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Experimental Investigation and Heat Transfer Analysis of Engine Fins by Varying Fin Geometry and Thermal Conductivity

Abstract- Extended surfaces (fins) are frequently used in heat exchanging devices for the purpose of increasing the heat transfer between a primary surface and the surrounding fluid. Various types of heat exchanger fins, ranging from relatively simple shapes, such as rectangular, cylindrical, annular, tapered or pin fins, to a combination of different geometry, have been used. These fins may protrude from either a rectangular or cylindrical base. The objective of this paper is to present an efficient heat sink model for better cooling of electronic devices. The optimum heat transfer through the fins depend on the fin height, fin thickness, fin length, base plate thickness, number of fins and fin shape or profile. In the present work, cooling is analysed by varying number of fins and fin profile. Five different types of fin profiles have been selected and the conjugate heat transfer analysis has been carried out. CFD simulation and CHT analysis is carried out with a commercial package provided by ANSYS-FLUENT. Heat sinks are devices that enhance heat dissipation from a hot surface, usually the case of a heat generating component, to a cooler ambient, usually air. For the following discussions, air is assumed to be the cooling fluid. Heat sink is a passive heat exchanger that cools a device by dissipating heat into the surrounding medium. The heat sink is a very important component in cooling design. It increases the component surface area significantly while usually increasing the heat transfer coefficient as well. Thus, the total resistance from the component junction to the surroundings is reduced significantly, which in turn reduces the junction temperature within a device

Keywords: CFD, Fins, ANSYS ICEM, ANSYS FLUENT, Heat Transfer Coefficient, CFD Post etc.

INTRODUCTION

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and -pressure gases produced by combustion applies direct force to some component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy.

BASIC PRINCIPLES:

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. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water.

I. ADVANTAGES

1. Air cooled engines are lighter because of the absence of the radiator**,** the cooling jackets and the coolant.
2. They can be operated in extreme climates, where the water may freeze.
3. In certain areas where there is scarcity of cooling water, the air cooled engine is an advantage.
4. Maintenance is easier because the problem of leakage is not there.
5. Air cooled engines get warmed up earlier than the water-cooled engines.

II. DISADVANTAGES

1. It is not easy to maintain even cooling all around the cylinder, so that the distortion of the cylinders takes place. This defect has been remedied sometimes by using fins parallel to the cylinder axis. This is also helpful where a number of cylinders in a row are to be cooled. However, this increases the overall engine length.

2. As the coefficient of heat transfer for air is less than that for water, there is less efficient cooling in this case and as a result the highest useful compression ratio is lesser in the case of air cooled engines than in the water cooled ones.

3.The fan used is very bulky and absorbs a considerable portion of the engine power (about 5%) to drive it.

4.Air cooled engines are more noisy, because of the absence of cooling water which acts as sound insulator.

5.Some engine components may become inaccessible easily due to the guiding baffles and cooling, which makes the maintenance difficult.

III. DIFFERENCE BETWEEN AIR COOLED ENGINES AND WATER COOLED ENGINES

Air cooling uses airflow directed at fins on the cylinders and heads is the cooling medium: heat is transferred directly to the air. The air comes either by natural convection (e.g., a motorcycle) or by forced air (e.g., air-cooled VW or Porsche engine.)

Water cooled engines circulate coolant around the heads + cylinders though a surrounding water jacket, and use a separate high- efficiency radiator for the final heat exchange to the air. (Marine engines are a bit different - they use the surrounding water instead, either directly or through a water-to-water heat exchanger.)

Air-cooled engines are simpler, lighter and easier to maintain as they don't have the 'wet' cooling system elements. They excel in cold climates where coolant freezing can be a problem. However, air cooling is less efficient due to the low heat capacity of air so these engines suffer from hot spots which reduces power, increases emissions and shortens their life.

Air-cooled engines are also considerably noisier - both from the engine directly and also from the air blower cooling fan if used. Water-cooled engines take advantage of water's high heat capacity to efficiently carry away the heat. So they offer the best control over temperature allowing for more aggressive / efficient tuning and optimal head design. While they have increased near-term maintenance costs (coolant, water pump, hoses, etc.) they make up for it in a longer-lived engine core (longer time between overhaul.) Water-cooled engines are also quieter due to the insulating properties of the water jacket and the lessened airflow requirement.

Water cooling also permits more flexibility in engine architecture and installation since there isn't a need to duct cooling air directly to the cylinders.

CONCLUSION

In this thesis, a cylinder fin body for Passion Plus 100cc motorcycle is modeled using parametric software Pro/Engineer. The original model is changed by changing the geometry of the fin body, distance between the fins and thickness of the fins.

Present used material for fin body is Cast Iron. In this thesis, thermal analysis is done for all the three materials Cast Iron, Copper and Aluminum alloy 6082. The material for the original model is changed by taking the consideration of their densities and thermal conductivity. Density is less for Aluminum alloy 6082 compared with other two materials so weight of fin body is less by 1.318 kg and 1.432 kg when compared with cast iron and copper respectively using Aluminum alloy 6082. Thermal conductivity is more for copper than other two materials. By observing the thermal analysis results, thermal flux is more for Aluminum alloy by 8.152 W/mm^2 and 6.943 W/mm^2 when compared with cast iron and copper respectively and also by using Aluminum alloy its weight is less, so using Aluminum alloy 6082 is better.

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