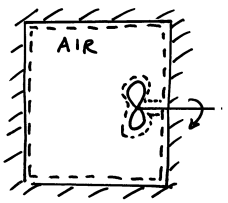
PROBLEM 2.64*

KNOWN: Air contained in a rigid well-insulated tank receives energy at a specified rate from a paddle wheel.

FIND: Determine the specific volume at the final state, the energy transfer by work, and the change in specific internal energy of the air.

SCHEMATIC & GIVEN DATA:



$V = 0.6 m^3$

$\dot{W} = -10 W$, $\Delta t = 1 h$

$m = 2 kg$

ASSUMPTIONS: 1. The air is the closed system. 2. For the system, $Q = 0$ and there are no changes in kinetic energy and potential energy. 3. The initial and final states are equilibrium states.

ANALYSIS: (a) Since the mass and volume are each constant, the specific volume at states 1 and 2 are the same: $v_2 = v_1$. Thus

$$v_2 = V/m = (0.6 m^3)/(2 kg) = 0.3 \frac{m^3}{kg} \longleftarrow v_2$$

(b) To evaluate W, integrate

$$W = \int_0^{1h} \dot{W} dt = \int_0^{1h} (-10W)\, dt = (-10 W)(1 h)\left|\frac{1 J/s}{1 W}\right|\left|\frac{3600 s}{1 h}\right|\left|\frac{kJ}{10^3 J}\right|$$

$$= -36 kJ \longleftarrow W$$

(c) The change in specific internal energy can be found from an energy balance:

$$\cancel{\Delta KE} + \cancel{\Delta PE} + \Delta U = \cancel{Q} - W \quad \Rightarrow \quad m \Delta u = -W$$

or

$$u_2 - u_1 = \frac{(-W)}{m}$$

$$= \frac{-(-36 kJ)}{2 kg} = 18 \frac{kJ}{kg} \longleftarrow u_2 - u_1$$