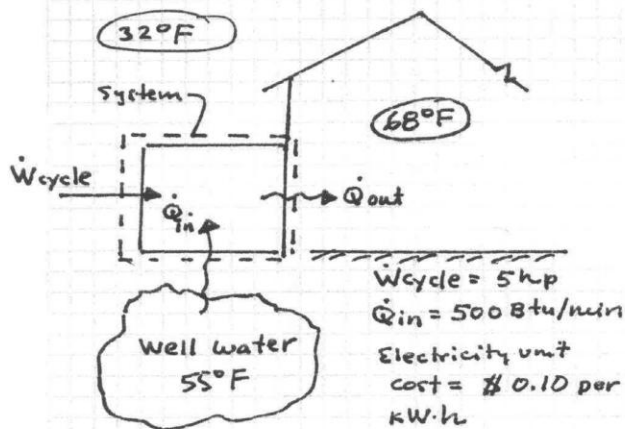


PROBLEM 2.95

KNOWN: Operating and cost data are provided for a heat pump.

FIND: Determine the coefficient of performance for the heat pump and the cost of electricity in a month when the heat pump operates for 300 hours.

SCHEMATIC & GIVEN DATA:



ENGINEERING MODEL:

1. The system shown in the schematic operates in heat pump cycle.
2. Energy transfers are positive in the direction of the arrows.
3. The heat pump operates steadily.
4. Electricity is valued at \$0.10 per kW·h.

ANALYSIS:

(a) Using Eq. 2.47 on a time rate basis,

$$\gamma = \frac{\dot{Q}_{\text{out}}}{W_{\text{cycle}}} \quad (1)$$

together with the cycle energy balance, Eq. 2.44, on a time rate basis: $\dot{W}_{\text{cycle}} = \dot{Q}_{\text{out}} - \dot{Q}_{\text{in}}$, we get:

$$\dot{Q}_{\text{out}} = \dot{W}_{\text{cycle}} + \dot{Q}_{\text{in}} = (5 \text{ hp}) \left| \frac{2545 \text{ Btu/h}}{1 \text{ hp}} \right| \left| \frac{1 \text{ h}}{60 \text{ min}} \right| + 500 \frac{\text{Btu}}{\text{min}}$$

212.1 Btu/min

$$\therefore \dot{Q}_{\text{out}} = 712.1 \text{ Btu/min}$$

Eq. (1) gives,

$$\gamma = \frac{712.1 \text{ Btu/min}}{212.1 \text{ Btu/min}} = 3.36$$

$$(b) \quad \$ = \left(212.1 \frac{\text{Btu}}{\text{min}} \right) \left[\frac{300 \text{ h}}{\text{month}} \right] \left[\frac{\$0.10}{\text{kW}\cdot\text{h}} \right] \left| \frac{60 \text{ min}}{1 \text{ h}} \right| \left| \frac{1 \text{ kW}}{3413 \text{ Btu/h}} \right|$$

$$= \$111.86/\text{month}$$

Unit conversions:
1 W = 3.413 Btu/h