IJRAME

ISSN (ONLINE): 2321-3051

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

OPTIMIZATION OF THE FINS TO THE FOUR STROKE SINGLE CYLINDER PETROL ENGINE

Amit Kumar Gupta[1], Nitin Kumar Sharma[2]

[1]*Assistant professor, IET-DAVV Indore, gupta.ak4@gmail.com*
[2] *Research Scholar, IET-DAVV Indore, nitin12dt108@gmail.com*
RH-12, scheme no. 54, sector-A vijay nagar,Inodre,M.P -452010,9406653327,gupta.ak4@gmail.com

Abstract

The present paper deals with the design of circular fins on the cylinder of four stroke single cylinder SI engine. The main objective of design is to provide the maximum cooling will result in producing high efficiency. The considerable specific data of the engine cylinder is compression ratio of the cylinder, bore diameter, stroke length, front tyre, and the rear tyre size, maximum torque, volume of the cylinder, economic speed at the expressway. The analytic process is to analysis the fins and provides the appropriate dimensions are for maximum cooling and to maintain the engine cylinder.

Keywords:Internal combustion engine, fins designing, air standard cycle.

1. Introduction

Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will varies between 1300-2000°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 abridge about 50-100°C at which the engine will work most effectively. Highly cooling is not desirable since it reduces the thermal efficiency. The introduction is better when written in a brief manner with sufficient information to convince the reader at the early stage. However, try not to over explaining the same topic or repeat unnecessarily; instead use a separate background section if you have enough materials to discuss after the introduction.

Air cooled system is generally used in small engines say up to 15-20 kW. In this system fins or extended surfaces are provided on the cylindrical wall, 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 in the form of convection and the radiation to the air..

The heat dissipated to air depends upon:
(a) Amount of air flowing over the fins.
(b) Fins surface area.
(c) Thermal conductivity of metal of the fins

2. Geared up design data

1) The compression ratio of the cylinder is 9.1:1.
2) The bore diameter of the cylinder is 52.4 mm.
3) The stroke length of the cylinder is 57.4 mm.
4) The volumetric size of the cylinder 124.7 cc.
5) The maximum torque is 10.35N-m @ 4000 rpm.
6) The economic speed of the engine at expressway is 45 km/hr
7) The front tyre size is 2.75*18-42P/4PR
8) The rear tyre size is 3.00*18-52P/6PR

2.1 Ideal otto cycle

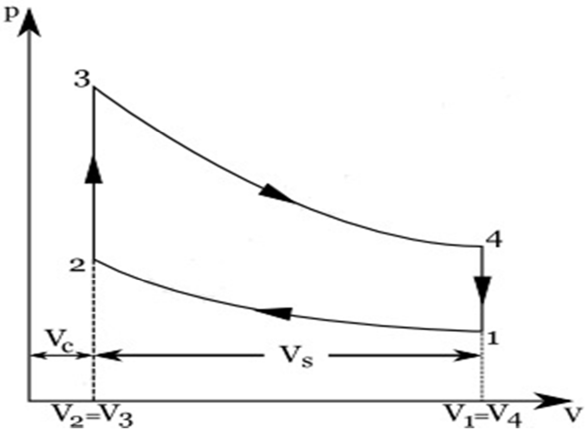

Figure 1:P-V diagram of ideal otto cycle

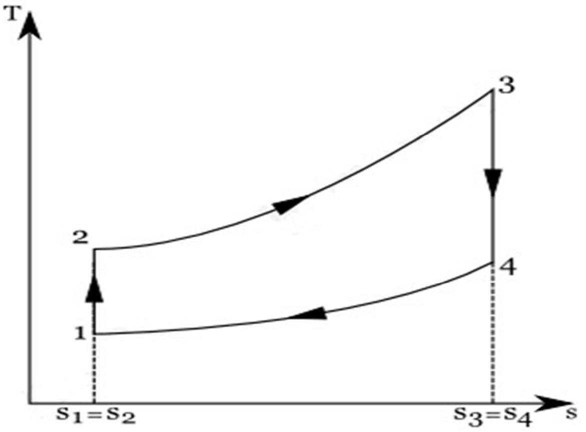

Figure 2:T-S diagram of ideal otto cycle

The processes are described by:
•Process 1-2 is an reversible adiabatic compression of the air as the piston moves from bottom dead centre (BDC) to top dead centre (TDC).
•Process 2-3 is a constant-volume heat transfer to the air from an external source while the piston is at the upper position (TDC). This process is intended to represent the ignition of the fuel-air mixture and the subsequent rapid burning.
•Process 3-4 is an isentropic expansion (power stroke).

•Process 4-1 completes the cycle by at constant-volume in which heat is rejected from the air while the piston is a bottom dead centre.

The otto cycle efficiency is given by:

$$\eta = 1- \left[\frac{1}{r^{\gamma-1}}\right]$$

Where ,

r = compression ratio of the cylinder

for the SI engine air and the fuel ratio varies between 12 ≤ A/F ≤ 18

The fuel air ratio is given by:

$$f = \frac{mf}{ma} = \frac{CvT1}{\Delta Hv}(\lambda - r^{(\gamma-1)})$$

In the above equation, ΔHv is the heat of reaction, the lower heat of reaction, at a constant volume and λ is the ratio of maximum temperature to the initial temperature of the cycle.

While torque is a valuable measure of a particular engine's ability for working depends upon engine size. A more useful relative engine performance measure is obtained by dividing the work per cycle by the cylinder volume displaced per cycle. The parameter so obtained has the force per unit area and is called the mean effective pressure (mep). Since

$$\text{Work per cycle } = \frac{P\times n}{N}$$

Where P is the power of the engine, n is the number of crank revolutions for each power stroke per cylinder (two for four-stroke cycles; one for two-stroke cycles), Mean effective pressure can also be expressed in terms of torque by:

$$\text{mep (kPa)} = \frac{6.28\times n\times T(N-m)}{Vd(cubicdm)}$$

The maximum brake mean effective pressure of excellent engine styles is well established, and is basically constant over a large vary of engine sizes, thus, the particular bmep that a selected engine develops may be compared with this norm, and therefore the effectiveness with that the engine designer has used the engine's displaced volume may be assessed. Also, for style calculations, the engine displacement needed to supply a given force or power, at a mere speed, may be calculable by assumptive acceptable values for bmep for that specific application

2.2Cylindrical designing

The cylindrical thickness is given by:

$$t = \frac{(maximum\ pressure \times D)}{(2\times\sigma)} + C$$

where,

D = The inside diameter of the cylinder or bore diameter.

σ = The permissible circumferential or hoop stress for cylinder material in MPa

C = factor of reboring.

Table 1: Factor of reboring

D(mm)	Below 75	100	150	200
C(mm)	1.5	2.4	4.0	6.3

2.3Heat transfer

The heat transfer rate for the cylinder is given by the Fourier Equation of conductive heat transfer

$$Q = [2\times\pi\times L\times k\times(T_3 - T_w)]/\ln(r_o/r_i)$$

Where

L =The stroke length of the cylinder
k = Thermal conductivity of the cast iron
T_3 = The maximum temperature generated inside the cylinder
T_w = The outside wall temperature of the cylinder
The film region of flow of air develops from the forefront of the plate during which the consequences of consistence square measure discovered is termed the physical phenomenon. The purpose typically has chosen wherever the speed becomes ninety nine percent of free-stream worth. Initially, the physical phenomenon development is laminar, however at some essential distance from the forefront, betting on the flow field and fluid properties, tiny disturbances within the flow begin to become amplified, and a transition method takes place till theflow becomes turbulent. The low region is also pictured as a random churning a action with chunks of fluid moving to and from all given directions.

$$\delta = ((5\times L)/\sqrt{Re})$$

The convective heat transfer coefficient of air is approximately:

$$h = (10.45 - v + 10\, v^{1/2})\, X$$

Where, v = the relative speed of the object through the air (m/s) and X is the convective factor which is having 1(J/m3K)
This is an empirical relation that can be used for velocities from 2 to 20 m/s

*2.3*Heat rejection through fins

The convective heat transfer rate of the fins in case of "the end of the fin is insulated"

$$Q_{fin} = [\sqrt{phKA}](T_b - T_a)$$

Where,
p = perimeter of the fins
A = cross sectional area of the fins
T_b = base temperature of the fins
T_a = ambient temperature of the fins
l = length of the fins
The efficiency of a fin is defined as the ratio of the actual heat transferred by the fin to the maximum heat transferable by fin, if entire fin area were at base temperature

$$\eta_{fin} = \left(\frac{actual heat transferred by the fin}{maximum heat by the whole surface}\right)$$

For a fin which is insulated at the tip

$$\eta_{fin} = \frac{\tanh(ml)}{ml}$$

Therefore, the effective heat transfer rate by the fin.

The efficiency of a fin forms a criterion for judging the relative merits of fins of different geometrics or materials. The thickness of the fins which is mounted on the cylindrical periphery having the minimum thickness that will provide the maximum heat rejection to the environment. The graph demonstrate from the above given relation and with the consideration of the specific efficiency of the fins

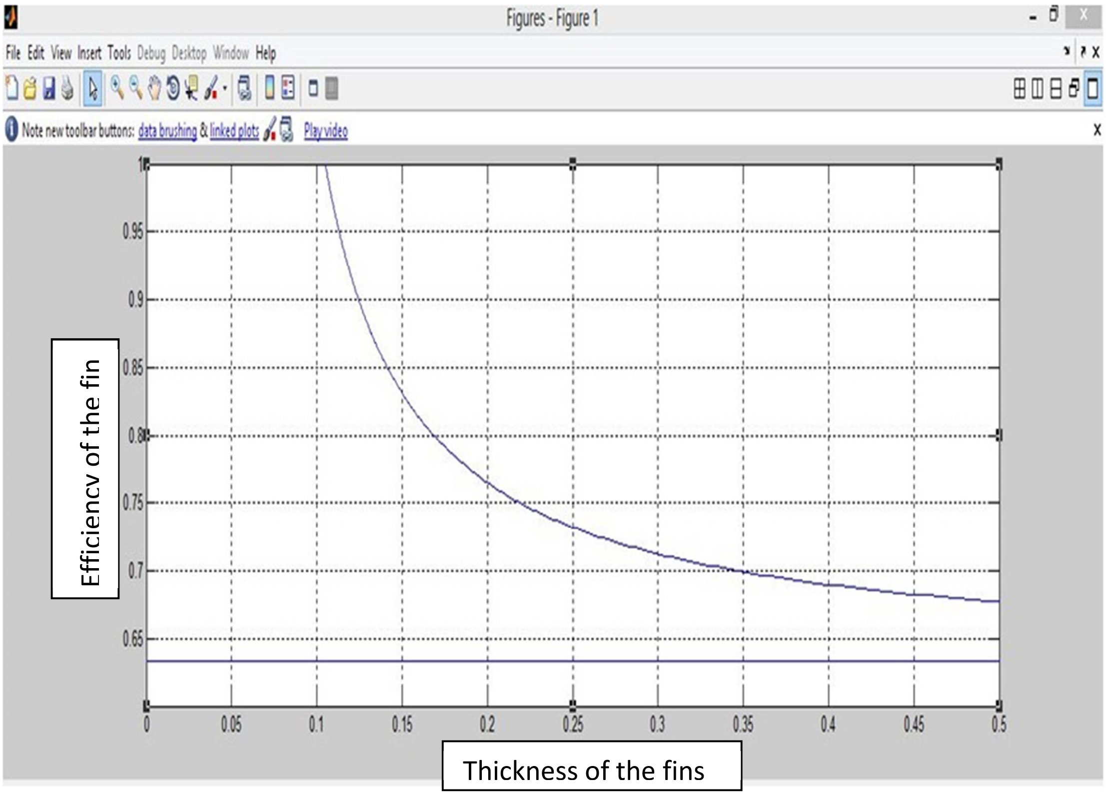

Figure 3: The thickness of the fin Vs efficiency graph

3. Results

Table 3

parameters	values
The efficiency of the cycle (γ = 1.2)	35.70%
The maximum temperature of the cycle	1825 K
Total heat rejection	211 kW
The torque provided to the shaft	3.26 N-m
The length of the fins with 0.98 efficiency	107 mm
The number of fins	11
the heat rejected by the fin	19.3 kW
The length of the fins	108 mm

Vol.2 Issue.5,
May 2014.
Pgs: 77-82

4. Conclusion

The maximum heat dissipated by the fins to provide the maximum cooling to the cylinder with the appropriate length of the fins under the condition of insulated at the fin tip and the minimum thickness of fin as well as the number of the appropriate fins mounted on the cylinder of otto cycle for the cooling of fin and the long duration riding of the air cooling engine as well as enhance the reliability of the engine at the maximum temperature

References

[1]Ravindra R. Navthar and Prashant A. Narwade, " Design and Analysis of Cylinder and Cylinder head of 4-Stroke SI Engine For Weight Reduction" Material Selection ,International Journal of Engineering Science and Technology, vol 4 No.03 march 2012

[2] Holman J.P. and Bhattacharyya Souvik, "Heat Transfer" in Steady state Heat Conduction-One Dimension, By Tata McGraw-Hill Education Private Limited, New Delhi , Vol. 10,1963, pp. 25-27, 40-46

[3] Heywood John B., "Internal Combustion Engine Fundamentals" in Engine Design And Operating Parameters, By Tata McGraw-Hill Education Private Limited, New Delhi: 2011, pp. 45-54

[4] Nag P.K, "Engineering Thermodynamics" in Gas Power Cycle, Otto Cycle,by Tata McGraw-Hill Education Private Limited, New Delhi: Vol. 04, 1981, pp. 507-514.

[5] Rajput R.K, "Heat and Mass Transfer" in Conduction-Steady-State One Dimension, By S.Chand& Company Ltd, New Delhi, ., Vol. 03, 1998, pp. 233-234