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THERMAL ANALYSIS OF THREE CYLINDER ENGINE HEAD A REVIEW

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ABSTRACT

In the thermal analysis of thermal barrier coated compression ignition engine is done .The heat transfer through the cylinder head with and without ceramic insulation is analysed .two different insulation coating materials are used .Heat transfer is analyzed and the amount of coolant required is optimized to save the heat lost and power consumed. Series of experimentation's and computational software are used for the thermal analysis of the L.H.R. (low heat rejection) engine. The rapid advances in computer and simulation technology make it possible to model complex geometrical shapes, assign load cases and analyze associated deformations and material behavior. The results show that optimization of the cooling system of the conventional and L.H.R. engine saves the extra heat lost in cooling and is available for improving the engine performance internal combustion engine is a rich source of examples of almost every conceivable type of heat transfer. There are a wide range of temperatures and heat fluxes in the various components of the internal combustion engine. Internal combustion engines come in many sizes, from small model airplane engines with a 0.25 " (6 mm) bore and stroke to large stationary engines with a 12" (300 mm).About 25 % of the air/fuel mixture energy is converted to work, and the remaining 75% must be transferred from the engine to the environment. The heat transfer paths are many, and include many different modes of heat transfer. In this review we will discuss the heat transfer processes in the engine components, then consider the engine parameters and variables which affect the heat transfer processes. Maximum amount of heat is transferred through the cylinder head. In this project we have taken efforts to analyze the heat transfer through the cylinder head of three cylinder S.I. engine. CAE is extensively used for simulation. Heat transfer is analyzed for different rates of coolant flow and a optimized coolant flow rate is suggested.

Keywords: Cylinder Head, Thermal Analysis, Heat Transfer.

I. INTRODUCTION

Internal combustion engines at best can transform about 25 to 35% of chemical energy in the fuel into mechanical energy. About 35% of heat generated is lost into the surrounding of combustion space. Remainder being dissipated through exhaust & radiation from the engine. It should be remembered that abstraction of heat from the working medium by the way of cooling the engine components is a direct thermodynamic loss. High pressure fuel injection systems such as common rail system & electronically controlled unit injector [EUI] systems have been widely applied modern heavy duty diesel engines. They are shown to be very effective for achieving high power density with high fuel efficiency & low exhaust gas emissions. However the increased peak combustion pressure gives additional structural & thermal load to engine structure. Thus proper material selection & thermal analysis of engine components are essential in order to meet the durability, requirements of heavy duty CI engines adopting high pressure injection systems. About 35% of the total chemical energy that enters an engine in the fuel it converted to crankshaft work, & about 30% of the fuel energy is carried array from the engine in the exhaust flow in the form of enthalpy & chemical energy. This leaves about one third of the total energy that must be dissipated to the surrounding by some mode of heat transfer. Temperatures within the combustion of an engine reach values on the order 2700 K & up. Materials in the engine cannot tolerate this kind of temperature & would quickly fail if proper heat transfer did not occur. Removing heat is highly critical in keeping an engine & engine lubricant away from thermal failure. On the other hand it is desirable to operate an engine as hot as possible to maximize thermal efficiency. It must be remembered that the reliability of an engine depends not so much, it is true on the proportion of the total heat converted into useful work, but rather upon the proportion of the total heat which is not so converted & which is left over to make trouble. Internal combustion engines at best can transform about 25 to 35% of chemical energy in the fuel into mechanical energy. About 35% of heat generated is lost into the surrounding of combustion space. Remainder being dissipated through exhaust & radiation from the engine. It should be remembered that abstraction of heat from the working medium by the way of cooling the engine components is a direct thermodynamic loss. High pressure fuel injection systems such as common rail system & electronically controlled unit injector [EUI] systems have been widely applied modern heavy duty diesel engines. They are shown to be very effective for achieving high power density with high fuel efficiency & low exhaust gas emissions. However the increased peak combustion pressure gives additional structural & thermal load to engine structure. Thus proper material selection & thermal analysis of engine components are essential in order to meet the durability, requirements of heavy duty CI engines adopting high pressure injection systems.

II. OBJECTIVES

Temperature of burned gases in the cylinder of an internal combustion engine may reach up to ten times of surface temperature and leads to great heat fluxes emitted to the chamber walls during the combustion period. Maximum metal temperatures for the inside of combustion chamber space are limited to much lower values by a number of considerations & hence cooling for the engine becomes essential. In regions of high heat flux, thermal stresses must be kept below levels that would cause fatigue cracking (less than about 400°C for cast iron & 300°C for aluminium alloys). The gas side surface of cylinder wall must also be kept low to prevent deterioration of the lubrication oil film. Heat transfer effects the engine performance, efficiency & emissions. It should always be remembered that abstraction of heat from the working medium by the way of cooling the engine components is a direct thermodynamic loss.For a given mass of fuel within the cylinder, higher heat transfer by extra cooling will lower the average combustion gas temperature & pressure which in turn reduce the work per cycle transferred to the piston. Thus specific power & efficiency are reduced. Various thermal efficient super alloys are been invented & used for I.C. engine component, but it is not possible to achieve all the mechanical, chemical & thermal properties from same material. The engine components are not directly exposed to elevated temperatures & thus are relieved from heavy thermal stresses increasing the working life. Also this reduces the amount of cooling required and results in power saving of the engine. As can be seen, it is very important to predict the magnitude of heat transfer in designing engines. Hence it is the objective in this analysis to study temperatures distribution overs the cylinder head & optimize its cooling.

III. METHODOLOGY

HEAT TRANSFER THROUGH CYLINDER HEAD

Heat transfer is that science which predicts the rate of energy transfer taking place between material bodies is a result of temperature difference between them. The study of heat transfer has become an increasingly intense concern in modern technology in the earth science, in organic metabolism in environmental Engineering. The study of heat transfer is carried out for the following purpose-

i) To estimate the rate of flow of energy as heat through the boundary of the system under study. (Both under steady and transient conditions)

ii) To determine the temperature field under steady and transient condition.

In almost every branch of engineering, heat transfer problems are encountered which cannot be solved by thermodynamics reasoning alone, but requires an analysis based on heat transfer principles. The areas covered under the discipline of heat transfer are-

1) Design of thermal and nuclear power plants.
2) Internal combustion engines.
3) Refrigeration and air conditioning units.
4) Design of cooling systems for electronics motors, generators and transformers.
5) Heating and cooling of fluids etc. in chemical operations.
6) Construction of dams and structures; minimization of building heat loss using improved insulation techniques.

7) Thermal control of space vehicles.
8) Heat treatment of metals.
9) Dispersion of atmospheric pollutants.

IV. RESULT AND DISCUSSION

The CAE softwares are nowadays widely used for simulation as the result achieved are quite close and approximate to the real condition. Various software were used in the project. Modeling was done with CATIA V5. Meshing was done with the thermal analysis was done with ANSYS WORKBENCH 2014.0.

To obtain the optimum condition of temperature we take three cases:CASE I: Coolant flow rate of 80 GPM

This is a thermal mapping of cylinder head for 50˚ C. the cooling rate required for this temp. is 80 GPM at this state cylinder head get overcooled.

V. CONCLUSION

The Three Cylinder Head S.I. engine in conventional mode is suggested to be operated at a flow rate of 63 GPM where the max. temp. 72˚ C. at the exhaust valve region. On reducing flow rate to 49 GPM the max temperature at the exhaust valve region goes to 90˚ C. where the cylinder head get overheated and for increasing the flow rate up to 80 GPM the temperature in the vicinity of exhaust valve reduces to 50˚ C. where cylinder head is overcooled.

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