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HEAT TRANSFER ENHANCEMENT USING NANO FLUID FOR RADIATOR

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ABSTRACT— Heat Exchanger is a very important device in every modern industry in the time when resources are limited and there is tough competition in the market heat exchanger marks special importance. In this project the thermal performance analysis of a heat exchanger using Nano-Fluid is performed by varying the composition of nano-fluids used, which a mixture is of $SIO_2$and base fluid water. An experimental analysis has been performed on pipe in engine radiator. The volume fraction of coolant varies. Experimental results such as heat transfer rates and overall heat transfer coefficient and heat exchanger effectiveness have been calculated to determine the performance of engine radiator. The objective of this project is too determined whether the use of Nano-fluids improves the heat radiator performances and at what percentage of Nanoparticles-coolant mixture the performance of radiator obtain maximum heat exchange rate and at what percentage.

Keywords:- Heat Exchanger, Radiator, Efficiency.

I. INTRODUCTION

Heat transfer fluids such as water and minerals oil and ethylene glycol play an important role in many industrial sectors including power generation, air-conditioning, transportation and microelectronics. Various techniques have been applied to enhance their heat transfer capabilities and performance is often limited by their low thermal conductivities.[1] With the rising demand of modern technology for process there was a need to develop new types of fluids that are more effective in terms of heat exchange performance. To achieve this, it has been recently proposed to small amounts of nanometer-size (10–100 nm) solid particles in base fluids, resulting in what is commonly known as nano-fluids.[2] The term nano-fluid was coined by Choi who was working with the group at the Argonne National Laboratory, USA, in 1995. The nanoparticles used are ultrafine therefore nano-fluids appear to behave like a single-phase fluid than a solid–liquid mixture. The commonly used materials for nanoparticles are metals and nonmetals, oxides ceramics (Al_2O_3,Tio_2,Sio_2), carbides, nitrides, layered and functionalized nanoparticles. The base fluid is usually a conductive fluid, such as water, oil, polymer solutions, bio-fluids and other common fluids, such as paraffin. Experiment have shown that nano-fluids possess enhanced thermo-physical properties such as thermal conductivity, thermal diffusivity, viscosity and convective heat transfer coefficients compared to those of base fluids like oil or water.[1] After their enhanced thermo-physical properties, nano-fluids have numerous industrial, engineering and bio-medical applications such as heat transfer applications: industrial cooling, smart fluids; nano-fluid coolant: vehicle cooling, electronics cooling; medical applications: magnetic drug targeting and nano-cryosurgery. In recent years, heat transfer has received many engineering applications such as heat exchanger, piping system, automobile radiator and electric conductors.

II. EASE OF USE

The nano-fluids will help to reduce the size and weight of the vehicle cooling systems by greater than 10-20% despite the cooling demands of higher power engines. Nano-fluids can help to prove the potential to allow higher temperature coolants and higher heat rejection in the automotive engine radiator. It shows that a higher temperature radiator could reduce the radiator size.[3] This translates into reduced aerodynamic drag and fluid pumping and fan requirements and 10% fuel savings. It is interesting idea in these years which humans involved in the energy and fuel shortage areas.

III. REVIEW

Prof. Ahmad Fakheri says that the concept of heat exchanger efficiency of radiator provides new and easy way for design and analysis of engine radiator and other type of heat exchanger and in heat transfer field.[4]

M. Z. Abdullah and M. Z. Yusoff proves nano-particle improves the thermal properties of base fluid and improves the heat transfer rate.[5]

Kaufui V. Wong experimentally compares the heat transfer rate between nano-fluids based water and simple water or oil in radiator in automobile engine. Result shows that increasing the fluid circulating rate improve the heat transfer performance.[2]

Datta N. Mehtre and S. Kore objective of this experimental study is to discuss the thermal performance of car radiator using nano-fluid in different temperature ranges under different fractions of nanoparticles by volume.[6]

Ummal Salmaan analysis thermal performance of radiator operated with nano-fluids is compared with a radiator using conventional coolant.[7]

Suying Yan in his paper developed equations which help to determine number of shells required and temperature profile across all exchangers.[8]

IV. PROPOSED BLOCK DIAGRAM

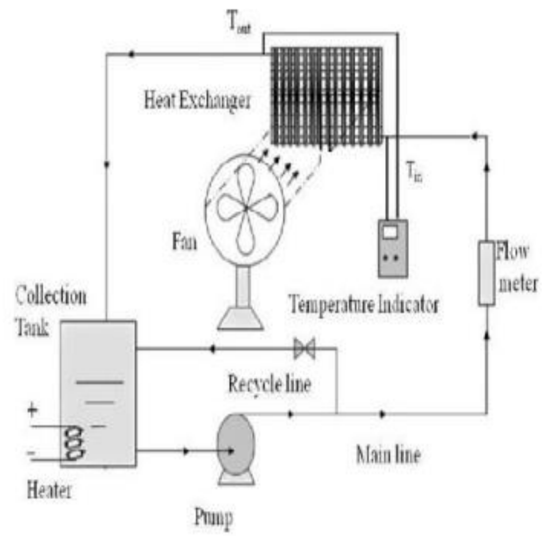

Fig. 1, Project Layout

The car radiator has lower fin and vertical Aluminum tubes with flat cross sectional area. The distances among the tube rows filled with thin perpendicular Aluminum fins. For the outer side, an axial force fan (1500rpm) installed close on axis line of the radiator .The DC power supply Adaptor convert AC to DC. For heating the working fluid by electric heater of capacity 2000 watt and controller were used to maintain the temperature 40o-80oC. Two type thermocouples have to implement on the flow line to record the radiator inlet and outlet temperature. Two thermocouples K types have to install in the radiator to measure the wall temperature of the radiator.

1. Nano fluid

Nano-fluids partials are engineered by suspending nano particles with average sizes below 100 nm in heat transfer fluids such as water, oil, diesel, ethylene glycol, etc. advance heat transfer fluids are produced by suspending metallic or non-metallic nanometer-sized solid particles. Experimentally shown that nano-fluids have substantial higher thermal conductivities compared to the base fluids. These suspended nanoparticles can change the transport and thermal properties of the base fluid.[9]

i. SIO_2

The convective heat transfer of SIO_2colloidal suspensions (5–34wt%) is investigated experimentally in a flow loop with a horizontal counter flow tube test section whose wall temperature is imposed.Experiment were performed at different inlet temperatures (20, 50, 70 _C) in cooling and/or heating conditions at various flow rates (200 < Re < 10,000). The Reynolds and Nusselt numbers were deduced by using thermal conductivity and viscosity values measured with the same temperature conditions as those in the tests.[10] Results indicate that the heat transfer coefficient values are increased from 10% to 60% compared to those.[11]

Fig. 2, SIO_2 partical

ii. Al_2O_3

The process of obtaining Nano fluids with 0.1%, 0.5% and 1% concentration of aluminum oxide (Al_2O_3) was studied by mechanical, vibrations and magnetic stirring. The samples extracted during the process were analyzed with the quartz crystal microbalance, in terms of homogenization and stability.[12] The experimentally showed a decrease of the time consumed with heating the nano-fluids and an improvement of the thermal transfer due to the nanoparticles of Al_2O_3Pure alumina (>99.5%) has been used due to its good mechanical properties and biocompatibility with the tissues. The advantages of nano-particals of alumina can be seen by comparing the micro and nano alumina particles.[13]

2. Radiator

Automobile radiator is key component of engine cooling system. Coolant surrounding engine passes through radiator. In radiator coolant goes cooled down and re-circulated into radiator. Radiator design is important factor while designing cooling system. Radiator size used to do heat transfer calculations of radiator.[3] Both this methods have its own advantages and preferred according to data availability. When the engine radiator inlet and outlet temperature are known LMTD gives faster depends on heat load as well packaging space availability. Heat load is depends on heat rejection required to keep engine surface at optimum temperature. Generally LMTD method is solution. When the temperature is unknown LMTD method undergoes iterations to find solution

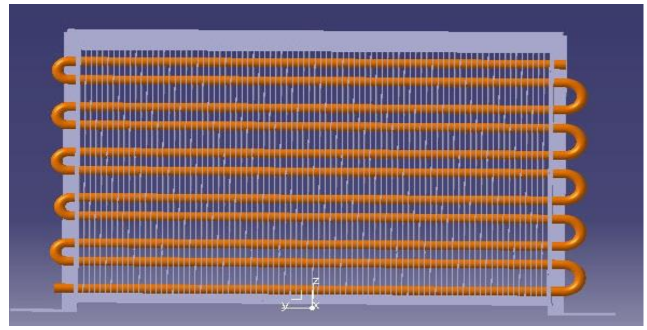

Fig.3, Radiator

3. Electric water heater

The electric heater is used for heating the water, heating is a heat transfer process that uses an energy source to heat water above its initial temperature. Heater is normally used in domestic uses of hot water include cooking, cleaning, bathing, and space heating. In the industry, hot water heated to steam have many uses. Appliances that provide a continual supply of hot water are called hot water heaters.

Fig.4, Electric Heater

4. Fan

The fan is used for transfer heat transfer from radiator it also called as forced convection, heat exchanger, used in refrigeration unit, air conditioning unit, radiator used with IC engine automobiles is rectangular or square in shape. But fan is in circular area developing low velocity zones or high temperature regions are created in the corners.[14] Also power consumed by fan is studied. The fan consumed by fan is 2 to 5% of power produced by engine. The radiator needs additional airflow.it to prevent the engine from overheating. This usually occurs at idle and slow speed. At higher vehicle speeds, the air flows through the radiator by the forward motion of vehicle provide all the cooling that is needed. The fan may be mechanical or electric fan

5. Pipe in pipe tube

In this project the thermal performance analysis of a pipe in pipe heat exchanger is performed by varying the composition of nano-fluids used, which is a mixture of SIO_2,$Al_2O_3$and Glycol respectively. An experimental analysis has been performed on pipe in pipe heat exchanger. The volume fraction of coolant varies. Experimental results such as heat transfer rates, overall heat transfer coefficient. and heat exchanger, pipe in pipe heat exchanger obtain maximum heat exchange rate and at what percentage

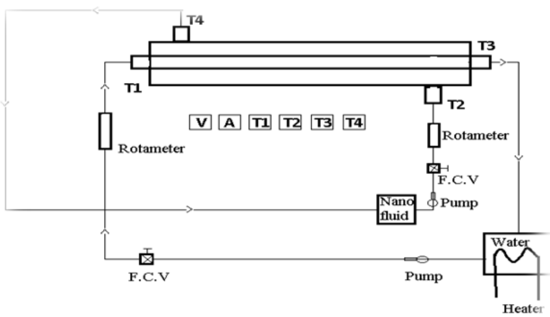

Fig.5, Heat Exchanger

V. SPECICATION

Material Specification:

Heat Exchanger type: Pipe in Pipe

Upper Pipe Diameter: 76.2 mm (3 inch)

Inner pipe diameter: 25.4mm (1 inch)

Heat Exchanger length: 1 m (1000mm)

Piping – ½ inch UPVC

VI. NOMENCLATURE

SIO_2	Silicon Di Oxide
Al_2O_3	Aluminumtri Oxide
nm	Nano Meter
RPM	Revolution per Minute
IC	Internal Combustion
FCV	Flow Control Valve
LMTD	Logarithmic mean temp. Difference
^oC	Degree Celsius
T_1,T_2,T_3,T_4	Temp. corresponding to point
mm	Milli Meter
UPCV	Unplasticized polyvinyl chloride

VII. CONCLUSION

The thermal performance of automobile radiator increased with the use of nano coolant compared to water. The enhancement in heat transfer of water nano fluid was significantly higher compared to the water. This may be due to the fact that nanofluid possesses higher thermal conductivity.

VIII. ACKNOWLEDGEMENT

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