Enhancement of Heat Transfer of Radiator by using Nano Fluid

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Abstract— the radiator is the most important part of C.I engine. Its main function is to cool the coolant circulating in the surrounding of engine body to radiator through pipes. The radiator is one type of heat exchanger and to increase the heat transfer rate of radiator we have to increase its size and more cooling water is required which leads to increase in performance of an engine. Our main aim is to increase the efficiency of radiator by using NANO-FLUID which will help us to increase the heat transfer rate of the radiator without any drastic increment in its size.

Key words: Nano Fluid, Enhancement of Heat Transfer of Radiator

I. INTRODUCTION

A nano fluid contains nano sized particles called as nano particles. These particles are either made from pure metal or metal oxides. Basically these nano particles are mixed with a fluid such as water, ethylene glycol, mineral oil etc termed as base fluid to form a complete nano fluid. In order to achieve the best magnitude of heat transfer rate the proper mixing ratio of nano particles with its base fluid is very much important Radiator is one of the very important part of an I.C engine. It plays a very important role in increasing the efficiency of an engine. Its main purpose is to cool the body of an engine. In the radiator there is a fins which helps in increasing the heat transfer area and forced draft fan is used which imparts the air on fins and tube with high velocity so that the heat transfer rate to the surrounding increases. The coolant used in the radiator absorbs the heat from the surface of the engine body and rejects it into atmosphere with the help of radiator and this fluid is recirculated in to the engine jacket.

On introducing the nano-fluid as a coolant will help us to increase the heat transfer rate of radiator.

II. WORKING METHODOLOGY

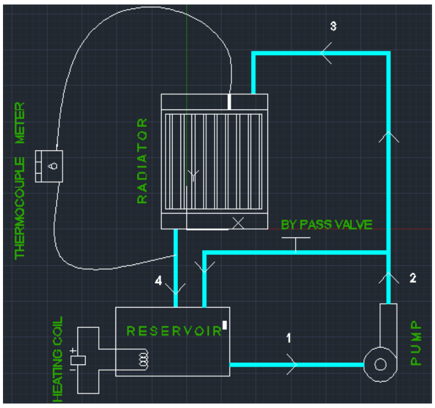

Fig. 1: Working Methodology

- Step 1: Switch on the heater which is placed into the reservoir. Now switch on the thermocouple meter.
- Step 2: As you attain the temp. above 180F or 82.33°C,switch on the pump & the radiator fan.
- Step 3: As you switched on the pump the water will be pumped into the reservoir through semi opened by pass valve at approximately 686.33LPH & remaining flow of water will pass through a radiator at approximately 290LPH.
- Step 4: Now as the fluid enters into the radiator, it rejects its heat into the atmosphere with the help of fins & high velocity air of a radiator fan at 500RPM & due to high vehicle speed.
- Step 5: Now the coolant fluid will cool down & temp. drop will take place. This temp. drop can be measured with the help of thermocouple meter.
- Step 6: The cold water will reenter into the reservoir & the process will take place again.

III. EQUATIONS

In our experiment consider a mixture of water & ethylene glycol as a base fluid & added an alumina particle with 0.22% concentration. The property of a particle of the alumina oxide at various temperature is finding out from a particular research paper.

To find out the thermal properties of base fluid or thermal properties of water with different proportion of ethylene glycol research paper is referred. To find out the thermal properties of nano fluid various research paper is referred & among them useful equation is as follows.

$$k_{nf} = \frac{1}{4}\left[(3\emptyset - 1)k_p + (2 - 3\emptyset)k_{bf}\right] + \frac{k_{bf}}{4}\sqrt{\Delta} \quad (1)$$

Where

$$\Delta = (3\emptyset - 1)^2\left(k_p/k_{bf}\right)^2 + (2 - 3\emptyset)^2 + 2(2 + 9\emptyset - 9\emptyset^2)\left(k_p/k_{bf}\right) \quad (2)$$

$$\rho_{nf} = (1 - \emptyset_V)\rho_f + \emptyset_V\rho_p \quad (3)$$

$$(\rho C_p)_{nf} = (1 - \emptyset_V)(\rho C_p)_p + \emptyset_V(\rho C)_p \quad (4)$$

$$\mu_{nf} = [1 + 2.5\emptyset]\mu_{bf} \quad (5)$$

In above equations $\emptyset$ means the percentage of volume concentration consider as a percentage of volume concentration divided by 100.

Abbreviation	Name
μ	Dynamic viscosity
k_{nf}	Thermal conductivity of a nano fluid
k_p	Thermal conductivity of a particle
k_{bf}	Thermal conductivity of a base fluid
$\emptyset(\emptyset_V)$	Volume concentration
ρ	Density
C_p	Specific heat at constant pressure

Table 1: Abbreviation

IV. RESULT & DISCUSSION

Fluid/Result	Water + Ethylene glycol (76.9231 +23.0769) %	Water +Ethylene glycol +Alumina Oxide (0.22%)
Inlet temp.	85°C	84°C
Outlet temp.	58°C	54°C
Inlet temp.(air)	36°C	31°C
Outlet temp.(air)	44°C	40°C

Logarithmic mean temp. difference(ΔT_{lm})	29.6050°C	32.3727°C
Overall heat transfer coefficient(U)	439.6766$\frac{W}{m^2K}$	441.1845$\frac{W}{m^2K}$
Heat transfer rate(Q)	9606.2640W	10540.3621W
% increase in heat transfer rate	0%	9.724%

Table 2: Result

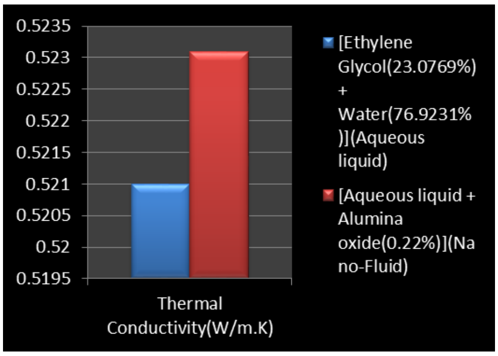

Fig. 2: Result

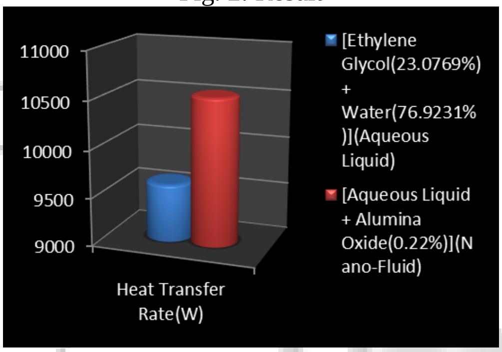

Fig. 3: Result

From fig 1 & 2 we conclude that the thermal conductivity of a nano fluid has been increased & due this the thermal property i.e., heat transfer rate is also increased.

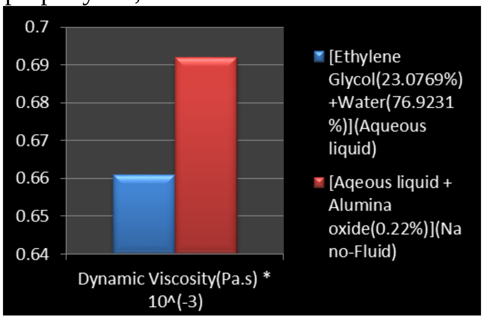

Fig. 4: Result

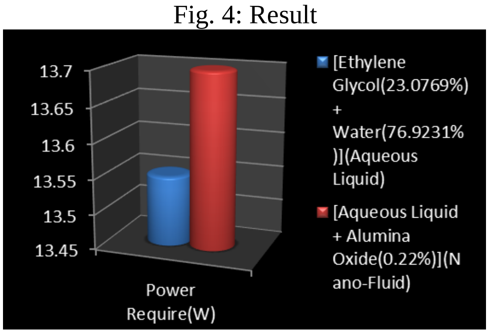

Fig. 5: Result

From fig 3 & 4 we conclude that the friction loss & also the pressure drop into the pipes is increased due to this the dynamic viscosity of a nano fluid, which the power required to pump a nano fluid is also significantly increased.

V. Conclusion

After performing this experiment we conclude that the heat transfer of a radiator is increased by 9.7% when compared with conventional mixture of ethylene glycol & water. The essential disadvantage of this type of fluid is its cost & thermal stability. For this type of fluid different device is used to check the thermal stability of a nano particles & to prevent the settle down of a particles some time different types of surfactants are introduced in the nano fluid.

From this experiment we also conclude that the surface area of the radiator is reduced by approximately 8.9%. As we know that the concentration of a nano particles is increased the dynamic viscosity of a fluid is also increased, so more power is required to pump a fluid at same height. We get the best result with minimum concentration of nano particle as possible as with the base fluid.

Description	Magnitude
Length of the tube(L)	370mm
Cross-sectional area (Radiator)	49.1416 mm^2
Thickness of the tube(Radiator)	1mm
Thermocouple	Range from 0°C to 4000°C(K-type)
Pump	50W,1000LPH
Heater	3kW
Radiator fan	30cm Diameter
Diameter of tube(Setup)	1.8cm
Cross sectional area	2.5450cm^2
No. of tubes	36

Table 3: Specification

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References

[1] “External & Internal flow convection” of Yens A. Cengel,Afshin J. Ghajar,7-8(2004) 418-508
[2] “Flow Through Pipes” of Dr.R.K.Bansal, 465-558(2014)
[3] Lazarus Godson Asirvatham, Nandigana Vishal, Senthil Kumar Gangatharan and Dhasan Mohan All, ”Experimental Study on Forced Convective Heat Transfer with Low Volume Fraction of CuO/Water Nanofluid”Vol.2 March 6th,2009,pp 97-119

[4] Periyasamy Mukesh Kumar, Jegadeesan Kumar , Rengasamy Tamilarasan , Seshachalam Sendhilnathan ,& Sivan Suresh "Review on nanofluids theoretical thermal conductivity models"Vol.19January 16th,2015, pp 68-83
[5] www.dowtherm.com
[6] http://www-ferp.ucsd.edu/LIB/PROPS/PANOS.al2o3.html
[7] Reza Aghayari,Heydar Maddah, Malihe Zarei, Mehdi Dehghani, and Sahar Ghanbari Kaskari Mahalle, "Heat Transfer of Nanofluid in a Dobule Pipe Heat Exchanger", by Hindwai Publishing Corporation.