During test on Single Cylinder oil engine, working on a four stroke cycle fitted with rope brake, the following readings are taken

Effective diameter of brake wheel = 600 mm, Dead load on brake = 200 N, Spring balance reading = 30 N, Speed = 450 rpm Area of indicator = 400 mm^2 length of Indicator diagram = 60 mm Spring Scale: 1.1 bar per mm Bore = 100 mm, Stroke: 150 mm, Quantity of oil = 0.815 kg/hr, Calorific value of oil = 42,000 kJ/kg Calculate the Brake power, indicator power, mechanical efficiency, brake thermal efficiency, brake specific fuel Consumption and Indicated thermal efficiency.

Given

Effective radius $R = \frac{600}{2} = 300 \text{ mm} = 0.3 \text{ m}$

$W = 200 \text{ N}$, $S = 30 \text{ N}$, $N = 450 \text{ rpm}$ $a_d = 400 \text{ mm}^2$,

$l_d = 60 \text{ mm}$ $S = 1.1 \text{ bar/mm}$

Bore dia $D = 100 \text{ mm} = 0.1 \text{ m}$, $L = 150 \text{ mm} = 0.15 \text{ m}$,

$m_f = 0.815 \text{ kg/hr}$ $CV = 42{,}000 \text{ kJ/kg}$

Brake Power (BP)

$$BP = \frac{2\pi N (W - S) R}{60}$$

$$= \frac{2\pi \times 450 \times (200 - 30) \times 0.3}{60}$$

$BP = 2403.32 \text{ W}$

$BP = 2.403 \text{ kW}$

$$P_m = \frac{a_d \times S}{l_d} = \frac{400}{60} \times 1.1 = 7.33 \text{ bar}$$

$$= 7.33 \times 10^2 \text{ kPa}$$

Area of Cylinder $= \pi/4 D^2$

$$= \pi/4 \times 0.1^2$$

$$= 7.854 \times 10^{-3} m^2$$

$$JP = \frac{P_m A L (N/2) \times n}{60} \quad [\because N/2 \text{ for 4 Stroke}]$$

$$IP = \frac{7.333 \times 10^2 \times 7.854 \times 10^{-3} \times 0.15 \times (450/2) \times 1}{60}$$

$n = 1$

$$IP = 3.2396 \text{ KW}$$

Mechanical efficiency

$$\eta_{mech} = \frac{BP}{JP} = \frac{2.403}{3.2396}$$

$$= 0.74175$$

$$= 74.175\%$$

Brake thermal efficiency

$$\eta_{Brake} = \frac{BP \times 3600}{m_f \times CV}$$

$$= \frac{2.403 \times 3600}{0.815 \times 42,000}$$

$$= 0.25273$$

$$= 25.273\%$$

Indicated thermal efficiency

$$\eta_{Indicated} = \frac{JP \times 3600}{m_f \times CV}$$

$$= \frac{3.2396 \times 3600}{0.815 \times 42000}$$

$$= 0.3407 = 34.07\%$$

Brake Specific fuel Consumption (SFC)brake

$$SFC_{brake} = \frac{M_f}{BP}$$

$$= \frac{0.1815}{2.403}$$

$$= 0.3392 \text{ kg/kw-hr.}$$