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IMPORTANCE OF HEAT TRANSFER AND FINS IN LIGHT WEIGHT AUTOMOBILE ENGINE

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Abstract:

Light Weight Automobile is the most important part of human life. In all developed and developing nations automobile sector is at its boon because it gives reliability to move freely and economically. The automobile has become safer over the years of researches and development. As automobile vehicle works by burning of gasoline, burning is done by the Otto cycle process which generate significant amount of heat energy. This generated heat energy makes to move piston back and forth and un-utilized heat is dissipated in temperature rise of engine. Temperature of piston head, crank shaft is increased to greater extent. For safety purpose fins and coolant are used to control the temperature of engine. If fins and coolants are absent in engine then engine may blast also.

Keywords: Fins, Gasoline, Otto cycle, CFD, FLUENT.

1. Introduction

This paper mainly concern with the heat transfer from low weight automobile vehicle so as to increase its efficiency by designing a proper heat transfer system. As Otto efficiency of typical low compression engine is 57.5% and that of highly modified engine such as racing car engine it is approximately up to 60%.
So,
Let total energy generated during fuel consumption be 100 units,

100-57.5= 42.5 (1)
100-60= 40 (2)

This 42.5 parts of total heat generated and 40 part of total heat generated during combustion of fuel in typical compression engine and highly modified engine respectively is converted into wastage heat which heats up the engine and increase the temperature of engine to the greater extent, which may cause blast in engine, detonation etc.
An effective, economic and undemanding method to remove heat from IC engine is the extended surface over the engine which is called fins. Fins are the surfaces that extend from an object to increase the rate of heat transfer to the surrounding by increasing the convection rate.
The heat dissipation through fins depends up on the following factors:

1. Thermal conductivity of metal used in fin.
2. Area of surface.
3. The convective heat transfer coefficient.
4. Temperature difference.

2. IMPORTANCE OF FINS

A calculative study of engine's heat generation and dissipation is done which shows the importance of fins in engine. And also show consequences of engine without fins.

The study showing importance of is shown below:-
As we know that the calorific value of a fuel is the quantity of heat produced by its combustion - at constant pressure and under "normal" ("standard") conditions (i.e. to *0ºC* and under a pressure of *1,013 mbar*).
Petrol (Gasoline) has calorific value of **47300kj/kg**, as IC engine works on the principle of Otto cycle. Here we are concerning about low weight automobile engine i.e. four stroke petrol engine. We are going to calculate efficiency of Otto cycle.

The air standard Otto cycle is the cycle for the spark-ignition internal combustion engines. This cycle is shown above on p-v and T-s diagrams. The Otto cycle 1-2-3-4 consists of following four processes:
Process 1-2: Reversible adiabatic compression of air.
Process 2-3: Heat addition at constant volume.
Process 3-4: Reversible adiabatic expansion of air.
Process 4-1: Heat rejection at constant volume.

P-V and T-S Diagrams of Otto Cycle:

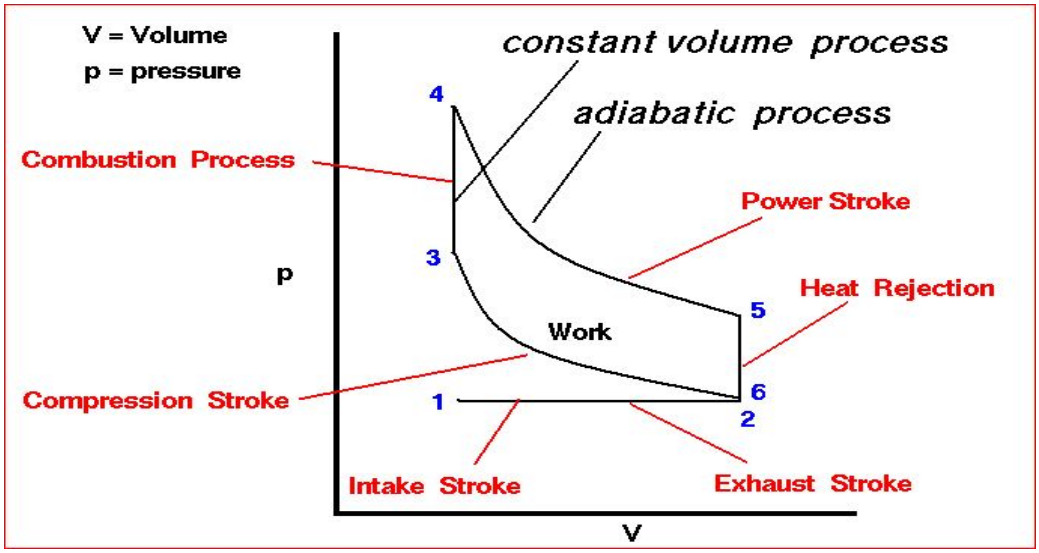

Figure 1: P-V diagram of Otto Cycle

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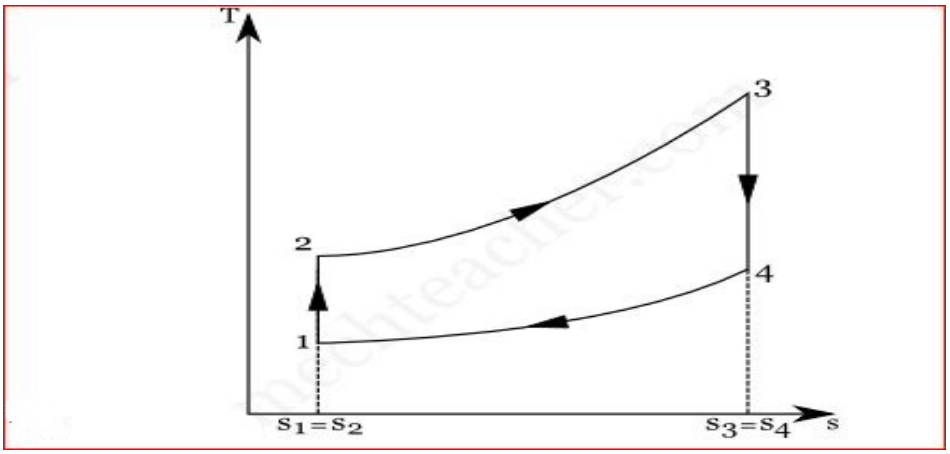

Figure 2: T-S diagram of Otto cycle

Thermal efficiency calculation of Otto Cycle:

$$\eta=1-[1/(r^{Y}-1)] \quad (3)$$

Where

η= thermal efficiency of Otto cycle.

r= compression ratio of cylinder

Y= specific heat ratio.

The compression ratio of petrol engines is restricted to maximum of 9 or 10 due to the phenomenon of knocking at high compression ratios. And specific heat ratio in case of air is 1.40. After calculation efficiency of ideal Otto cycle comes out to be 58.4% and that for practical cycle thermal efficiency of 4 stroke petrol engine about 57.5%

Calculation:

Efficiency of ideal Otto cycle is 58.4 % which means only 58.4 part of gasoline is converted into heat, as this is for ideal Otto cycle but in real world nothing is ideal. After many calculations done by various researchers it is found that thermal efficiency of practical Otto cycle is obtained up to only 57.5%. Thermal efficiency means the heat content of the fuel that is consumed in useful work i.e. mechanical work done by engine.

Now,

Calorific value of gasoline (or petrol) is 47300 kj/kg-^{o}C, of which only 58.4% is burn in ideal Otto cycle in light weight automobile engine.

Heat utilized through gasoline by Otto cycle= calorific value of gasoline * efficiency of ideal Otto cycle

= (47300 kj/kg- ^{o}C * 58.4)/ 100

= 27623.2 kj/kg- ^{o}C (3)

As efficiency of practical Otto cycle is only 57.5%, which is thermal efficiency of engine.

So, amount of heat utilized in mechanical work done = heat utilized through gasoline by Otto cycle *practical Otto cycle efficiency

= (27623.2 kj/kg- ^{o}C * 57.5)/100

= 15883.34 kj/kg- ^{o}C (4)

Amount of heat wastage= heat utilized through gasoline by Otto cycle - amount of heat utilized in mechanical work done

= (27623.2 kj/kg- ^{o}C -15883.34 kj/kg- ^{o}C)

= 11739.86 kj/kg- ^{o}C (5)

This 11739.86 kj/kg- ^{o}C heat energy give rise to temperature rise of engine body

As most of the engines are manufactured through aluminium alloy which has specific heat 0.92 kj/ kg –^{o}C. Calculation are done to analysis that how much temperature rises of engine due to wastage of heat.

The amount of heat needed to increase the temperature of any object can be figured using this relationship.

Heat in calories = mass in engine (kilogram) * temperature difference (between surrounding to engine ^{o}C) * specific heat of AL [kcal / kilogram ^{o}C] **(6)**

Approximate weight of engine = 30kg

Calorific value of aluminium = 0.92 kj/ kg- ^{o}C

3. RESULT:

On the basis of above calculation and study we reached to the result that shows the importance of fins in automobile vehicle. If we fill our bike engine (without fins and coolant) with 1kg of gasoline, and allowed to run engine till it consume whole of the gasoline at different surrounding temperatures. Then according to the results shown below states that engine temperature goes up to 475.357 ^{o}C, which is very high. This much temperate may cause damage of engine.

Table 1: Temperature rise of petrol engine at various surrounding temperatures

Surrounding temperature (^{o}C)	**Running engine temperature** (without fins ^{o}C)
25 ^{o}C	450.357 ^{o}C
30 ^{o}C	455.357 ^{o}C
35 ^{o}C	460.357 ^{o}C
40 ^{o}C	465.357 ^{o}C
45 ^{o}C	470.357 ^{o}C
50 ^{o}C	475.357 ^{o}C

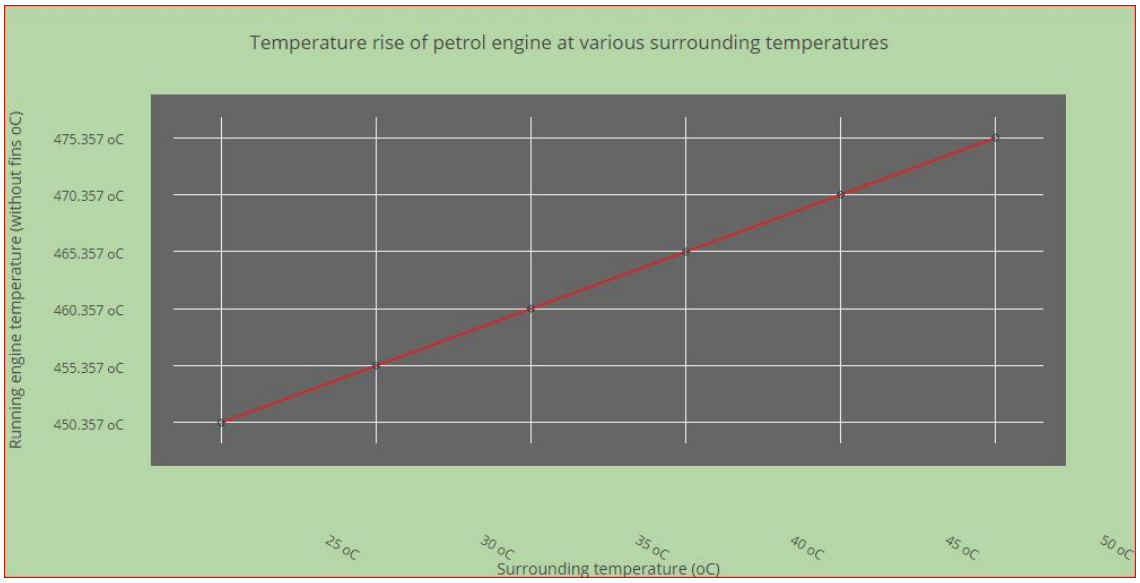

Figure 3: graph shows the variation of engine temperature at different surrounding temperature.

4. CONCLUSION:

This paper gives us the importance of heat transfer through fins. The study over fins is done by the various data collected from various sources and calculative study has been performed. As per the result of study we concluded that if an engine run without fins and 1kg of gasoline is burn in it then this give rise to engine temperature approximately up to 450- 500^{o}C. This much temperature may cause detonation and blast in engine. So fins must be placed on engine for convection of heat to the surrounding from engine. In the initial phase only fins importance is unveil here. In future a proper designing of fin and CFD (Computational fluid dynamics) analysis is to be done on FLUENT.

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