

**Soal 5.1**

Dik. Siklus Otto

$$r_v = 8.5$$

$$P_1 = 100 \text{ kPa}$$

$$T_1 = 27 \text{ }^\circ\text{C} = 300 \text{ K}$$

$$q_m = 820 \text{ kJ/kg}$$

Diminta a. T, P, v

b.  $\eta_{th}$ 

c. mep

Udara

$$C_p = 1.0035 \text{ W/kg} \cdot \text{K}$$

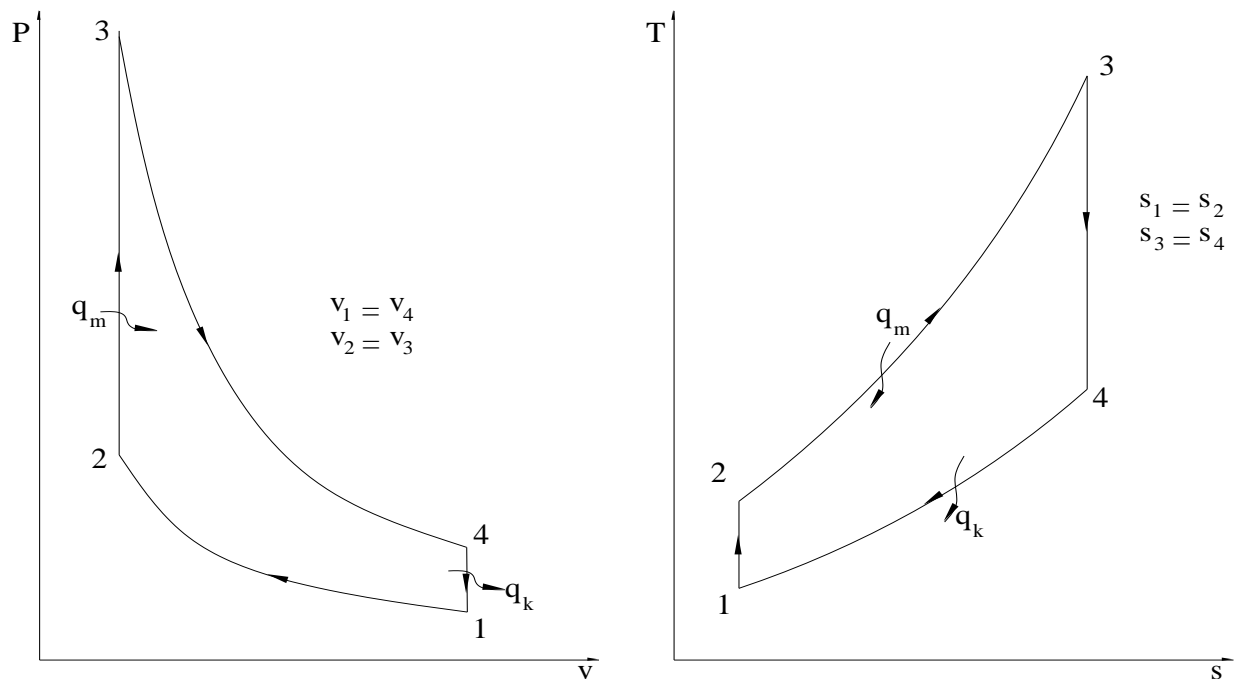
$$C_v = 0.7165 \text{ W/kg} \cdot \text{K}$$

$$R = C_p - C_v = 0.287$$

$$k = \frac{C_p}{C_v} = 1.4$$

Jawab

Diagram P - v dan T - s



a. T, P, v pada setiap titik

Titik 1

$$v_1 = \frac{RT_1}{P_1} = \frac{0.287 \cdot 300}{100} = 0.8610 \text{ m}^3/\text{kg}$$

**Siklus Otto**

Titik 2

$$r_v = \frac{v_1}{v_2} \rightarrow v_2 = \frac{v_1}{r_v} = \frac{0.8610}{8.5} = 0.1013 \text{ m}^3/\text{kg}$$

Proses 1 - 2 Isentropik

$$\frac{T_2}{T_1} = r_v^{k-1} \rightarrow T_2 = 300 (8.5)^{0.4} = 706.1 \text{ K}$$

$$\frac{P_2}{P_1} = r_v^k \rightarrow P_2 = 100 (8.5)^{1.4} = 2000.7 \text{ kPa}$$

Titik 3

$$v_3 = v_2 = 0.1013 \text{ m}^3/\text{kg}$$

$$q_m = C_v (T_3 - T_2)$$

$$820 = 0.7165 (T_3 - 706.1)$$

$$T_3 = \frac{820}{0.7165} + 706.1 = 1850.59 \text{ K}$$

$$P_3 = \frac{RT_3}{v_3} = \frac{0.287 \cdot 1850.6}{0.1013} = 5243.3 \text{ kPa}$$

Titik 4

$$v_4 = v_1 = 0.8610 \text{ m}^3/\text{kg}$$

Proses 3 - 4 Isentropik

$$\frac{T_3}{T_4} = r_v^{k-1} \rightarrow T_4 = \frac{T_3}{r_v^{k-1}} = \frac{1850.6}{(8.5)^{0.4}} = 786.22 \text{ K}$$

$$P_4 = \frac{RT_4}{v_4} = \frac{0.287 \cdot 786.2}{0.1013} = 2228 \text{ kPa}$$

$$q_k = C_v (T_4 - T_1) = 0.7165 (786.22 - 300) = 348.4 \text{ kJ/kg}$$

$$W_{\text{net}} = q_m - q_k = 820 - 348.4 = 471.6 \text{ kJ/kg}$$

b. Efisiensi termal ( $\eta_{th}$ )

$$\eta_{th} = \frac{W_{net}}{q_m} = \frac{471.6}{820} = 57.5 \%$$

$$\eta_{th} = 1 - \frac{T_1}{T_2} = 1 - \frac{300}{706.1} = 57.5 \%$$

$$\eta_{th} = 1 - \frac{1}{r_v^{k-1}} = 1 - \frac{1}{(9)^{0.4}} = 57.5 \%$$

c. Tekanan efektif rata-rata (mep)

$$mep = \frac{W_{net}}{v_1 - v_2} = \frac{471.6}{0.8610 - 0.1013} = 620.8 \text{ kPa}$$