Problem on Indicated Power (IP)

A single-cylinder, four-stroke engine has a cylinder bore of 0.1 meters and a stroke length of 0.12 meters. The engine operates at 3000 RPM with an average effective pressure of 800 kPa. Calculate the indicated power of the engine.

Given:

- Cylinder bore (D) = 0.1 m
- Stroke length (L) = 0.12 m
- Engine speed (N) = 3000 RPM
- Mean effective pressure (P_{mean}) = 800 kPa = 800,000 Pa

First, calculate the cross-sectional area of the cylinder:

$$A = \frac{\pi D^2}{4} = \frac{\pi (0.1)^2}{4} = 0.00785\,\mathrm{m}^2$$

Since it is a four-stroke engine, it completes one power stroke every two revolutions:

$$\text{Power strokes per minute} = \frac{N}{2} = \frac{3000}{2} = 1500\,\text{strokes/min}$$

The indicated power (IP) is given by:

$$IP = \frac{P_m \cdot L \cdot A \cdot N \cdot K}{60}$$

For a single-cylinder engine ($K = 1$):

$$IP = \frac{800,000 \times 0.12 \times 0.00785 \times 1500 \times 1}{60}$$

$$IP = 1884\,\mathrm{W} = 1.884\,\mathrm{kW}$$

Problem on Thermal Power

An internal combustion engine consumes 0.02 kg/s of fuel with a calorific value of 42,000 kJ/kg. Calculate the thermal power generated by the fuel.

Given:

- Fuel consumption rate ($\dot{m}_f$) = 0.02 kg/s
- Calorific value (CV) = 42,000 kJ/kg = 42,000,000 J/kg

The thermal power (Q_{th}) is given by:

$$Q_{th} = \dot{m}_f \cdot CV$$

$$Q_{th} = 0.02 \times 42,000,000 = 840,000\,\mathrm{W} = 840\,\mathrm{kW}$$

Problem on Indicated Thermal Efficiency

An engine has an indicated power of 75 kW. It consumes fuel at a rate of 0.015 kg/s, and the fuel has a calorific value of 44,000 kJ/kg. Calculate the indicated thermal efficiency of the engine.

Given:

- Indicated power (IP) = 75 kW
- Fuel consumption rate ($\dot{m}_f$) = 0.015 kg/s
- Calorific value (CV) = 44,000 kJ/kg = 44,000,000 J/kg

First, calculate the thermal power (Q_{th}):

$$Q_{th} = \dot{m}_f \cdot CV$$

$$Q_{th} = 0.015 \times 44,000,000 = 660,000\,\mathrm{W} = 660\,\mathrm{kW}$$

Now, calculate the indicated thermal efficiency (η_{ith}):

$$\eta_{ith} = \frac{IP}{Q_{th}} = \frac{75}{660} = 0.1136 \text{ or } 11.36\%$$