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Question:
A single cylinder reciprocating compressor has a bore of 120 mm and a stroke of 150 mm. and is driven at a speed of 1200 rpm. It is compressing CO_2 gas from a pressure of 120 Kpa and temp. of 20°C to a temp. of 215°C. Assuming polytropic compression with n = 1.3, no clearance and volumetric efficiency of 100% calculate (i) pressure ratio, (ii) Indicated power, (iii) shaft power with mech. efficiency 80%, (iv) mass flow rate

Answer:

Q5 b.

$$\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{n/n-1}$$

$$P_2 = 1.2\left(\frac{488}{293}\right)^{\frac{1.3}{1.3-1}}$$

$$P_2 = 10.92 \text{ bar}$$

$$\text{Pressure Ratio} = \frac{P_2}{P_1} = 9.1$$

$$V_s = \frac{\pi}{4} d^2 l \times N$$

$$= \frac{\pi}{4} \times (0.12)^2 \times 0.15 \times \frac{1200}{60}$$

$$V_1 = 2.036 \text{ m}^3/\text{min}$$

$$\text{I.P.} = \frac{n}{n-1} P_1 V_1 \left(\left(\frac{P_2}{P_1}\right)^{n-1/n} - 1\right)$$

$$= \frac{1.3}{1.3-1} \times 1.2 \times 10^5 \times \frac{2.036}{60}\left[(9.1)^{\frac{1.3-1}{1.3}} - 1\right]$$

$$= 11.68 \text{ KW}$$

Shaft power when mech efficiency 80%.

$$\text{Shaft Power} = \frac{\text{I.P.}}{\eta_{mech}} = \frac{11.68}{0.8}$$

$$= 14.6 \text{ KW}$$

$$P_1 V_1 = m R T_1$$

$$m = \frac{P_1 V_1}{R T_1} = \frac{1.2 \times 10^5 \times 2.036}{287 \times 293}$$

$$= 2.9054 \text{ kg/min}$$