Thermodynamics (MEL2020)    Kartik Choudhary [B20CS025] Assignment 9

(1) Given values are:

fuel consumption $C = 22\,L/h$

specific gravity $= 0.8$

output power $P = 55\,KW$

heating value $H = 44000\,KJ/kg$

The energy intake will be

$\rightarrow E = C \times P \times H$

$= \left(\frac{22}{3600}\right) \times (1000) \times (0.8) \times (44000)$

$= 215111.1\,J/s$

The output power

$P = 55\,KW$

$= 55000\,J/s$

efficiency will be $= \frac{Out}{Inp.}$

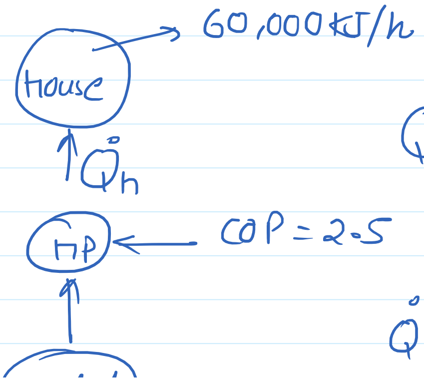
$= \frac{55000}{215111.1}$

$= 0.2557$

$= 25.6\%$

Ans!

(2a) The rate of heat loss, the rate of internal heat gain and the COP of a heat pump are given. The power input to the heat pump is to be determined.




$\dot{Q}_H = 60,000 - 4000$

$\dot{Q}_h = 56000\,KJ/h$

Outside

Using the def$^n$ of COP, the power input to the heat pump

$$\dot{W}_{net,in} = \frac{\dot{Q}_H}{COP_{HP}} = \left[\frac{56000\ kJ/h}{2.5}\right]\left[\frac{1\ kW}{3600\ kJ/h}\right]$$

$$= \underline{\underline{6.22\ kW}}$$ Ans!

(3.) $COP = 8.7$

$\dot{W}_{net} = 4.25 kW$

$T_{source} = T_H = 26°C = 299K$

The COP of a reversible heat pump

$$COP_{HP} = \frac{T_H}{T_H - T_L}$$

$$8.7 = \frac{299}{299 - T_L}$$

$$299 - T_L = \frac{299}{8.7}$$

$$T_L = 299 - 34.367$$

$$T_L = 264.6\ K$$

∴ The low temprature is $\boxed{T_L = 264.6 K}$

The heating load effect of the heat pump

$$COP_{HP} = \frac{\dot{Q}_H}{\dot{W}_{net}}$$

$$8.7 = \frac{\dot{Q}_H}{4.25}$$

$$\dot{Q}_H = 36.975 kW$$

∴ Required heating load $\boxed{\dot{Q}_H = 36.975 kW}$

$\therefore$ Required heating load $\boxed{Q_H = 36.975 KW}$

(4.) Cooling load $\dot{Q} = 360 KJ/min$

$$Q = 6 KW$$

$$COP = \frac{\text{cooling load}}{\text{Input power}} = \frac{6}{2} = 3$$

The rate of heat rejection (H) to the room is equal to the sum of the refridgerator cooling load and input power

$$H = Q + W = 6 + 2 = 8 KW$$

(5.) $COP_{refridgerator} = \beta = 3$

$COP_{heat pump} = \beta' = 4$

Replacement heat transfer equals the loss

$$\dot{Q} = 0.5 (T_H - T_{amb})$$

$$\dot{W} = \frac{\dot{Q}_H}{\beta'} = 0.5 \left[\frac{T_H - T_{amb}}{4}\right]$$

$$T_H - T_{amb} = 4 \frac{\dot{W}}{0.5} = 9.6 K$$

heat pump mode: Minimum $T_{amb} = 20 - 9.6$
$= 10.4°c$

The unit as a refridgerator must cool with rate

$$\dot{Q} = 0.5 [T_{amb} - T_{house}]$$

$$\dot{W} = \frac{\dot{Q}_L}{\beta} = 0.5 \left[\frac{T_{amb} - T_{house}}{3}\right]$$

$$T_{amb} - T_{house} = 3 \frac{\dot{W}}{0.5} = 7.2K$$

Refridgerator mode : Maximum $T_{amb}$

$= 20 + 7.2$

$= 27.2\,^{\circ}C$

Ans