A REVIEW ON COOLING SYSTEM IN AUTOMOBILE & CARS

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Abstract

Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. In air cooling system, heat is carried away by the air flowing over and around the cylinder**.** In water-cooling system of cooling engines, the cylinder walls and heads are provided with jacket through which the cooling liquid can circulate**.** Modern engine which produce efficient results in form of fuel efficiency and power to weight ratio runs at higher rpm and produce more power every cycle, this is a great boon but the amount of heat to be released from the engine to the surrounding increases with the increase in maximum power and speed requirement. In this paper the design and development of portable car cooling system is described.

Keyword; Cooling, heat, conventional, engine, air.

1. Introduction

Nowadays, car is one the most important transportation for each individual compare to public transport. The transportation of goods and passengers using the modern highways where the speed requirement is lot higher with heavy load on the vehicle combined with problems in hot summers surely require an advance engine cooling system.[1]

We know that in case of Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result into seizing or welding of the same. So, this temperature must be reduced to about 150-200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature.[2]

2. CONVENTIONAL ENGINE COOLING SYSTEM

Combustion of air and fuel takes place inside the engine cylinder and hot gases are generated inside an internal combustion engine. The temperature of gases may raise up to around 2300-2500 ℃, which is a very high temperature and may result into burning of oil film between the moving parts, pre combustion and may result into seizing or welding of the moving parts. So, this temperature must be reduced to lower values at which the engine will work properly and much more efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency and reduces the vaporization of fuel thereby showing improper burning in form of black smoke in exhaust. Though the conventional engine cooling system which are either air cooled or water cooled are designed to remove about 30-35% of total heat that the engine dissipates, for now these system somehow fulfilling the existing requirements but with the advancement in the engine technology, increasing relative brake horse power (BHP), aerodynamic design requirements, emissions standards and energy crisis, it need advancement.

- The radiators fitted in current engine cooling system are limited by air side resistance and require a large frontal area to meet cooling needs.
- Current engine cooling system has limited heat dissipation and does not meet the requirement at high engine output.
- Heat dissipation to volume ratio of the system is less.
- At high speeds it is difficult to maintain the temperature of engine components.
- Heat rejected by the system (about 35%of heat generated) is wasted to the atmosphere.[3]

3. TYPES OF COOLING SYSTEMS

There are mainly two types of cooling systems:

(a) Air cooled system, and

(b) Water cooled system.

3.1. AIR COOLING SYSTEM

Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines. In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air.

The amount of heat dissipated to air depends upon:

(a) Amount of air flowing through the fins.

(b) Fin surface area.

(c) Thermal conductivity of metal used for fins.

Advantages of Air Cooled System

Following are the advantages of air cooled system:

(a) Radiator/pump is absent hence the system is light.

(b) In case of water cooling system there are leakages, but in this case there are no leakages. (c) Coolant and antifreeze solutions are not required.

(d) This system can be used in cold climates, where if water is used it may freeze.

Disadvantages of Air Cooled System

(a) Comparatively it is less efficient.

(b) It is used in aero planes and motorcycle engines where the engines are exposed to air directly.

3.2. WATER COOLING SYSTEM

In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. The water when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward motion of the vehicle. The cooled water is again recirculated through the water jackets.[4]

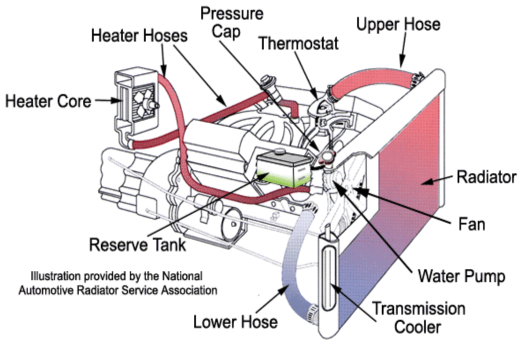

Fig3.1. water cooling system

Advantages of Water Cooling System

(a) Uniform cooling of cylinder, cylinder head and valves.
(b) Specific fuel consumption of engine improves by using water cooling system.
(c) If we employ water cooling system, then engine need not be provided at the front end of moving vehicle.
(d) Engine is less noisy as compared with air cooled engines, as it has water for damping noise.

Disadvantages of Water Cooling System

(a) It depends upon the supply of water.
(b) The water pump which circulates water absorbs considerable power.
(c) If the water cooling system fails then it will result in severe damage of engine.
(d) The water cooling system is costlier as it has more number of parts. Also it requires more maintenance and care for its parts.

4. DEVELOPMENT OF PORTABLE CAR COOLING SYSTEM

In order to obtain the optimum performance of the product, the design of the product is the most important. Due to that, Table.1 demonstrates the function of the component in the system and Figure 4.1 Illustrates the proposed cooling system. The materials used for hardware development is white derlin because this type of material is cheap, lightweight, easy to handle and it easy for manufacturing purposes. The primary 12VDC motor is used to drive the fan blades at the speed of 5 meters per second. Simultaneously, the 6Vdc secondary motor will drive the rotating cloth which has damp after immersion in water compartment. Interesting here, this system is able to produce wind with water vapours that creates cosiness in the car. The primary button and secondary button are used for switch on the primary and secondary motors respectively.[5]

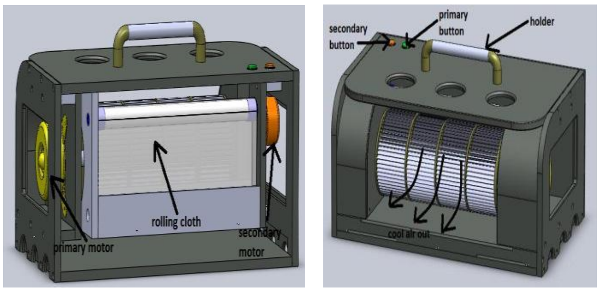

Fig4.1. Concept drawing of Portable Car Cooling system

Table1. *Function Of The Component In Portable Car* Cooler

Component	**Function**
Primary motor	Control the main fan in the system

Secondary motor	Control the rotation of rolling cloth
Rolling cloth	Produce cool air when it start to rotate
Primary button	Control the main motor (on/off)
Secondary button	Control the activation of secondary motor
Water compartment	Small water reservoir and placed for cloth moisture

5.DESIGN OF CONVENTIONAL RADIATOR

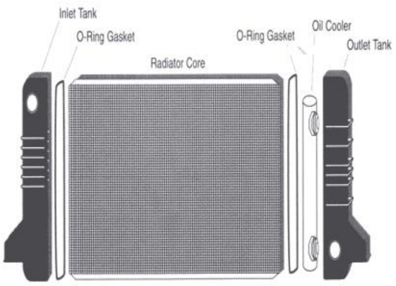

Fig 5.1 radiator of automobile.

Considering a conventional car radiator having Height of 365 mm and Width is 610 mm and depth of radiator (L_{out}) is 22mm. The fin dimensions are: thickness of fin (Th_{fin}) is 0.35, pitch of fin is 1.52 mm, and separation between two adjacent tubes is 8mm and the tube wall thickness of 0.4 mm. The corresponding value of Th_{avg} (hot water average temperature) is 90^{O}Cwith Q_d tubes as discharge rate fluid which is 1.30 x 10-3 m^3/sec, Q_{req}= 35596 W at maximum brake horse power of 37969 W, the wind velocity which is mainly due to forward motion of vehicle is (V_{air}) 150 km/hr.

RATE OF HEAT TRANSFER OVER THE SURFACE OF RADIATOR IS GIVEN BY:

Q= U x A x Ѳm And

$\Theta m = T_{Havg} - T_{Cavg}$

= 90– 40

= 50^0C

UA= 1 / R_{toalt}, (total thermal resistance between water and air)

Where U is overall heat transfer coefficient between two fluids and Ѳm is AMTD (arithmetic mean temperature difference)

$R_{total} = R_{in} + R_{f, in} + R_{cond} + R_{out} + R_{f, out}$ (1)

$R_{in} = 1/ (h_{in} \times A_{total, in})$

$A_{total, in}$= .979416

Defining Nu as nusselt number, K_{air} as thermal conductivity of air, Re as Reynolds number and Pr as Prandtl number.

Re = (ρ x v x L_c) / μ

= $.9937 \times 10^4$

Pr = (μ x cp) / k

= 1.8936

Nu = 3.66 + [(0.668 (D/W) x Re x Pr) / (1 + 0.04 ((D/W) x Re x Pr)$^{2/3}$]

Nu = 6.3366

Nu = (h_{in} x L_c) / k

Where L_c is characteristic length. h_{in}= 2122.3 W/ m2 K

Assuming R_{in} as convective resistance between the water & the inner surface of the tube, $R_{f,in}$ as fouling resistance that occurs on the internal surface of the tube, R_{cond} as resistance to conduction through tube wall, Rout as resistance between the air and the surface of the fins and the outer tube surface (it is due to both convection and conduction resistance to the fin) and R_f out as fouling resistance that occurs on the outer surface of the tubes.

R_{in}= 4.81 x 10-4 0C W^{-1}

$R_{f,\ in}$ = $R''_{f,\ in}$ / $A_{total\ in}$

= 1.021x 10^{-4} ^{O}C W^{-1}

$R_{f,\ out}$ = $R''_{f,\ out}$ / $A_{total\ out}$

= 3.3126x10^{-4} $^{O}CW^{-1}$

We have R”f, in as fouling factor for inside, R”f, out as fouling factor for outside,

R_{cond} = th / [k_{tube} x $_{Atotal\ in}$]

= 0.0163x10^{-4} $^{O}CW^{-1}$

R_{out} = 1 / (η_o x h $_{out}$ x $A_{total,out}$)

$A_{total\ out}$ = 6.037528 m^2

η_o = 1 –[($A_{s\ fin\ tot}$ / A_{tot})(1-η_{fin})]

η_{fin}= .983

η_o = .985

Let V is velocity of air flow, ν kinematic viscosity of air, $A_{s\ fin\ total}$ is total fin surface area, $A_{s\ unfin}$ is total un-finned surface area

Re = (ρ x v x L_{out}) / μ = 5.4x104

Pr = (μ x c_p) / k_{air}

= .7046

Nu = 0.036 x $(Re)^{4/5}$ x $(Pr)^{1/3}$

= 195.67

Nu = (h $_{out}$ x L_{out}) / k_{air}

h $_{out}$ = 241 W/m^2K

R_{out} = 6.977 x10^{-4O}C W^{-1}

R_{total} = 16.13693 x $10^{-4OC}W^{-1}$

U A = 1 / R_{total}

= .6197 x 10-3 W/ ^{O}C

Therefore, the rate of heat transfer for the radiator is Q = 30984 W over total fin surface area of 5.2096 m^2 and total un-finned surface area of 0.827928 m^2. And the difference in heat rate, ΔQ = Q_{req} - Q_{act} = 4612W.[6]

CONCLUSION

As a conclusion, the portable car cooling system was successfully developed. The main objective of the research is to propose a cooling system that able to control and maintain temperature inside the car. The radiator material in the design shows an increased rate of heat transfer which is much greater than the required value. The developed portable car cooling system is in a medium size and the design is suitable for good features, high performance with simple and effective way in reducing the car's cabin temperature. The existing radiator can be made smaller in size. That's means there is an extra availability of space in engine compartment and decrease in the frontal surface area. A great way to enhance the rate of convection between the inner walls of the tubing and the fluid.

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