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B20A1049

Assignment - 9

1.
→ Assuming that engine operates steadily

Acc. to ques, the mass consumption rate is

$$\dot{m} = \rho \cdot \dot{V} = 0.8 \frac{g}{cm^2} \times 22 \frac{L}{H}$$

$$\Rightarrow m = 0.8 \frac{h}{L} \times 22 \frac{L}{h} = 17.6$$

Given that fuel's heating value $= 44 \times 10^3$ kJ/kg
$\times 176$ kJ/h

$$= 774400 \times \frac{kJ}{3600 s} = 215.11 kW$$

Hence, the thermal efficiency can be given by

$$\eta = \frac{\dot{W}_{net}}{Q} = \frac{55 kW}{215.11 kW} = 0.255$$

$= 25.57\%$.

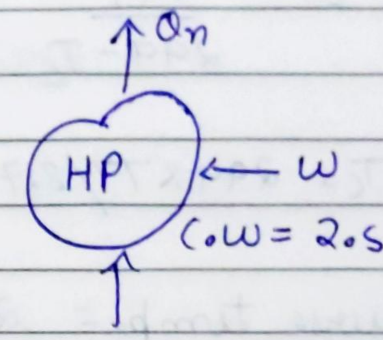
$$\boxed{\eta = 25.57\%}$$

2.

→ Assuming that Heatpump (HOP) operate strictly

We know that $(COP)_{HOP} = \frac{\dot{Q}}{\dot{W}_m} = 2.5$

$\dot{Q}_n$ in this case in diff. b/w the heat last to outside & heat generate from work



$\Rightarrow \dot{Q}_H = 60000 \frac{kJ}{h} - 4000\ kJ/h$

$= 56000 \times \frac{kJ}{3600\,h} = 15.55\ kW$

now $(COP)_{HOP} = 2.5 = \frac{Q}{W} = \frac{15.55\,kW}{W_{net}}$

$\Rightarrow W_{net} = \frac{15.55}{2.5}\ kW = 6.22\ kW$

Power input from heat pump = $\underline{\underline{6.22\ kW}}$

3.
→ Given $(COP)_{HOP} = 8.7$; $T_H = 26°C = 299K$; $W = 4.25\ kW$

We know that, $(COP)_{HOP} = \frac{Q}{W} \Rightarrow \dot{Q} = COP \times \dot{W}$

$\Rightarrow \dot{Q} = 8.7 \times 4.25\,kW = \underline{36.975\,kW}$

morever $COP = \frac{T_H}{T_H - T_C} =$ (T_C = reverse temp.)

$\Rightarrow 5.7 = \frac{299}{299 - T_L}$ $\Rightarrow 299 \times 7.7 = 8.7\,T_C$

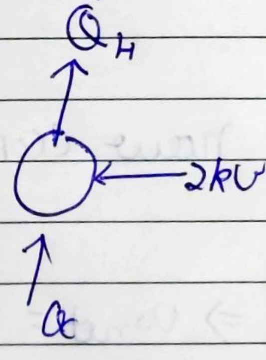
$\Rightarrow T_C = 299 \times 77/8.7 = 264.63\,K = -8.36\,°C$

{Reverse temp. = $264.63\,K = -8.36\,°C$}

Heat load = $36.975\,kW$

4.

→ Given $\dot{Q}_C = 360\,kJ/mm = 6\,kW$



$\dot{Q}_C = 6\,kW$

& $\dot{W}_i = 2\,kW$

$\Rightarrow (COP)_R = \frac{\dot{Q}_C}{W} = \frac{6\,kW}{2\,kW} = 3$

Rate of heat rejected $(Q_H) = Q_C + W$
$= 6\,kW + 2\,kW = 8\,kW$

$\Rightarrow \boxed{(COP)_R = 3}$ and $\boxed{Q_H = 8\,kW}$

5.

→ As a refrigirator, cooling is done with rate

$\dot{Q}_1 = 0.5(T_0 - T_{off})$ $[T_{min.} = 20°C]$

$(COP)_R = 3 = \frac{Q_0}{W} = \frac{\dot{Q}_1}{1.2\,kW} \Rightarrow \dot{Q}_1 = 3.6\,kW$

$\Rightarrow 3.6\,kW = (0.5)(T_0 - 20°C)$

$\Rightarrow \boxed{T_0 = 27.2°C}$

Heat pump

$Q_2 = 0.5(20 - T_0)$

$(COP)_m = 4 = \frac{Q_2}{W} = \frac{0.5(20 - T_0)}{1.2} \Rightarrow 20 - T_0 = 9.6°C$

$\Rightarrow \boxed{T = 10.4°C}$

min^m & max^m outside temp. $\boxed{10.4°C \;\&\; 27.2°C}$