PERFORMANCE ANALYSIS OF AUTOMOBILE RADIATOR

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Abstract - *An Automobile radiator is a component which is used to transfer the heat from the engine to surroundings. Radiator is used only for the water cooled engines. Radiator is just the heat exchanger which transfer the heat from the engine to the surroundings by its complex working principle. Heat transfer from a radiator occurs by all the usual mechanisms: thermal radiation, convection into flowing air or liquid, and conduction into the air or liquid. A radiator may even transfer heat by phase change, for example, drying a pair of socks. In practice, the term "radiator" refers to any of a number of devices in which a liquid circulates through exposed pipes (often with fins or other means of increasing surface area). The term "convector" refers to a class of devices in which the source of heat is not directly exposed. In this project such an automobile radiator is taken and its performance is analyzed.*

Key Words: **Radiator, Heat transfer, Cooling System**.

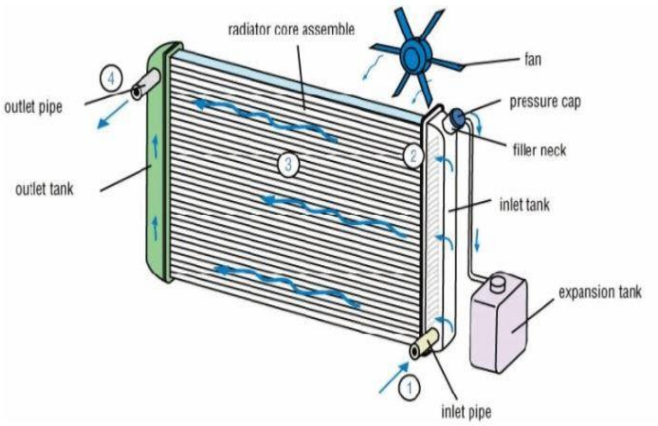
1. INTRODUCTION

In this project work, an automobile radiator in working condition is chosen. The other requirements are: Pump, which pumps and recirculates the liquid into the radiator, Thermometers, to measure the temperature at inlet and outlet of the radiator, a flow control valve to regulate the flow, and a flow meter to measure the flow rate of the liquid passing into the radiator and a water heater (instead of engine) to heat the water. These values are needed in order to calculate the heat transfer rate of the radiator. Using this principle performance of any radiator can be analyzed.

2. COMPONENTS

2.1 Radiator

A radiator is a type of heat exchanger. It is designed to transfer heat from the hot coolant that flows through it to the air blown through it by the fan. Most modern cars use aluminum radiators. These radiators are made by brazing thin aluminum fins to flattened aluminum tubes. The coolant flows from the inlet to the outlet through many tubes mounted in a parallel arrangement. The fins conduct the heat from the tubes and transfer it to the air flowing through the radiator.

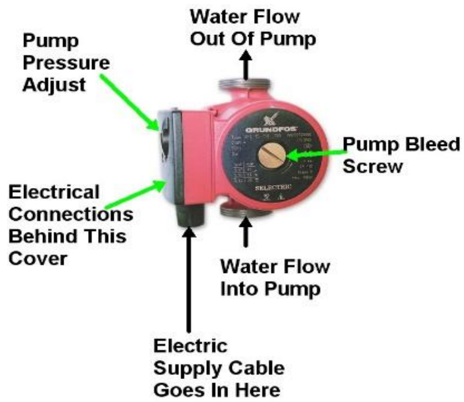


2.2 Water Heater

Water heating is a heat transfer process that uses an energy source to heat water above its initial temperature. Typical domestic uses of hot water include cooking, cleaning, bathing, and space heating. In industry, hot water and water heated to steam have many uses. This type of water heater is used to heat the water and it is cooled and recirculated. The Electric water heater is used instead of engine.

2.3 Radiator Pump

A radiator pump is a device used to pump and recirculate the working fluid from the engine to the radiator and the cycle continues until the engine stops. The radiator pump should be chosen which could withstand the high temperature. As the liquid from the engine carries the heat from the engine, hence the pump should withstand that temperature otherwise the impeller may melts.

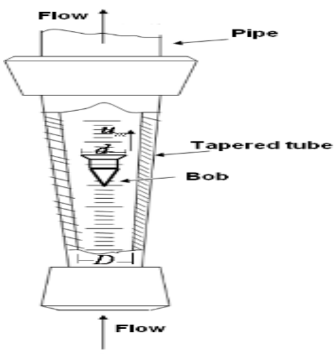


2.4 Rotameter

A Rota meter is a device that measures the volumetric flow rate of fluid in a closed tube. It belongs to a class of meters called variable area meters, which measure flow rate by allowing the cross-sectional area the fluid travels through to vary, causing a measurable effect.

This variable area principle consists of three basic elements: A uniformly tapered flow tube, a float, and a measurement scale. A control valve may be added if flow control is also desired. In operation, the rotameter is positioned vertically in the fluid system with the smallest diameter end of the tapered flow tube at the bottom. This is the fluid inlet. The float, typically spherical, is located inside the flow tube, and is engineered so that its diameter is nearly identical to the flow tube's inlet diameter.

When fluid, gas or liquid is introduced into the tube, the float is lifted from its initial position at the inlet, allowing the fluid to pass between it and the tube wall. As the float rises, more and more fluid flows by the float because the tapered tube's diameter is increasing. Ultimately, a point is reached where the flow area is large enough to allow the entire volume of the fluid to flow past the float. This flow area is called the annular passage. The float is now stationary at that level within the tube as its weight is being supported by the fluid forces which caused it to rise. This position corresponds to a point on the tube's measurement scale and provides an indication of the fluid's flow rate.



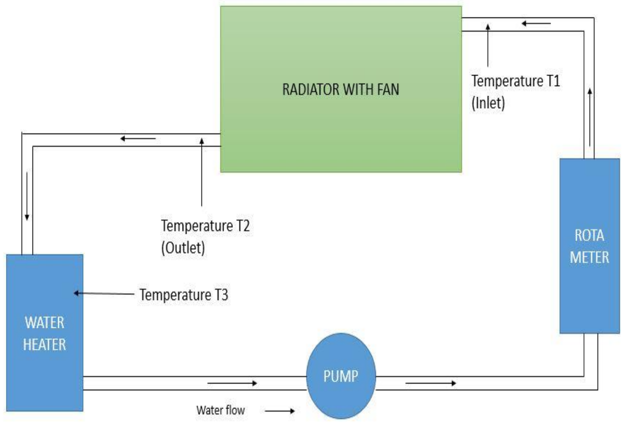
2.5 Thermometer

A thermometer is a device that measures temperature or a temperature gradient. A thermometer has two important elements: (1) a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer or the digital sensor in an infrared thermometer) in which some change occurs with a change in temperature, and (2) some means of converting this change into a numerical value (e.g. the visible scale that is marked on a mercury-in-glass thermometer or the digital readout on an infrared model).

Here three thermometers are used to measure the temperature. One at the inlet of the radiator and at the outlet of the radiator and other at the heating tank.

3. ASSEMBLY OF THE SYSTEM

The radiator along with the water heater, radiator pump and the flow meter is connected as shown in the below figure.



4. FORMULAS FOR CALCULATION

1. Heat transfer rate (Q_{avg})

$Q_{avg}=mc_p(T_{in}-T_{out})$

$Q_{avg}=hA(T_b-T_w)$

Where,

m- mass flow rate of fluid in kg/sec

c_p- specific heat capacity of fluid in kJ/kg.K

T_{in}-Inlet temperature of fluid in ºC

T_{out}-Outlet temperature of fluid in ºC

T_b-Bulk mean temperature in ºC

T_w-Mean surface temperature in ºC

2. Nusselt number (Nu)

$$Nu=\frac{h_{exp} D_h}{k}$$

Where,

h_{exp}- Heat transfer coefficient in W/m^2-K

D_h- Hydraulic diameter in m

k – Thermal conductivity of fluid in W/m-k

3. Reynolds number (Re)

$$Re=\frac{\rho v D}{\mu}$$

Where,

ρ -Density of fluid in kg/m^3

v-Velocity of fluid in m/sec

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μ-Dynamic viscosity in N-sec/m^2

4. Friction factor (f)

Darcy equation $f = \frac{64}{Re}$

After the assembly of the system the heater is turned on to heat the liquid and the hot water circulates through the radiator. The temperature at the inlet, temperature at the outlet and the flow rate are noted down and they are substituted in the formulas and the calculation of heat transfer is done. Thus the performance of the radiator can be analyzed.

5. CONCLUSION

This performance analysis of automobile radiator project thus serves to identify the performance of the radiator by measuring the temperatures at inlet and outlet and the heat transfer rate is calculated by the various formulas. Hence the performance of various radiators can be identified and it is very helpful in choosing the best radiator for the various applications.

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