MANTECH Publications

Journal of Product Design, Quality Engineering & Technology
Volume 1, Issue 1, January-April 2016

Investigation of Engine Cooling Performance Based On Nano Fluids

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Abstract

Heat transfer enhancement by adding solid nano-particles to liquids for many industrial applications has gained a lot of interest of late. This paper discusses nanoparticles dispersed in water as a base fluid conducted in a car radiator experimentally. Four different concentrations of Nano fluids (Al2O3) in the range of 2%, 2.5%, 3% and 3.5% were used in the experiment. The flow rate changed in the range of 550 LPH to 650 LPH. There are many different applications of thermal-fluid systems, including automotive cooling systems. Base fluids, such as water, ethylene glycol and glycerol were used as conventional coolants in automobile radiators. The results showed that as the concentration of Nano fluid increases, temperature difference also increases the cooling effect.

Keywords: *Nano fluid , Heat transfer, Fluid Flow*

INTRODUCTION

The temperature of the gases in the engine cylinder reaches up to 500 to 650°C, and if the heat is not dissipated; it results in failure of the cylinder material. Due to high temperature and the resultant large temperature differences, high thermal stress distorts the engine components. That is why it is important to keep temperature changes to a minimum. Higher temperatures also decrease the volumetric efficiency of the engine.

The radiator is a device for dissipation of heat which the coolant has absorbed from

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the engine. It is manufactured to store some amount of water in tubes or passages, which provide a large area in contact with the atmosphere. It usually consists of a radiator diameter, with its water-tubes and large cooling area that are connected to a receiving tank at the top and to a dispensing tank at the bottom.

ide flow radiators have their end caps on the sides that allow a lower hood line.

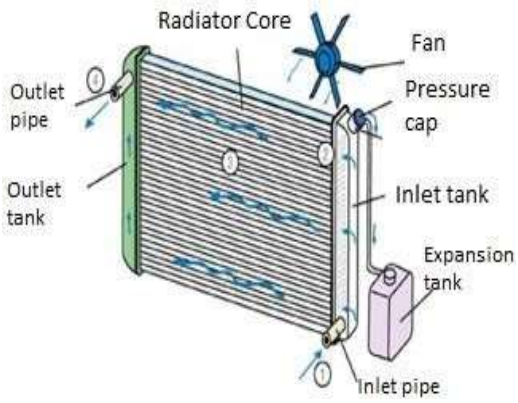

Fig. 1: Typical radiator and its components

LITERATURE REVIEW

This paper discusses the friction factor and convection heat transfer of Nano particle mixed in water and Ethylene Glycols as a base fluid conducted in a car radiator experimentally and numerically. The friction factor study with convection of heat transfer enhancement of Nano fluids Forced convective heat transfer in water and nano fluid was compared

If the car is not overheating, this will reduce the engine's temperature. The AC evaporator is located in front of the radiator, and it adds heat to the air going to your engine. The hotter the incoming air, the less efficient the radiator will be.

suspended in water was carried out. Significant increase in heat transfer enhancement was observed with the concentration of nanoparticles addition. [1]

The heat transfer performance of pure water and pure EG was compared with basic mixtures. Furthermore, different concentrations of Al2O3 nanoparticle have been added into these base fluids and its effects on the cooling performance of the car radiator have been determined experimentally. [2]

This study focused on the ethylene glycol with copper Nano fluids in an automotive cooling system. Heat transfer rate and volume concentration of nano particles is also increased. [3]

experimentally to that of water in an automobile radiator. Increasing the flow

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rate of working fluid enhances the heat transfer coefficient for pure water and nano fluid considerably, while the variation of concentrations of nano fluid Inlet temperature in the radiator changes the heat transfer slightly. [4]

EXPERIMENTAL SETUP

Parts in the experimental setup

a) Radiator

Radiator is a key component of engine cooling system. Recently, compact sized radiators are in high demand in modern car industries. The problem of heat dissipation, overheating, choking of water and energy losses occur commonly in radiators and greatly reduce the engine efficiency. See Figure 2.

b) Pump

The pumping of Nano fluid is a basic technique that pumps Nano fluid through the system. Half HP pump is used in the system with high temperature sealing whose discharge capacity is of 2000 LPH.

c) Rota meter

Rota meter is used for flow measurement in the system, which is varied by control valve. Rota meter is specially designed for the Nano fluid with temperature range up to 1100 C, and flow range 0 to 2500 LPH.



Fig. 2: Radiator

For evaluating the performance of these radiators, standard test rig is developed which will give an idea of the effect of change in geometrical parameters on the performance of radiator. In a testing set up, electrical heater is used as heat source which is kept in insulated steel tank. Moreover, pump, Rota meter, thermocouples, cooling fan, flow control valves and electric power consumption meter are incorporated into the

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testing set up to carry out the standard practice for evaluating radiator performance.

The test rig is used to measure heat transfer coefficient and friction factor in the automotive radiator. This experimental setup includes a reservoir tank, electrical heater, a centrifugal pump, a flow meter (Rota meter), flow control valves, a fan, a DC power supply; 10 thermocouples type K for temperature measurement. An electrical heater (2000W) inside a steel storage tank is put to represent the engine and to heat the fluid. A voltage regulator provided power to keep the inlet temperature to the radiator at a constant level. A flow meter and two valves are used to measure and control the flow rate. The fluid flows through tubes by a pump from the tank to the radiator at the constant flow rate. The total volume of the circulating fluids is constant in all the experimental steps but the flow rate varies. Two thermocouples types are fixed on the flow line for recording the inlet and outlet fluid temperatures. Eight thermocouples are fixed to the radiator surface to ensure more of surface area measurement. Two thermocouples are also fixed to the tube in front of the fan and the other side of radiator to measure air temperatures.



Fig.3 Experimental Setup

Minimum thickness and high thermal conductivity of the copper tubes causes the inside temperature of the tube to be equal to the outside. A handheld digital thermometer with was used to take accuratetemperatures from thermocouples. Calibration of the thermocouples and thermometers carried out by using a constant temperature water bath and the accuracy estimated to two small plastic where

$$Q=h*A*\Delta T=h*A*(T_b-T_s)$$

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tubes connected at inlet.

The coolants used were:

i. 2 % Al2O3 particles at glycol base.

ii. 2.5 % Al2O3 particles at glycol base.

iii. 3 % Al2O3 particles at glycol base.

iv. 3.5 % Al2O3 particles at glycol base.

EXPERIMENTAL DATA ANALYSIS

Sample calculation

According to the Newton's cooling law, the following procedure was followed to

$Q = m*C*\Delta T = m*C*(Tin - Tout)$

Obtain heat transfer coefficient and corresponding Nusselt number as [1]

$Q = h*A*\Delta T = h*A*(T_h - T_s)$

where D_h tube. is the hydraulic diameter of the

$$D_h = \frac{4 \times Area}{Wetted\ Perimeter}$$

$$Dh = \frac{4*[\frac{\pi d^2}{4} + 2(D-d)d]}{\pi d + 2(D-d)}$$

$=0.01632$ m

$=5.17*3.476*(68-57)$

$=213.04$ W

coolants,temperatures at radiator inlet and outlet are noted down for each coolant and Nusselt number can be calculated as

$$Nu_L = \frac{h.L}{k_f} =$$

$=3436$

Reynolds number (Re) is determined as,

$$Re = \frac{\rho VD}{\mu}$$

$=3819703$

RESULTS AND DISCUSSION

After conducting trials on manufactured prototype of radiator with various, that temperature difference is plotted against the time required to carry out the trial.

The coolant flow Q is maintained at 550 and 650 LPH and air velocity at 2.4 m/s during all trials.

The nature of temperature and time achieved through radiator for different coolants are as follows:

T3 = Inlet Temperature T4 = Outlet Temperature

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Table 1: Reading of Different temperature in 0 C at 550 LPH

T1	T2	T3	T4	T5	T6
80	76	57	68	55	39
75	70	53	66	54	36
70	65	50	59	49	35
65	62	48	55	47	34
60	59	46	53	45	33
55	56	44	48	42	32
50	53	42	44	40	30

Table 2. Different Values by Calculation

h ($w/m^2\,^0C$)	Q (W)	u (m/s)	μ(NS/m^2)	K w/mk	Nu
486348	213.035	2.4	0.003767	2.31	3436.02
614414.6	251.7687	2.4	0.003767	2.31	4340.8
493422.2	174.3014	2.4	0.003767	2.31	3486
436105.4	135.5677	2.4	0.003767	2.31	3081.06
456872.4	135.5677	2.4	0.003767	2.31	3227.77
304581.6	77.46728	2.4	0.003767	2.31	2151.85
171327.1	38.73364	2.4	0.003767	2.31	1210.42

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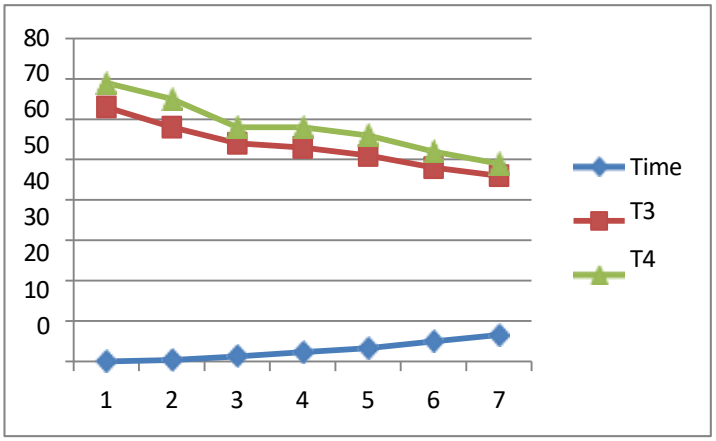
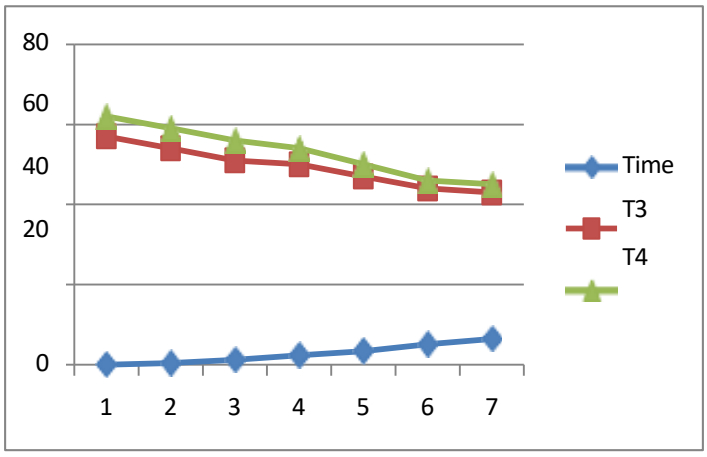
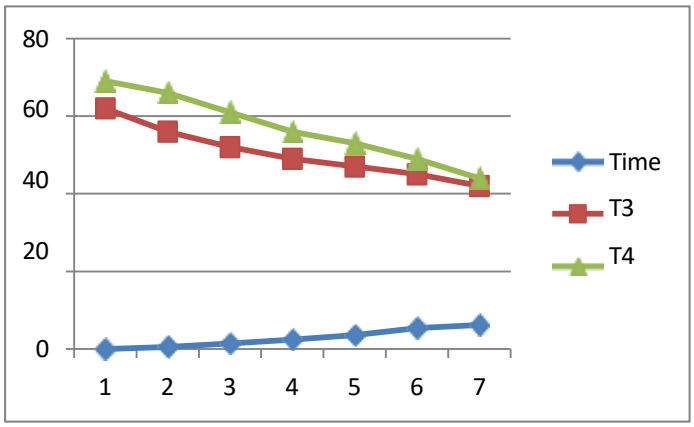


Graph 2 % Al2O3 Nano fluid at 550LPH



Graph 2.5% Al2O3 Nano fluid at 550LPH



Graph 3.0 % Al_2O_3 Nano fluid at 550LPH

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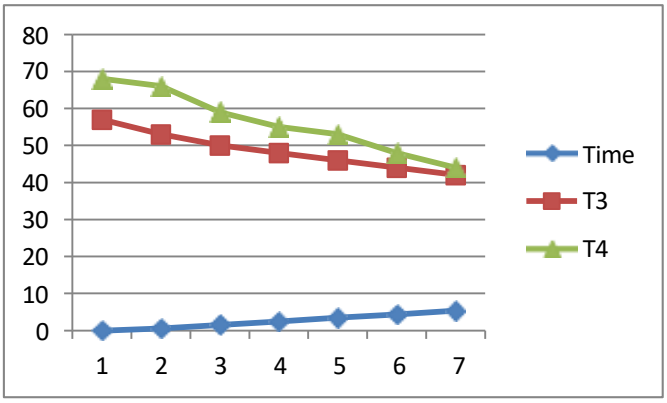
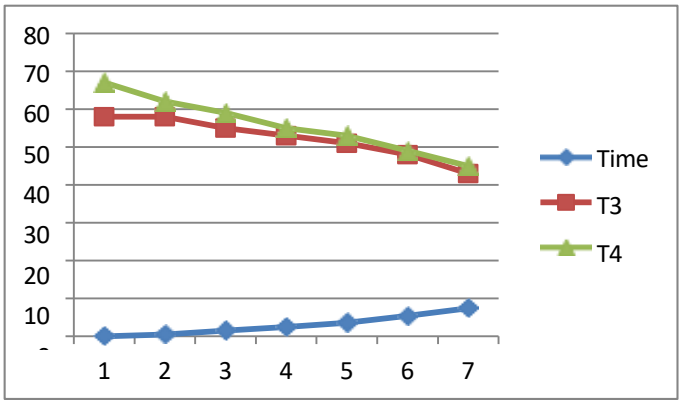
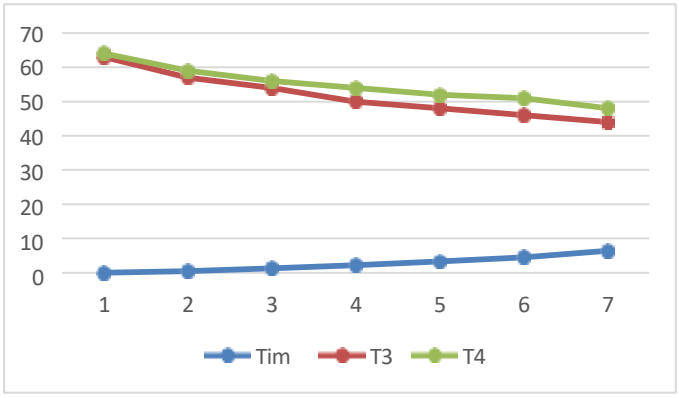


Graph 3.5 % Al_2O_3 Nano fluid at 550LPH



Graph 2 % Al_2O_3 Nano fluid at 650LPH



Graph 2.5 % Al_2O_3 Nano fluid at 650LPH

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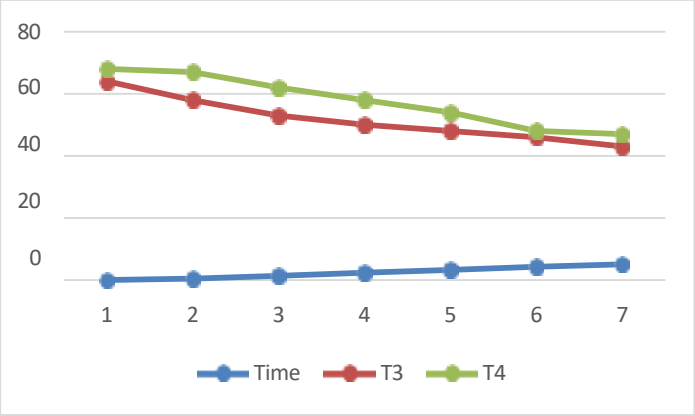
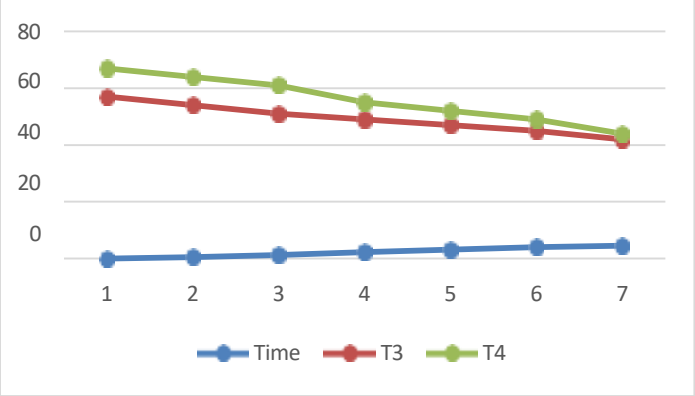
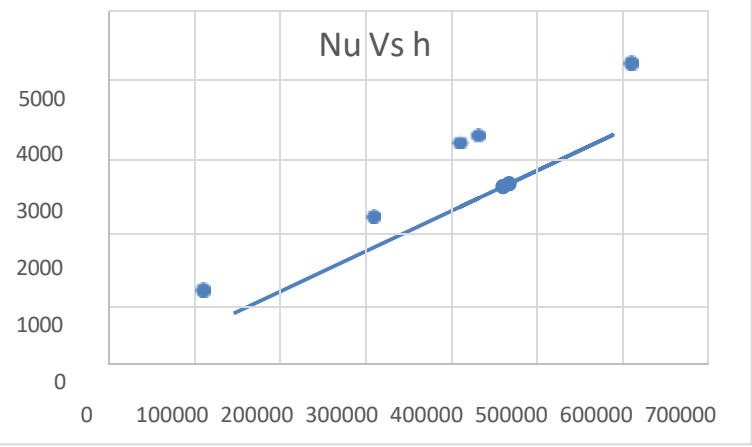


Graph 3 % Al_2O_3 Nano fluid at 650LPH



Graph 3.5 % Al_2O_3 Nano fluid at 650LPH



Graph Heat transfer coefficient and Nusselt Number

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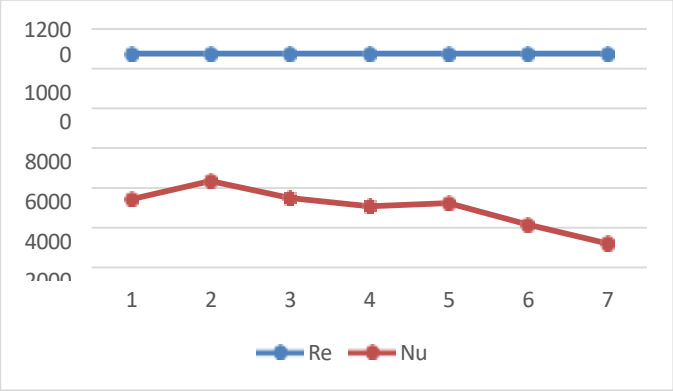

Graph Re Number vs Nu Number

CONCLUSIONS

1. As the concentration of Nano fluid increases, temperature difference also increases the cooling effect.
2. As the flow of nano fluid increases, cooling effect also increases.

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