

Reminders 12-5-07:

- Quiz on Heat Transfer and 1st Law Today
- Thermodynamics Conceptual Questions due
- Heat Engine Worksheet Due
- Homework 12 Due 12/9
- Exam 4 12/10.

Objectives:

- Heat Pumps and Refrigerators
- Exam 4 and Final Exam Discussion

$$\begin{aligned} \epsilon &= \frac{W}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}} \\ &= 1 - \frac{Q_c}{Q_H} \end{aligned}$$

$$\epsilon_{\text{Carnot}} = 1 - \frac{T_c}{T_H}$$

- A heat pump has a COP of 3.0 and is rated to do work at a rate of 1500W. How much heat can be added to a room per second? If you ran this as an air conditioner, what do you expect the COP to be?

$$\text{COP} = \frac{Q_H}{W} = 3$$

$$\begin{aligned} \circ Q_H &= 3W \\ &= 3(1500) = 4500\text{W} \end{aligned}$$

$$\text{If } Q_H = 4500\text{W} \quad W = 1500\text{W}$$
$$Q_C = 3000\text{W}$$

$$(\text{COP})_R = \frac{Q_C}{W} = \frac{3000\text{W}}{1500\text{W}} = 2$$

- A 33% efficient power plant puts out 800MW of electrical energy. Cooling towers are used to take exhaust heat. If air temp. can rise by 7.0°C, what volume of air is heated per day? If the heated air were to form a layer 200m thick, what area would it cover for 24h of operation? ($c_{\text{air}} = 1008 \text{ J/kg}^\circ\text{C}$ $\rho_{\text{air}} = 1.29 \text{ kg/m}^3$)

$$E = 33\% \quad \underline{W} = 800 \text{ MW}$$

$$E = \frac{W}{Q_{\text{in}}} = 1 - \frac{Q_{\text{out}}}{Q_{\text{in}}} = 33\%$$

$$33\% = \frac{800 \text{ MW}}{Q_{\text{in}}} \quad Q_{\text{in}} = 2400 \text{ MW}$$

$$Q_{\text{out}} = 1600 \text{ MW}$$

$$1600 \text{ MW} = 1600 \times 10^6 \text{ J/s} = Q_c$$

$$(1600 \times 10^6 \text{ J/s})(3600 \text{ s/h})(24 \text{ h/day})$$

$$(1600 \times 10^6)(86,400) = m c_{\text{air}} 7^\circ\text{C}$$

$$m = \frac{(1600 \times 10^6)(86,400)}{7(1008 \text{ J/kg}^\circ\text{C})}$$

$$\approx 1.96 \times 10^{10} \text{ kg}$$

$$V = \frac{m}{\rho} = \frac{1.96 \times 10^{10} \text{ kg}}{1.29 \text{ kg/m}^3}$$

$$\approx 1.52 \times 10^{10} \text{ m}^3$$

$$= 15.2 \text{ km}^3$$

$$V = Ah \quad A = \frac{V}{h} = \frac{15.2 \text{ km}^3}{.2 \text{ km}}$$

$$= 76 \text{ km}^2$$