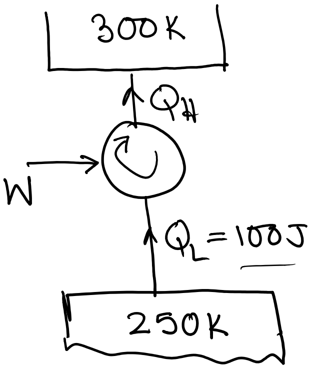


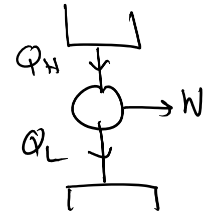
$$(COP)_{max,Ref} = \frac{Q_{L,R}}{Q_{H,R} - Q_{L,R}}$$

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

$$= \frac{250}{50} = 5$$

$$\eta_{Carnot} = 1 - \frac{T_L}{T_H}$$

$$\eta = 1 - \frac{Q_L}{Q_H}$$

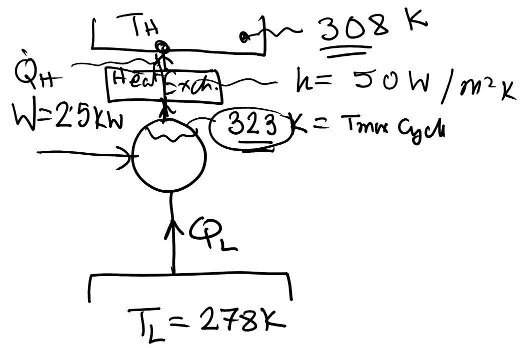


$$1 - \frac{Q_L}{Q_H} = 1 - \frac{T_L}{T_H}$$

$$\boxed{Q_L / Q_H = \frac{T_L}{T_H}}$$

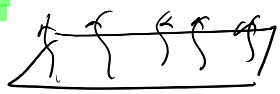
$$COP = \frac{Q_L}{W} \Rightarrow W = \frac{Q_L}{COP} = \frac{Q_L}{5} = 20J$$

7.68 A refrigerator uses a power input of 2.5 kW to cool a 5°C space with the high temperature in the cycle as 50°C. The Q_H is pushed to the ambient air at 35°C in a heat exchanger where the transfer coefficient is 50 W/m² K. Find the required minimum heat transfer area.



$$\dot{Q}_H = A h (T_{max\,cycle} - T_H)$$

h



$$\dot{Q}_H = \dot{Q}_L + W$$

For minimum H.T. area (Q_H), W should be minimum

This means minimum Area of Heat exchanger is enough when the cycle is reversible.

$$(COP)_{max} = \frac{T_L}{T_H - T_L} = \frac{278}{45} = 6.17$$

$$Q_L = 6.17W$$

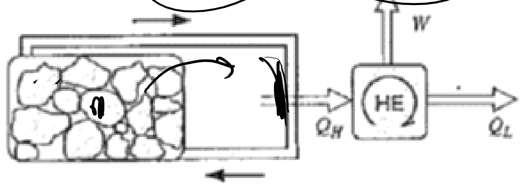
$$Q_H = 6.17W + W = 7.17W = 2.5 \times 7.17 = 17.925 \text{ kW}$$

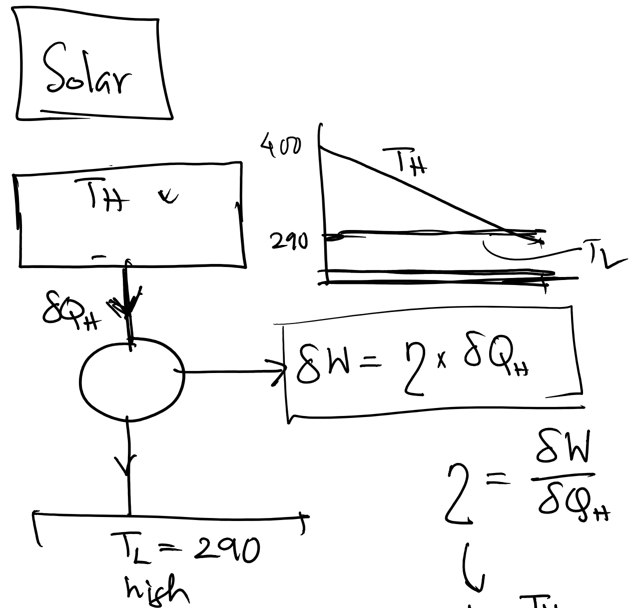
$$Q_H = hA(T_H - T_{amb})$$

$$A = Q_H / h\Delta T = \frac{17.925}{50 \times (50-35)} = \frac{17.925}{50 \times 15}$$

7.61 A thermal storage device is made with a rock (granite) bed of 2 m³ that is heated to 400 K using solar energy. A heat engine receives a Q_H from the bed and rejects heat to the ambient surroundings at 290 K. The rock bed therefore cools down, and as it reaches 290 K the process stops. Find the energy the rock bed can give out. What is the heat engine efficiency at the beginning of the process, and what is it at the end of the process? How much work is performed if the H.E. is rev.?

Consider $\rho = 2750$ kg/m³, $c = 0.89$ kJ/kgK





$$\eta = \frac{\delta W}{\delta Q_H}$$

$$1 - \frac{T_H}{T_L}$$

Energy balance of the reservoir

$$\delta Q_H = -mc\,dT_H$$

$$\delta W = -mc\,dT_H\left(1 - \frac{T_H}{T_L}\right)$$

$$W = \int_{400}^{290} -mc\left(1 - \frac{T_H}{T_L}\right) dT_H \qquad T_L = 290$$

$$\boxed{m = \rho \times V} \quad \text{volume}$$

$$= \int_{290}^{400} mc\left(1 - \frac{T_H}{T_L}\right) dT_H$$

$$=$$