PROBLEM 2.64

KNOWN: Data are provided for a ridgid, closed tank fitted with a paddle wheel. The tank contains Refrigerant 22.

FIND: (a) Q and W for the refrigerant. (b) Evaluate the constant K in the heat transfer relation provided.

SCHEMATIC & GIVEN DATA:

$\dot{Q} = -Kt$ (kW/min, min), $\dot{W} = -0.1\,kW$

$u_1 = 232.92\ kJ/kg$

$u_2 = 276.67\ kJ/kg$

$P_1 = 0.9\ MPa$, $P_2 = 1.2\ MPa$ $\quad \Delta t = 20\ min.$

ENGR. MODEL:

1. The Refrigerant 22 is the closed system.
2. No overall changes in kinetic or potential energy occur.

ANALYSIS: (a) $W = \int_1^2 \dot{W}\,dt = -(0.1\,kW)(20\,min)\left|\frac{60s}{1\,min}\right|\left|\frac{1\,kJ/s}{1\,kW}\right| = -120\,kJ$ ←

Energy Balance:

$\Delta U + \cancel{\Delta KE} + \cancel{\Delta PE} = Q - W \Rightarrow Q = \Delta U + W \Rightarrow Q = m(u_2 - u_1) + W$

$\therefore\ Q = 1\,kg\,(276.67 - 232.92) + (-120\,kJ) = -76.25\,kJ$ ←

(b) $Q = \int_1^2 \dot{Q}\,dt = \int_0^t -Kt\,dt = -\frac{Kt^2}{2} \Rightarrow$

$$K = -\frac{2Q}{t^2} = -\frac{2(-76.25\,kJ)}{(20\,min)^2}\left|\frac{1\,kW}{1\,kJ/s}\right|\left|\frac{1\,min}{60s}\right|$$

$$= 6.359 \times 10^{-3}\ \frac{kW}{min}$$ ←