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# Comparison of Water and Ethylene Glycol as Engine Coolants and Experimental Investigation on Single Cylinder Diesel Engine

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**Abstract:** For cooling of internal combustion (I.C) engines either air or a liquid is employed to remove the waste heat. Cooling is very much essential because high temperatures damage engine materials and lubricants. Cooling becomes more important when the climate becomes very hot. IC engines burn fuel hotter than the melting temperatures of engine materials and it is hot enough to set fire to lubricants. Engine cooling removes heat energy fast enough to keep temperatures low so that the engine can survive. A cooling curve test was performed in order to find the effect of using different types of coolants in I.C engines. The types of coolants used for this test were: (1).Water (2).Ethylene glycol based coolants. Coolant concentration of 50% in ethylene glycol was examined. The experiment was conducted on kirloskar made 4 stroke single cylinder vertical hand cranking type diesel engine. The main focus of this experiment was to determine the rate of heat carried away by coolant and specific fuel consumption. Temperature of coolant at outside was varied, while the speed of engine was kept constant. To achieve a particular temperature for ethylene glycol based coolant, the flow rate was made to reach a required value and it was compared with the flow rate of water.

**Keywords**: IC engine, coolant, ethylene glycol based coolants, heat carried, Specific fuel consumption, cooling curve test.

## I INTRODUCTION

In earlier days the most commonly used engine coolant was water, but its inability to remain in liquid state at elevated temperatures made it unfit to be used as a best engine coolant. It has a very low boiling and high freezing points are the main demerits for employing water as an effective engine coolant. The I.C engine needs some effective techniques for the dissipation of heat for the survival of engine [1]. Selection of the proper cooling fluids depends on the environment in which the engine is employed for the specific task and also the interaction of the engine material with the cooling fluid. Engine coolants are sometimes referred to as antifreeze because in certain cases engine may be exposed to extreme cold environments, at that condition the coolant used should not lost its liquid state and should remain in its liquid state for the proper functioning.

## II. LITERATURE REVIEW

The main two engine coolants used in earlier times were water and air, hence the cooling systems of engines were broadly classified into two categories, (1).Air cooled engines and (2).Water cooled engines [1]. Air cooled engine systems have gained much popularity as the engines at that time were operating at low horse power as a result of which less excess heat has to be removed. The major drawback of the air cooled systems is the outer surface of engine should be exposed to the surrounding air for heat transfer.

In case of water cooled engines, the heat transfer fluid which carries away the excess heat and flows to the radiator is water, and the excess heat is dissipated to the surrounding air. The major drawbacks of water cooled engine are the low boiling point (100$^{o}$C) and high freezing point (0$^{o}$C) of water. In order to overcome the drawback of low boiling point and high freezing point of water, ethylene glycol was introduced. The antifreeze characteristics shown by ethylene glycol were very good. Pure ethylene glycol had a freezing point of -9$^{o}$C.The freezing point and boiling point of 50% ethylene glycol water mixture is -36.8$^{o}$C and 107$^{o}$C respectively[2].

A study conducted on the thermal conductivities of ethylene glycol + water, diethylene glycol + water and tri ethylene glycol + water mixtures, measured at temperatures ranging from 25°C to 40°C and concentrations ranging from 25 wt. % glycol to 75 wt.% glycol showed that increasing the concentration of glycol leads to decrease of thermal conductivity. Increasing the temperature of mixture resulted in slight increase in thermal conductivity [3].

Glycerin is an alternative to ethylene glycol coolant, but its higher cost and weaker freeze point depression are the major drawbacks.

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## III. DESCRIPTION OF EQUIPMENT


Fig. 1. Shows the single cylinder diesel engine

Engine - Kirloskar Made 4 stroke single cylinder vertical hand cranking type diesel engine.
Stroke - 110mm
Bore - 80mm
Rated speed -1500RPM

## IV. EXPERIMENTAL PROCEDURE

The focus of this experiment is to find out the effect of coolant on heat transfer and specific fuel consumption by varying the outlet temperature of coolant and also to attain a specific temperature by varying the flow rate of coolant.

Procedure

*** Find out the maximum load by allowing the engine to run at rated speed ***

- Both the fuel and coolant supplies are opened and the engine is made to start at half load and the speed is adjusted to reach the rated rpm of engine.
- Engine is made to run for at least 2 times in order to attain steady conditions by adjusting the coolant flow to reach a maximum value.
- Note the time required for the consumption of a fixed quantity of fuel.

Repeat the above steps for different outlet temperatures of coolant by varying (reducing) the coolant flow rate, without varying the load (i.e. Keeping the load constant).

## V. EQUATIONS USED

Brake power
BP = VI/1000 (kW) (1)
where, V = Voltage in volts
I = current in Ampere

Fuel consumption

TFC= (V*3600*ρ)/(1000*t) (kg/hr) (2)
where, V = Volume of fuel consumed
t = time taken for fixed quantity of fuel consumption (in s)
Specific fuel consumption = TFC / BP (kg/kW-hr) (3)

Heat carried away by cooling water

Qw =Mw(To-Ti) Cpw (KW)
Cpw = Specific heat of water (KJ/KgK)
To = Cooling water a outlet Temperature (K)
Ti = Cooling water at inlet Temperature (K)
Mw = Mass of water flow through rotameter (Kg/s)

## VI. RESULT

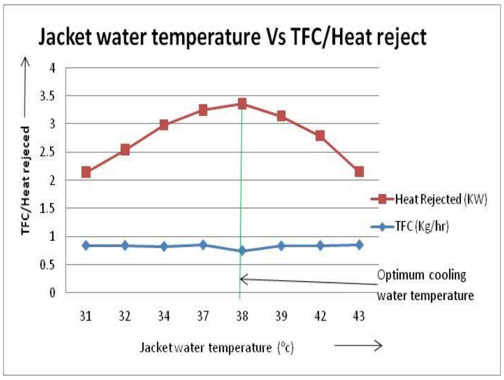

Fig. 2. Shows cooling curve for water alone.

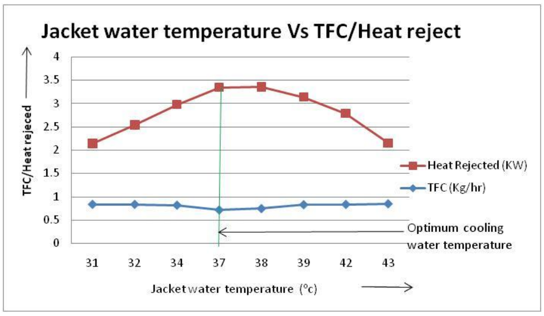

Fig. 3. Shows cooling curve for water and 50% ethylene glycol mixture

## VII. CONCLUSION

It was noted that the optimum coolant temperature at outlet was almost 38$^{o}$C in both the cases, maximum heat carried away by cooling water and maximum fuel economy was observed at this optimum temperature. There was not much difference in the optimum temperature and fuel economy by varying the coolant alone; they varied when the flow rate was varied.

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