Review: Engine Cooling System Using Nanofluids

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Abstract - Trial investigation of compelling warm conductivity of Nano fluid will be exhibited in this work. The Nano fluid will be set up by scattering nanoparticles in ethylene glycol utilizing a sonicator and including surfactant. Ethylene glycol based Nano fluid containing nanoparticles at various strong volume divisions (low to high) was inspected for the examination. The warm conductivity of Nano fluids will be tentatively measured. This work will be done for Engine cooling framework application where as we can apply these impacts on to about all warmth exchange applications. The fixation included will be of aggregate volume division as 0.5, 1.0, 1.5, 2.0, and 2.5 % for aggregate volume portion.
In this a player in work investigation of fundamental data of motor cooling framework and segments alongside Nano fluid essential is finished.

Keywords– *4 Stroke engine, Nano fluids*

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I. INTRODUCTION

The execution of the ordinary motor cooling framework has dependably been compelled by the latent way of the framework and the need to give the required warmth dismissal ability at high-control conditions. This prompts extensive misfortunes in the cooling framework at part-stack conditions where vehicles work more often than not. An arrangement of configuration and working elements from cutting edge motor cooling frameworks is inspected and assessed for their capability to give enhanced motor assurance while enhancing fuel proficiency and discharges yield. Despite the fact that these elements show critical potential to enhance motor execution, their maximum capacity is constrained by the need to adjust between fulfilling the motor cooling prerequisite under all working surrounding conditions and the framework adequacy, as with any traditional motor cooling framework. The presentation of controllable components permits breaking points to be set on the working wrap of the cooling framework without confining the advantages offered by receiving these elements. The incorporation of split cooling and exactness cooling with controllable components has been recognized as the most encouraging arrangement of ideas to be received in a cutting edge motor cooling framework.
We realize that if there should be an occurrence of Internal Combustion motors, burning of air and fuel happens inside the motor barrel and hot gasses are produced. The temperature of gasses will be around 2300-2500°C. This is a high temperature and may come about into blazing of oil film between the moving parts and may come about into seizing or welding of the same. In this way, this temperature must be decreased to around 150-200°C at which the motor will work generally proficiently. An excess of cooling is additionally not alluring since it diminishes the warm effectiveness. In this way, the object of cooling framework is to keep the motor running at its most productive working temperature. It is to be noticed that the motor is very wasteful when it is icy and henceforth the cooling framework is composed in a manner that it forestalls cooling when the motor is warming up and till it achieves most extreme proficient working temperature, then it begins cooling. There are fundamentally two sorts of cooling frameworks:

(a) Air cooled framework, and
(b) Water cooled framework.

In Air cooled framework is by and large utilized as a part of little motors say up to 15-20 kW and in aero plane motors. In this framework balances or augmented surfaces are given on the chamber dividers, barrel head, and so forth. Heat created because of ignition in the motor chamber will be directed to the balances and when the wind streams over the blades, warmth will be disseminated to air.
The measure of warmth dispersed to air relies on:
(a)Amount of air coursing through the blades.
(b)Fin surface region.
(c)Thermal conductivity of metal utilized for balances.

In water cooling framework cooling water coats are given around the chamber, barrel head, valve seats and so on. The water when coursed through the coats, it ingests warmth of ignition. This boiling hot water will then be cooling in the radiator mostly by a fan and in part by the stream created by the forward movement of the vehicle. The cooled water is again recycles through the water coats.

II. LITERATURE REVIEW

Recently, number of research papers has been published on the heat transfer enhancement by using Nano fluid in heat exchanger, among this nanoparticles Alumina (Al_2O_3) is one of the most common and inexpensive nanoparticles used by many researchers in their experimental investigations is reviewed and is categorized as experimentally, numerically and analytically. Some of this work is highlighted as follow.

In 2011, S.M. Hoseini., S.M. Peyghambarzadeh, S.H. Hashemabadi, M. Seifi Jamnani., [1] conducted experiment on forced convective heat transfer in a water based Nano fluids, has been experimentally compared to that of pure water in an automobile radiator with different concentrations of Nano fluids. Additionally, the effect of fluid inlet temperature to the radiator on heat transfer coefficient has also been analyzed by varying the temperature. Results demonstrate that increasing the fluid circulating rate can improve the heat transfer performance while the fluid inlet temperature to the radiator has trivial effects. Meanwhile, application of Nano fluid with low concentrations can enhance heat transfer efficiency up to 45% in comparison with pure water.

In 2012, Ramaraju Ramgopal Varma, Veeredhi Vasudeva Rao, [2] deals with experimental determination of convective heat transfer coefficient in a counter flow double pipe heat exchanger using water based TiO_2, ZnO Nano fluids with 0.002% & 0.004% volume concentrations. Experiments are conducted at various Reynolds numbers ranging from 1600 to 6100. From the experimental results it is found that heat transfer coefficient increases with increase of volume concentration of nanoparticles as well as Reynolds number. Enhancement of heat transfer coefficient between Nano fluids with 0.002% volume concentration of TiO_2, ZnO and the inner walls of copper tube in a double pipe heat exchanger increased up to 30.37% and 57.31% respectively. The enhancements are as high as 66.12% and 78.30% when the volume concentration is 0.004% of TiO_2 and ZnO respectively for same set of operating conditions when compared to pure water at Reynolds number 6100. The experimental results are presented in graphical form. The variation of heat transfer coefficient in both dimensional and non-dimensional form is presented as a function of Reynolds number for different volume concentrations of Nano fluids. The effectiveness of heat exchanger is also presented as a function of volume concentration of Nano fluids.

In 2014, R J Bhatt, 2H J Patel, 3O G Vashi, [3] studied the basics of cooling system and nanofluid. Cooling system is one of the important systems amongst all. It is responsible to carry large amount of heat waste to surroundings for efficient working of an engine. It also enhances heat transfer and fuel economy which leads to maximize the performance of an engine. Most internal combustion engines are fluid cooled using either air or a liquid coolant run through a heat exchanger (radiator) cooled by air. The heat transfer through radiator can be improved by maximizing the heat transfer area and increasing the heat transfer coefficient. The heat transfer coefficient can be increased either by using more efficient heat transfer methods or by improving the thermo physical properties of the heat transfer material i.e. coolant. Earlier, Water was widely used in radiator as a coolant for its good ability to holding heat, transfer heat and can be readily obtained. Also the mixture of water & ethylene glycol later introduced as a coolant. Both of them having certain merits & demerits. With the advancement of nanotechnology, the new generation of heat transfer fluids called, “Nano fluids” have been developed and researchers found that these fluids offer higher thermal conductivity compared to that of conventional coolants. Nano fluids which consist of a carrier liquid, such as water, ethylene glycol dispersed with tiny Nano-scale particles known as nanoparticles. This comprehensive study on cooling system importance, coolant used in automobiles and its limitations and applications and challenges of Nano fluids as a coolant have been compiled and reviewed for automobile radiator.

In 2014, Adnan M. Hussein, K.V. Sharma, R.A. Bakar, K. Kadirgama., [4] studied experimentally and numerically reviewed the nanoparticles as additives. They studied the computational simulations and found that most of them are in agreement with results of experiments. Smaller particle sized additives found to enhance heat transfer rate than that of the larger sized. They presented a report showing enhancements in the heat transfer coefficient of smaller size particles when compared to values obtained with a larger size. High volume fraction of various Nano fluids will be useful in car radiators to enhance the heat transfer numerically and experimentally. Correlation equations can expose relationships between the Nusselt number, the Reynolds number.

In 2014, Mohammad Hemmat Esfe, Seyfolah Saedodin, [5] presented the Experimental study of effective thermal conductivity of ZnO/EG Nano fluid in this research. The Nano fluid was prepared by dispersing Zno nanoparticles in ethylene glycol using a sonicator and adding surfactant. Ethylene glycol based Nano fluid containing ZnO nanoparticles with a nominal diameter of 18 nm at different solid volume fractions (very low to high) at various temperatures was examined for the investigation. The thermal conductivity of Nano fluids is experimentally measured with THW method and it is found that the thermal conductivity of Nano fluids increase with the nanoparticle volume concentration and temperature. Also, based on experimental values of thermal conductivity of nanofluid, three experimental models are proposed to predict thermal conductivity of nanofluids. The proposed models show reasonably excellent agreement with our experimental results.

III. OBJECTIVES

The main objective of proposed work is concentrated towards the heat transfer enhancement in finned tube heat exchanger (Radiator) by using nanoparticles with respect to different % concentration.

1. Obtain results for conventional base fluid (Water) used in engine cooling system.
2. Optimization of nano material weight concentration 0.5, 1, 1.5, 2, 2.5 percent of base fluids.
3. Comparison of results.

IV. PROBLEM DEFINITION

Traditional forced convection heat transfer in a car radiator is performed to cool circulating fluid consisting of water or a mixture of water and anti-freezing materials like ethylene glycol (EG). The efficiency of this system decreases with fluctuations in air velocity. It requires increase in surface area of finned heat exchanger. But the increase in area of heat exchanger reduces the heat transfer rate of the cooling media and thereby reduces the efficiency of the system. In present system pre-cooling system with the help diffuser device will be used. In addition, nanofluid with the base fluid to increase the heat transfer rate will be used. Both the addition of nanofluid and pre cooling system helps increase in heat transfer rate and will thereby increase the efficiency of the system. The heat transfer performance of pure water and pure EG has been compared with their binary mixtures. Furthermore, different amounts of nanoparticles have been added into these base fluids and its effects on the heat transfer performance of the radiator have been determined experimentally. Thermal conductivity, heat transfer coefficient and heat transfer rate of the fluid increases by adding nanoparticles. Higher thermal conductivity and better thermo physical properties can be applied in heat exchanger to increase the heat transfer rate. Forced convective heat transfer in a water based nanofluid has been experimentally compared to that of pure water in an automobile radiator for different concentrations of nanofluids.

V. METHODOLOGY

For performance evaluation of engine cooling system using nanofluids required water cooled system and the components of this systems are Radiator, Thermostat valve, Water pump, Fan, Water Jackets, and Antifreeze mixtures

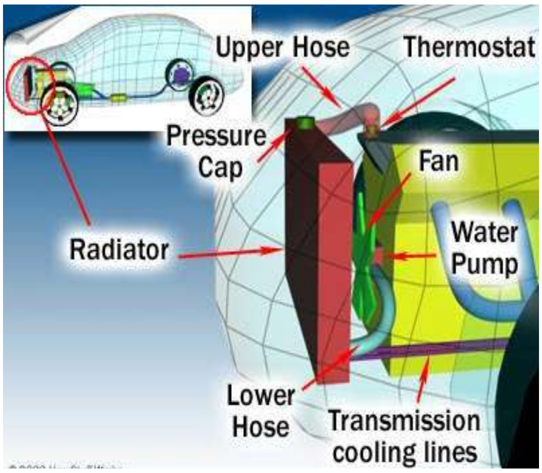

Fig. 1 Water Cooling System

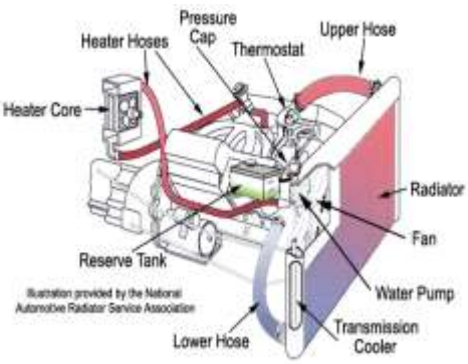

Fig.2 Water Cooling System of a 4-cylinder Engine

A. Radiator

It mainly consists of an upper tank and lower tank and between them is a core. The upper tank is connected to the water outlets from the engines jackets by a hose pipe and the lover tank is connect to the jacket inlet through water pump by means of hose pipes. There are 2-types of cores:

(i) Tubular

(ii) Cellular as shown.

When the water is flowing down through the radiator core, it is cooled partially by the fan which blows air and partially by the air flow developed by the forward motion of the vehicle. As shown through water passages and air passages, water and air will be flowing for cooling purpose. It is to be noted that radiators are generally made out of copper and brass and their joints are made by soldering.

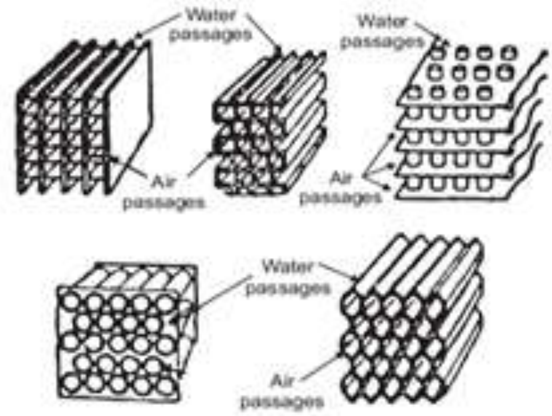

Fig. 3 Types of Cores (a) Tabullar Radiator Sections and (b) Circular Radiator

B. Thermostat Valve

It is a valve which keeps stream of water from the motor to radiator, so that motor promptly reaches to its most extreme effective working temperature. In the wake of accomplishing greatest productive working temperature, it naturally starts working. For the most part, it keeps the water beneath 70°C. Fig. 4 demonstrates the Bellow sort indoor regulator valve. It contains a bronze cry containing fluid liquor. Howl is associated with the butterfly valve circle through the connection. At the point when the temperature of water builds, the fluid liquor dissipates and the cry extends and thus opens the butterfly valve, and permits heated water to the radiator, where it is cooled.

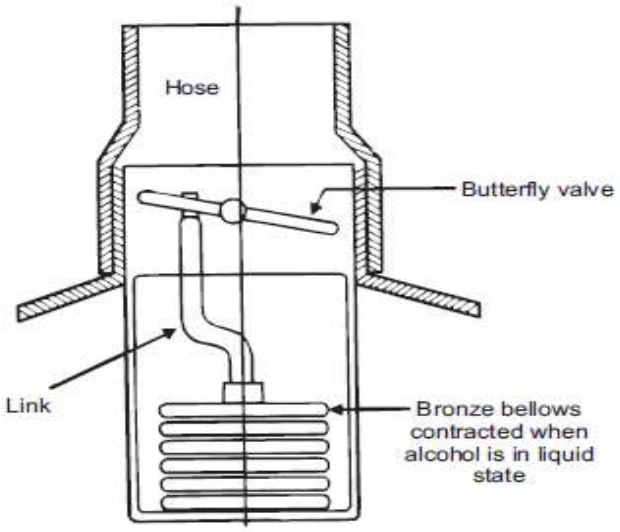

Fig. 4 Bellow type thermostat valve

C. Water Pump

It is utilized to pump the coursing water. Impeller sort pump will be mounted at the front end. Pump comprises of an impeller mounted on a pole and encased in the pump packaging. The pump packaging has gulf and outlet openings. The pump is driven by method for motor yield shaft just through belts. When it is driven water will be pumped.

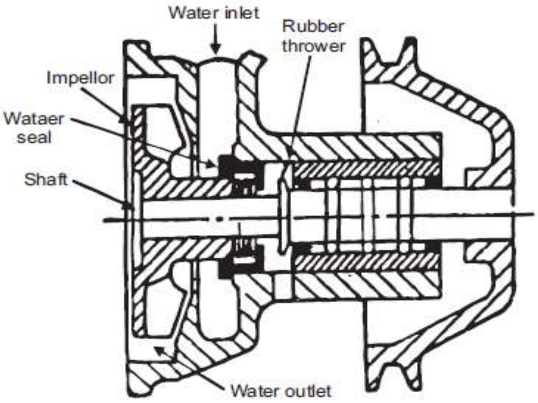

Fig. 5 Water Pump

D. Fan

It is driven by the motor yield shaft through same belt that drives the pump. It is given behind the radiator and it blows air over the radiator for cooling reason.

E. Water Jackets

Cooling water coats are given around the barrel, chamber head, valve seats and any hot parts which are to be cooled. Heat created in the motor barrel, led through the chamber dividers to the coats. The water coursing through the coats assimilates this warmth and gets hot. This heated water will then be cooled in the radiator.

F. Antifreeze Mixture

In western nations if the water utilized as a part of the radiator solidifies as a result of cool atmospheres, then ice shaped has more volume and produces splits in the chamber squares, channels, and radiator. Along these lines, to counteract solidifying liquid catalyst blends or arrangements are included the cooling water.

The perfect liquid catalyst arrangements ought to have the accompanying properties:

i. It ought to break up in water effectively.
ii. It ought not dissipate.
iii. It ought not store any remote matter in cooling framework.
iv. It ought not have any destructive impact on any piece of cooling framework.
v. It ought to be shabby and effectively accessible.
vi. It ought not consume the framework.

No single liquid catalyst fulfills every one of the prerequisites. Ordinarily taking after are utilized as liquid catalyst arrangements:

i. Methyl, ethyl and isopropyl alcohols.
ii. An answer of liquor and water.
iii. Ethylene Glycol.
iv. An answer of water and Ethylene Glycol.
v. Glycerin alongside water, and so forth.

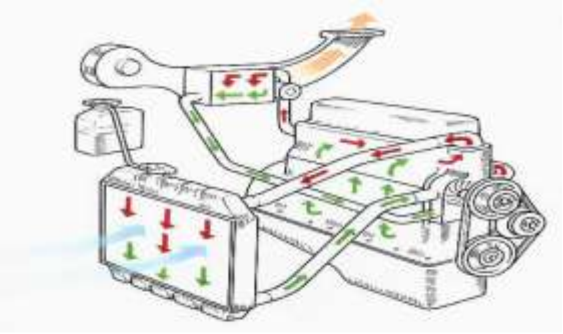
Fig. 6 Liquid cycle in the system

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