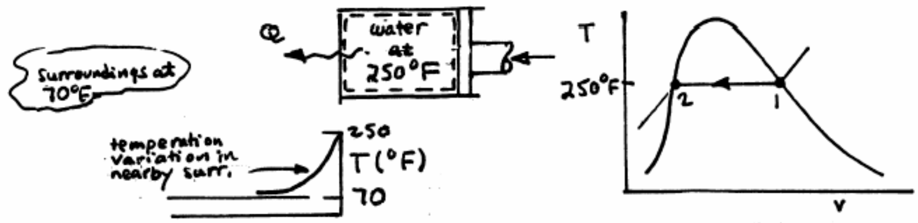
PROBLEM 5.8*

KNOWN: Water within a piston-cylinder assembly cools isothermally at 250°F from saturated vapor to saturated liquid.

FIND: Determine if the process is internally reversible, is reversible.

SCHEMATIC & GIVEN DATA:



ASSUMPTIONS: 1. The system is the water in the piston-cylinder assembly. 2. The system undergoes a constant-temperature process from saturated vapor to saturated liquid.

ANALYSIS: Since temperature is constant during the process, the pressure also remains constant. As shown by the T-v diagram, the process is a sequence of equilibrium states, and thus is internally reversible.

The process is not reversible because there is a significant irreversibility in the surroundings — namely, the spontaneous heat transfer taking place between the water at 250°F and the surroundings at 70°F.

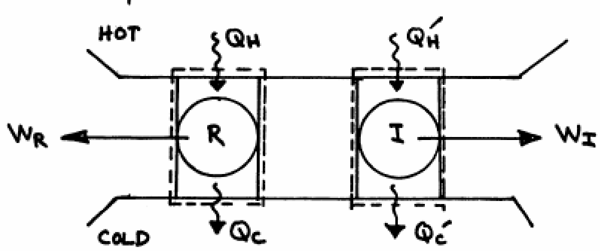
PROBLEM 5.11

KNOWN: A reversible power cycle R and an irreversible power cycle I operate between the same two reservoirs.

FIND: (a) If each cycle receives the same amount of energy from the hot reservoir, show that I discharges more energy to the cold reservoir.

(b) If each cycle develops the same net work, show that I receives more energy from the hot reservoir.

SCHEMATIC & GIVEN DATA:



To show:

(a) $Q_H = Q_H' \Rightarrow Q_C' > Q_C$

(b) $W_R = W_I \Rightarrow Q_H' > Q_H$

ASSUMPTION: The system denoted by R in the accompanying figure undergoes a reversible power cycle while system I undergoes an irreversible power cycle.

ANALYSIS: (a) By the first Carnot Corollary, $\eta_R > \eta_I$. Since both cycles receive the same amount of energy Q_H, it follows that $W_R > W_I$.

An energy balance for R and I read, respectively

$$W_R = Q_H - Q_C$$
$$W_I = Q_H - Q_C'$$

Collecting results

$$Q_H - Q_C > Q_H - Q_C'$$

Accordingly

$$Q_C' > Q_C \longleftarrow$$

as was to be demonstrated.

Thus, not only do actual cycles develop less work they also discharge more energy by heat transfer to their surroundings, thereby increasing the effect of <u>thermal pollution</u>.

(b) Since $\eta_R > \eta_I$ and $W_R = W_I \equiv W$,

$$\frac{W}{Q_H} > \frac{W}{Q_H'} \Rightarrow Q_H' > Q_H$$

If the hot reservoir were maintained by, say, energy from the combustion of a fossil fuel, cycle I would have the greater fuel requirement. Also, note that cycle I also would have the greater energy discharge to the cold reservoir, so the comments of (a) would also be applicable.