated from temperature difference between initial and final temperatures of water. Initial temperature is measured at inlet of two liquids at start-up of the experiment. Final temperature is measured at outlet. Velocity of water and nano fluid for circulation is constant for all volume fractions of Nano-Fluid (Different volume fractions of Water-Aluminium Nano-Fluid will be prepared for experimentation). Hot water is pumped from reservoir and circulated through shell side. Tube side, nano fluid is pumped.

3.1 Experimental Conditions

1. Velocity of hot water and nano fluid is constant for all volume fractions.
2. Time of circulation is constant for all volume fractions.
3. Temperature is measured at the entry and exit.
4. Velocity of water and nano fluid is controlled by flow control valve.
5. Constant initial temperature is maintained for both clear water and Nano-Fluid for all volume fractions.

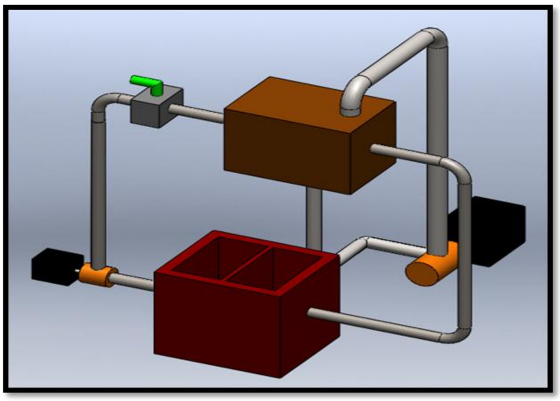

Fig -2: Experimental setup

3.2 Equipment Details

Centrifugal pump is used for circulate water, it collects hot water from container and circulates through pipe. Then, water is delivered to cold water tank same for nano fluid. Pump configuration for experiment is as follows:

Speed (S)	:	2880 Rpm
V & I	:	230Volt @ 3.2 Amps(current)
Head (H)	:	20m
Discharge (Q)	:	16 LPM

4. CONCLUSIONS

Nano fluid technology is developing field. Many researches are going on this to study properties and fraction prediction for getting desirable properties. Literature is done in point of benefit of nano fluids, pure metal nano fluids, water based nano fluids and fraction influence of nano particles in base fluid. I have decided to concentrate on influence volume fraction of aluminium nano particles in water. It will lead to get relationship between heat transfer rate and volume fraction of aluminium-water nano fluid. The purpose of this project is to explore relationship between volume fraction of nano particles of aluminium and heat transfer rate in a water based nano fluid. Experimental investigation setup will be fabricated. It will resemble a heat exchanger and consists of hot water pump, copper tubes, flow control valve and temperature measuring devices. Experimental investigation is done.

Curve fitting is done using experimental data in scientific computing tool MATLAB. From that, specific heat capacity of water-aluminium nano fluid as a function of volume fraction of nano particles in base fluid is obtain. Fitted curve and function is given below. In this relation x is volume fraction and f(x) is the dependent specific heat capacity of nano fluid, the coefficient are determined to polynomial curve fitting method with R-Square equal to1. The following is the empirical relation between volume fractions to specific heat capacity of nano fluid in the range of 0 to 20.Empirical Relation

$$F(x) = 0.117x^4 - 4.5x^3 + 54.57x^2 - 196.2x + 4132$$

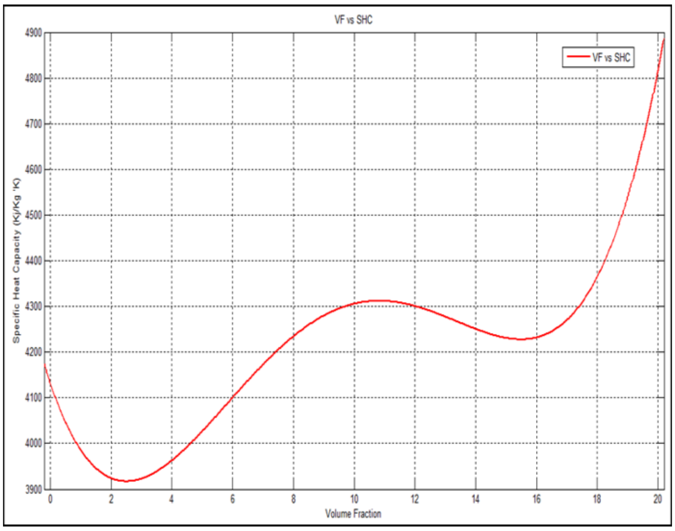

Fig-3 Fitted Curve

REFERENCES

[1] Akbar N.S. et. al (2013) 'Radiation effects on MHD stagnation point flow of nano fluid towards a stretching surface with convective boundary condition', Chinese Journal of Aeronautics, Vol 26, pg: 1389-1397.

[2] Bang C.I. et. al (2005) 'Boiling heat transfer performance and phenomena of Al2O3–water nano-fluids from a plain surface in a pool', International Journal of Heat and Mass Transfer 48 2407–2419, Elsevier.

[3] Barber J et. al (2011) 'A review on boiling heat transfer enhancement with nanofluids', Nano-scale Research Letters 6:280, Springer.

[4] Chan C.Y. et. al (2013) 'Enhancement of surface finish using water-miscible nano-cutting fluid in ultra-precision turning', International Journal of Machine Tools & Manufacture, Vol 23, pg: 62-70.

[5] Cheneler D. et. al (2011) 'Micro squeeze flow rheometer for high frequency analysis of nano-litre volumes of visco-elastic fluid', Vol 88, pg: 1726-1729.

[6] Manoj Chopkar A. et. al (2008) 'Pool boiling heat transfer characteristics of ZrO2–water Nano-fluids from a flat surface in a pool', Heat Mass Transfer, 44:999–1004, Springer-Verlag.

[7] Dakwar G.R. et. al (2014) 'Colloidal stability of nano-sized particles in the peritoneal fluid: Towards optimizing drug delivery systems for intra peritoneal therapy', Acta Biomaterialia.

[8] Das S.K et. al (2003) 'Pool boiling characteristics of nano-fluids', International Journal of Heat and Mass Transfer 46, 851–862, Elsevier.

[9] Heidary H. et. al (2012) 'Heat transfer enhancement in a channel with block(s) effect and utilizing Nano-fluid", International Journal of Thermal Sciences 57,163-171, Elsevier.

[10] Kang S.W. et. al (2006) ' Experimental investigation of silver nano-fluid on heat pipe thermal performance', Applied Thermal Engineering 26, 2377–2382, Elsevier.