Trevor Swan **ECHE225: QUIZ #4 // 9.26.24**

1. Efficiency of Irreversible always less than a reversible cycle

2. Ideal HP Given

$$CoP_{HP} = \frac{Q_{out}}{W_{in}} = \frac{1}{1 - \frac{Q_L}{Q_H}} \Big\} \text{ generally}$$

$CoP_{HP} = 1.9$

$T_L = 240K$ air

Find T_H

$$CoP_{HP} = \frac{1}{1 - \frac{T_L}{T_H}} \Big\} \text{ Ideal/carnot}$$

$$CoP_{HP}\left(1 - \frac{T_L}{T_H}\right) = 1 \qquad T_H = \frac{T_L}{1 - \frac{1}{CoP_{HP}}}$$

$$1 - \frac{T_L}{T_H} = \frac{1}{CoP_{HP}} \qquad = \frac{240K}{1 - \frac{1}{1.9}} = 612K$$

$$\frac{T_L}{T_H} = 1 - \frac{1}{CoP_{HP}}$$

$$\boxed{T_H = 612K}$$

3. Carnot Heat Engine

$$\eta_{th,carnot} = 1 - \frac{T_L}{T_H} = .60$$

Generally

$$\eta_{th} = \frac{\dot{W}_{out}}{\dot{Q}_H} \rightarrow \dot{W}_{out} = \eta_{th} \cdot \dot{Q}_H$$

$\dot{Q}_H = \dot{Q}_{in}$

1st Law: $\dot{Q}_{in} = \dot{m}(h_{in} - h_{out})$

$$\dot{Q}_{in} = \dot{m} \times c_p \times (T_{in} - T_{out})$$

$T_{in} = T_H$ $T_{out} = T_L$

$$1 - \frac{T_L}{T_H} = 0.60$$

$$1 - \frac{T_L}{500} = 0.60$$

$$\rightarrow T_L = 200$$

$$\dot{Q}_{in} = \dot{m} \times c_p \times (T_H - T_L)$$

$$= 0.05 \frac{kg}{s} \times 4.18 \frac{kJ}{kg \cdot K} \times (500K - 200K)$$

$$\dot{Q}_{in} = 62.7\,kW \rightarrow \dot{W}_{out} = 0.60 \cdot 62.7\,kW = 37.62$$

$$\boxed{\dot{W}_{out} = 37.62\,kW}$$