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Subject : DMS Assignment 4

Semester : VIII

Roll No. : 76

Sign :

Remarks :

1. Piston

Ans - The piston is a disc which reciprocates within a cylinder. It is either moved by the fluid or it moves the fluid which enters the cylinder.

- The main function of the piston of an internal combustion engine is to receive the impulse from the expanding gas & to transmit the energy to the Crankshaft through the connecting rod.

- The piston of IC engines of trunk type & of following parts.

1. Head or Crown :

The piston head or crown may be flat, convex or concave depending upon the design of combustion chamber. It withstands the pressure of gas in the cylinder.

2. piston rings : The piston rings are

used to seal the cylinder in order to prevent leakage of the gas past the piston.

3. Skirt :
The skirt acts as a bearing for the side thrust of the connecting rod on the walls of cylinder.

4. piston pin :
It is also called gudgeon pin or wrist pin. It is used to connect the piston to the connecting rod.

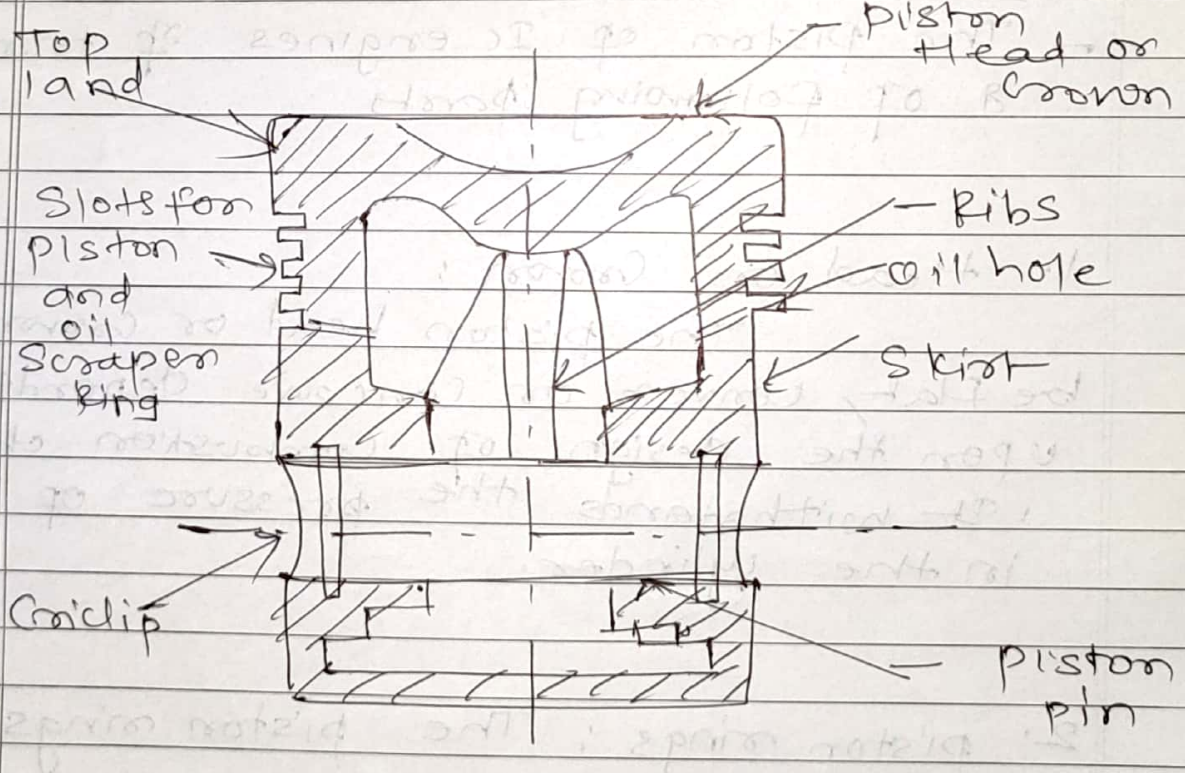


Fig: Piston for I.C. engines.

Part

2. A four stroke single cylinder water cooled diesel engine develops 7.5 kW brake power when operating at 1000 rpm

(a) Determine the size of engine
(b) Design wet liner & cylinder
(c) Design piston with pin & piston rings.

Soln:

Given :- 4 stroke diesel engine
brake power B.P = 7.5 kW
Speed N = 1000 rpm

1. Determine the bore & stroke of the engine

* step 1 & Assumptions

(i) for Diesel engine, take compression ration (R_c) = 14

(ii) for 4-stroke diesel engine, assume $\eta_{mech} = 0.75$

(iii) Mean indicated pressure $P_{mi} = 0.9$ MPa

(iv) $\frac{L}{D} = 1$

(b) Maximum pressure $P_{max} = P_1 \times R_c^{\gamma}$

▷ step 2 : To calculate maximum pressure (P_{max})

$P_{max} = P_1 \times R_c^{\gamma}$

$= 1 \times (14)^{1.4} = 40.23 \approx 40$ bar

▷ step 3 : To calculate the bore & stroke of engine

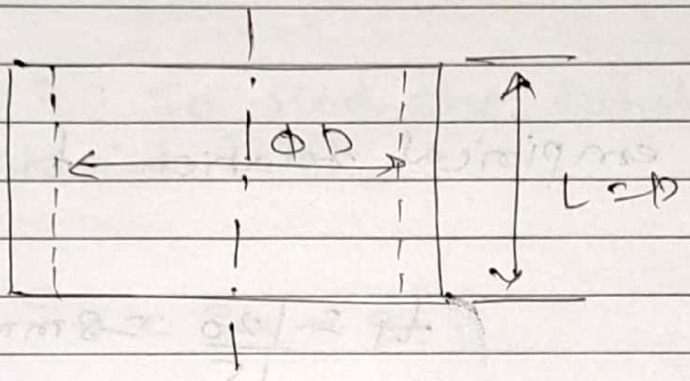
$\eta_{mech} = \frac{B.P}{I.P}$

$0.75 = \frac{7.5}{I.P}$

$I.P = 10$ KW

$$I.P. = \frac{P_{mi} \times LAn}{60}$$

$$L = D = 0.1193m = 119.3mm$$



Cylinder bore $D = 120mm$
Stroke $L = 120mm$

2.

2. Design of cylinder head & wet liner

Step 4 : To find the minimum thickness of liner (t_{min})

(A) $$t_{min} = \frac{D}{2}\left[\left[\frac{S_d + 0.4P_{max}}{S_d + -1.3P_{max}}\right]^{\frac{1}{2}} - 1\right]$$

$$t_{min} = \frac{120}{2}\left[\left[\frac{90+0.4\times4}{90+1.3\times4}\right]^{\frac{1}{2}} - 1\right]$$

$$= 2.36 \text{ mm}$$

(B) By empirical relation $t_1 = \frac{D_i}{15}$

$$t_1 = \frac{120}{15} = 8 \text{ mm}$$

▷ Step 5 : To find the pressure stress induced (S_x)

$$S_x = \frac{P_{max} D}{2t_1} = \frac{4\times120}{2\times8} = 30 \text{ N/mm}^2$$

▷ Step 6 : To find the thermal stress induced (S_t)

$$S_t = \frac{E \alpha \Delta T}{2(1-\mu)}$$

$$S_t = 168.3 \text{ N/mm}^2$$

▷ Step 7 : To find the total stress in material (S_T)

$$S_T = S_x + S_t$$

$$= 30 + 168.3 = 198.3 \text{ N/mm}^2$$

8. Design of piston

▷ Step 8 : To select piston material

Allowable stress, $[S_d] = 70$ MPa

▷ Step 9 : To find the crown thickness (t_c)

(A) Maximum pressure Criteria

$$t_c = D\left[\frac{3}{16}\frac{P_{max}}{[S_d]}\right]^{\frac{1}{2}} = 12.42\text{ mm}$$

(B) Thermal Stress Criteria

$$t_c = \frac{\uparrow D^2 \times 10^{-2}}{16\, C_1\, \Delta T}$$

$K = 0.08$

To find BSFC

$$ISFC = 0.2\ \frac{kg}{kW\,hr}$$

$$\eta_{mech} = \frac{ISFC}{BSFC}$$

$$0.75 = \frac{0.2}{BSFC}$$

$$BSFC = 0.266\ \frac{kg}{kW\,hr}$$

$t_c = 3.67\ cm = 36.7\ mm$

(C) By empirical relation,

$$t_c = 0.032D + 1.5\ mm$$

$$= 5.34\ mm$$

▷ Step 10: To find radial thickness of piston ring (t_r)

(A) Using bearing pressure criteria

$$t_r = D\left[\frac{3P_w}{[S_d]}\right]^{\frac{1}{2}}$$

$$t_r = 120\left[\frac{2 \times 0.05}{100}\right]^{\frac{1}{2}} = 2.94\ mm$$

(B) Using empirical relationship

$$t_r = (0.04 \sim 0.045)D$$

▷ Step 11 : To find the no. of piston rings

$$n = 0.4\sqrt{D} = 4.38 \approx 5$$

▷ Step 12 : To find axial thickness of piston rings (t_n)

(A) Minimum thickness

$$t_{am} = \frac{D}{10n} = \frac{120}{10 \times 5} = 2.4 \approx 3\text{ mm}$$

(B) Using empirical relationship

$$t_a = 0.8 t_1 = 4.8\text{ mm}$$

▷ Step 13 : To find stress in piston ring (S_c)

$$S_c = \frac{1.6 \times E \times t_r}{D - t_r + \frac{\pi r}{\pi}}$$

▷ Step 14 : To find other dimensions

(3) Piston ring

(i) Gap Between free ends $G_1 = 3.8 t_r$
$= 22.8 mm$

(ii) Gap between ring ends when ring is in Cylinder

$G_2 = 0.003D = 0.36 mm$

(iii) Thickness between ring grooves

$t_w = 0.85 t_a = 4.08 mm$