MECHANICAL ENGINEERING SCIENCE

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PERFORMANCE PARAMETERS OF IC ENGINES - NUMERICALS

1) **The following data refers to a test on a single cylinder engine working on four stroke cycle:**
   Diameter of brake drum = 60 cm
   Rope diameter = 3 cm
   Load on brake drum = 25 kg
   Spring balance reading = 5 kg
   Speed of engine = 400 rpm
   Bore = 10 cm
   Stroke = 15 cm
   Indicated Power = 3.141 kW

   Calculate (i) Brake Power (ii) Mechanical Efficiency

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1) Brake Power (BP)

Torque $= T = (W - S) \times \left(\frac{D_b + d_r}{2}\right) = (25 - 5) \times 9.81 \times \left(\frac{0.6+0.03}{2}\right) = 61.803\ Nm$

Brake Power $= BP = \frac{2\pi NT}{60\times1000} = \frac{2\times\pi\times400\times61.803}{60\times1000} = 2.589\ kW$

2) Mechanical Efficiency

$\eta_{mech} = \frac{BP}{IP} = \frac{2.589}{3.141} = 0.8241\ or\ 82.41\%$

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2) The following observations are taken during a trial on four stroke diesel engine.

Cylinder diameter = 25 cm
Stroke = 40 cm
Speed = 250 rpm
Brake load = 70 kg
Brake drum diameter = 2m
Diesel oil consumption = 0.1 litres/min
Specific gravity of fuel = 0.78
Calorific value of fuel = 43900 kJ/kg
Indicated Power = 24.54 kW

Determine (i) Brake Power (ii) Mechanical efficiency (iii) Brake thermal efficiency (iv) Indicated thermal efficiency.

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Solution:

1) Brake Power

We know that brake power is given by

$$BP = \frac{2\pi NT}{60000} = \frac{2\times\pi\times250\times70\times9.81\times1}{60000} = 17.98\ kW$$

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Solution:

2) Mechanical efficiency

We know that mechanical efficiency is given by,

$$\eta_{mech} = \frac{BP}{IP} = 73.3\%$$

3) Brake Thermal Efficiency

We know that brake thermal efficiency is given by,

$$\eta_{Bth} = \frac{BP}{m_f \times CV} = \frac{17.98}{\frac{0.1\times0.78\times1000}{1000\times60}\times43900} = 31.5\%$$

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Solution:

4) Indicated Thermal Efficiency

We know that indicated thermal efficiency is given by,

$$\eta_{Ith} = \frac{IP}{m_f \times CV} = \frac{24.54}{\frac{0.1 \times 0.78 \times 1000}{1000 \times 60} \times 43900} = 43\%$$

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3) A four cylinder four stroke petrol engine develops 30 kW at 2500 rpm. The mean effective pressure on each piston is 8 bar and mechanical efficiency is 80%. Calculate the diameter and stroke of each cylinder.

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Solution:

We know that,

$$\eta_{mech} = \frac{BP}{IP}$$

Therefore,

$$IP = \frac{BP}{\eta_{mech}} = \frac{30}{0.8} = 37.5\ kW$$

Also, $IP = \frac{np_mLANK}{60\times1000}$

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Solution:

$$37.5 = \frac{4 \times 8 \times 10^5 \times L \times (\frac{\pi}{4} d^2) \times 2500 \times (\frac{1}{2})}{60 \times 1000}$$

$$7.16 \times 10^{-4} = Ld^2$$

From data, L/d = 1.5 or L = 1.5d

Therefore,

$$7.16 \times 10^{-4} = (1.5d)d^2$$

This gives, d = 0.078 m = 78 mm; L = 1.5d = 117 mm

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4) A diesel engine develops 5 kW. Its indicated thermal efficiency is 30% and mechanical efficiency is 75%. Estimate the fuel consumption of the engine in a) kg/hr and b) litres/hr. Also find ISFC and BSFC. Take CV of fuel = 42000 kJ/kg and specific gravity of fuel = 0.87.

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Solution:

We have,

$$\eta_{mech} = \frac{BP}{IP}$$

$$Therefore, IP = \frac{BP}{\eta_{mech}} = \frac{5}{0.75} = 6.67kW$$

We know that,

$$\eta_{ITH} = \frac{IP}{m_f \times CV}$$

$$Therefore, m_f = \frac{IP}{\eta_{ITH} \times CV}$$

PERFORMANCE PARAMETERS OF IC ENGINES - NUMERICALS

Solution:

We have,

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$$Therefore, IP = \frac{BP}{\eta_{mech}} = \frac{5}{0.75} = 6.67kW$$

We know that,

$$\eta_{ITH} = \frac{IP}{m_f \times CV}$$

$$Therefore, m_f = \frac{IP}{\eta_{ITH} \times CV}$$

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Solution:

So,

$$m_f = \frac{6.67}{0.3 \times 42000} = 5.293 \times 10^{-4}\ kg/s = 1.9057\ kg/hr$$

To get fuel consumption in litres/hr,

$$m_f = \frac{1.9057}{0.87 \times 1000} = 2.1905 \times 10^{-3}\ m^3/hr$$

$$= 2.1905 \times 10^{-3} \times 1000 = 2.1905\ \ litres/hr$$

$$ISFC = \frac{m_f}{IP} = \frac{1.9057}{6.67} = 0.2857\ kg/kWhr$$

$$BSFC = \frac{m_f}{BP} = \frac{1.9057}{5} = 0.3811\ kg/kWhr$$

THANK YOU

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