Improving the Effectiveness of Automobile radiator using Copper Oxide Nanofluid as a Coolant

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Abstract— **In this project work, we are using the nanofluid copper oxide with pure water and ethylene glycol as a coolant in a automobile radiator. The nanofluid is varied with three different concentration in the range of 0.1-1% have been prepared by the addition of copper oxide nanoparticles into pure water and ethylene glycol. The effect of the radiator on heat transfer co-efficient has also been analyzed for pure water, ethylene glycol with nanofluids. Comparing the heat transfer co-efficient of the nanofluids copper oxide with pure water and ethylene glycol coolant of a automobile radiator**.

**Keywords— Copper oxide
Ethylene glycol
Radiator
Heat transfer coefficient**

I. INTRODUCTION

The application of ethylene glycol / copper oxide (CuO) nanofluid instead of pure water in the radiator as a coolant. It is common in the area of cold or hot weathers that some additives are added to the copper oxide in the automotive radiator which decrease freezing point of copper oxide. It keeps the radiator fluid from freezing when it is very cold and keeps the car from overheating on very hot days. The additive which is used is specially ethylene glycol. The major use of ethylene glycol is as a medium for convective heat transfer. Because copper oxide is a much better engine coolant, the mixture of copper oxide and ethylene glycol has been used. The trouble with ethylene is that it freezes or boils at extreme temperatures. Anti – freezing agents like ethylene glycol can withstand much greater temperature extremes, so by adding it to the copper oxide nanofluids.

Convectional fluids such as refrigerants, water, engine oil, ethylene glycol have poor heat transfer performance and therefore high compactness and effectiveness of heat transfer system are necessary to achieve the required heat transfer. An experimental investigation of the convective turbulent heat transfer characteristics of nanofluid (CuO – ethylene glycol) with 0.1 – 1% vol. the Nusselt number for the nanofluid increase with the increase of volume concentration and Reynolds number. The convective heat transfer of nanofluid in the region under laminar flow condition. It is based on the copper oxide nanofluid along with ethylene glycol. The laminar flow heat transfer of nanofluid (CuO – ethylene glycol) in a constant wall temperature boundary condition. An investigation of the laminar flow convective heat transfer of CuO–ethylene under constant wall temperature with 0.1 – 1% vol of nanoparticle for Reynolds number varying between 700 and 2050. 1% vol of CuO which is mixture with ethylene glycol which is used as a coolant to cool the heat transfer through the tubes in the radiator.

By this method we are improving the effectiveness of radiator by using copper oxide as a nanofluid and the effects of the operating conditions on its heat transfer performance are analyzed. The minimum freezing point is observed when the ethylene glycol percent in copper oxide is about 70%. However the boiling point for aqueous ethylene glycol increases monotonically with increasing glycol percentage. Thus the use of ethylene glycol not only declines the freezing point but also elevates the boiling point such that the operating range for the heat transfer fluid is broadened on both ends of the temperature scale. Nanofluids are formed by suspending metallic or non-metallic oxide nanoparticles. It has been proved that conventional fluids, such as copper oxide and ethylene glycol have poor convective heat transfer performance and therefore high compactness and effectiveness of heat transfer systems are necessary to achieve the required heat transfer. In car radiators, the coolant media is pumped through the flat tubes while the air is drawn over the fins by forced convection, thereby heat exchanges between the hot circulating fluid and air constant velocity and temperature of air are considered throughout the experiments in order to clearly investigate the internal heat transfer.

Radiator is used for storing cooling water which is circulated around the cylinder. The radiator is provided fins for air venting. This experiment includes a storage tank, a heating element (radiator), a pump and a pressure gauge. The test fluid flows through the five layer insulated tubes from the feed tank to the radiator by a centrifugal pump with constant flow rate of 12 l/min. water from the sump enters the heating element which is heated to absorb the heat and enters to the radiator tube. Hot water which is enters to the radiator and goes out as cold water because of the copper oxide which is used as a nanofluid enters to the radiator tube as a coolant which is high heat resistance through it, and comes out as cold water. Inside the radiator, the tube present is copper tube.

Temperature indicator is used to indicate the range of temperature of inlet, intermediate and outlet. Also with that we are using sensor which is connected to it. Pressure gauge is used to noted the flow range of fluid which passes through the tube. The range of pressure gauge is 0-10kgf/cm^2. heating coil which is we use similar to the induction coil which shows the range of 230-240^{0}C. pump is used to circulate the fluid which passes through the tubes along with the nanoparticle which is present in it. Collecting tank is used to collect the fluid and help to pass through the tubes. On the bottom of the collecting tank there is a drain plug is present which is used to remove the fluid out when it is not necessary. The capacity of collecting tank contains 1-1.5lits of storage fluids.

Nanofluids are the new window which was opened recently and it was confirmed by several authors that these working fluid can enhance heat transfer performance. Further enhancement in heat transfer is always in demand, as the operational speed of these device depends on the cooling rate. New technology and advance fluid with greater potential to improve the heat transfer performance. The test section is made up with a typical automobile radiator and the effects of the operating condition on its heat transfer performance are analyzed.

It has been proved that conventional fluids, such as copper oxide and ethylene glycol have poor convective heat transfer performance and therefore high compactness and effectiveness of heat transfer systems are necessary to achieve the required heat transfer. In car radiators, the coolant media is pumped through the flat tubes while the air is drawn over the fins by forced convection, thereby heat exchanges between the hot circulating fluid and air constant velocity and temperature of air are considered throughout the experiments in order to clearly investigate the internal heat transfer.

COMPONENTS:

- Radiator (heat exchanger).
- Heating element.
- Temperature indicator.
- Fan.
- Pressure gauge.
- Circulating pump.

RADIATOR:

Radiator is used for storing cooling water is circulated around the cylinder. The radiator is provided fins for air venting. This experiment include storage tank, a heating element (radiator), a pump and a pressure gauge. The test fluid flows through the five layer insulated tubes from the feed tank to the radiator by a centrifugal pump with constant flow rate of 12 l/min. water from the sump enters the heating element which is heated to absorb the heat and enters to the radiator and goes out as cold water because of the copper oxide which is used as a nanofluid enters to the radiator tube as a coolant which is high heat resistance through it, and comes out as a cold water. Inside the radiator, the tube present is copper tube.

HEATING ELEMENT:

FOR HEATING THE WORKING FLUID, AN ELECTRICAL HEATER AND A CONTROLLER WERE USED TO MAINTAIN THE TEMPERATURE OF AROUND 200-250*C. (WHICH IS USED TO WITHSTAND HIGH HEAT RESISTANCE). SINCE THE HEATING ELEMENT IS A DEVICE WHICH PRODUCE A HEAT TO THE EXPERIMENTAL SETUP. THE HEAT SOURCE IS MAIN IN THIS EXPERIMENT SO THE HEATING ELEMENT WHICH IS USED MUST BE HAVING GREATER EXTENT OF HEAT. SO THAT THE HEATING ELEMENT IS MUST REQUIRED FOR THIS EXPERIMENTAL SETUP. IN THIS EXPERIMENT IS INDUCTION COIL WHICH HAS A TEMPERATURE OF AROUND 240^{0}C. HEATING ELEMENT WHICH IS AROUND IN THE COLLECTING TANK. WHEN THE WATER FROM THE COLLECTING TANK ENTERS THROUGH THE HEATING COIL IS HEATED TO THE CERTAIN TEMPERATURE OF 230^0-240^{0}C AND ENTERS THE RADIATOR

temperature indicator:

The thermostat is device used for measuring the temperatures at 3 stages of the experiment. Since three thermostats are used in this experiment, which should be placed in 3 different stages, Such as inlet, outlet and intermediate stages. The inlet thermostat is used to measure the of water flow at the inlet opening. The outlet is used to measure the temperature at the outlet of the experimental set up, the intermediate thermostat is used to measure the temperature at the intermediate. Three temperature measurement is connected to the sensor with the help of a switch which is rotated the reading of the inlet, outlet and intermediate temperature is noted. Hot water which is enters to the radiator and goes out as cold water because of the copper oxide which is used as a nanofluid enter to the radiator tube as a coolant which is high heat resistance through it comes out as cold water. Inside the tube the flow of water along with the mixture of nanofluid to measure the velocity along with the pressure regulator. Temperature indicator is used to measure the temperature range which is done by the flow of water enters to the tubes and it reaches to a certain temperature.

RADIATOR FAN:

Radiator fan is used to reduce the heat of the coolant which is passing in the tube of the radiator. Here using 1400rpm fan with 45watts and 0.35amps.

PRESSURE GAUGE:

Pressure gauge is used to measure the flow of coolant. In this experiment dial gauge is used to measure the flow of coolant of the radiator. Pressure gauge range 0-10kgf/cm^2. Two pressure gauge is used, to measure the inlet and outlet flow of coolant.

CIRCULATING PUMP:

Pump is used to circulate the coolant into the radiator tube. In this experiment centrifugal pump is used to circulate the flow rate of 10-12 l/min. it has the rate of 0.05kw. the total volume of circulating liquid is constant in this experiment.

ETHYLENE GLYCOL:

The ethylene glycol mixture is used as coolant for the radiator to increase the cooling efficiency. Since it is mixed with the nano particle as the coolant to cool the engine in the radiator. It is a solution which has high cooling efficiency when compare with all other common solutions. And it dissipate high heat when compare with the other solutions. The nano particle will easily dissolve in this solution, then the ethylene glycol has high capacity.

copper oxide nanoparticles (0.1, 0.2, 0.3, 0.4 …….., 2) have been added to different base fluids including pure water and ethylene glycol (5, 10,….20 % vol EG). There was no dispersant or stabilizer added to the nanofluid. This is due to the fact that the addition of any agent may change the fluid properties and the authors were interested to estimate the easiest actual condition encountered in the radiator. Additionally creating highly turbulent flow condition in the radiation tubes connecting pipes can improve the stabilization of the nanoparticles in copper oxide fluid. By assuming that the nano particle are well dispersed within the base fluids. the particle concentration can be considered uniformly throughout the system. The following correlations have been used to predict nanofluid density, specific heat, and thermal conductivity respectively at different temperatures and concentration.

COPPER OXIDE:

Copper oxide is a nanofluid which is used as a coolant in the radiator. This is due the fact that the addition of any agent may change the fluid properties. By assuming that nanoparticle are well dispersed within the base fluids. Copper oxide has better heat transfer performance when compare to the aluminum oxide and silicon oxide.

Ethylene glycol:

Conventional fluids such as refrigerants, water, ethylene glycol, engine oil, etc have poor heat transfer performance and therefore high compactness and effectiveness of heat transfer systems are necessary to achieve the required heat transfer. Among the efforts for enhancement of heat transfer the application of additives to liquids is more noticeable.

Copper oxide

The liquids are water based nanofluid which consists of water and small amount of copper oxide nanoparticle. There was no dispersant or stabilizer added to nanofluid. Additionally creating highly turbulent flow condition in the radiator tubes connecting pipes guarantees the stabilization of the nanoparticle in water.

TESTING:

The following testing which is based on:

I. Ethylene glycol.
II. Pure water.
III. CuO+ethylene glycol.
IV. CuO+pure water.

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