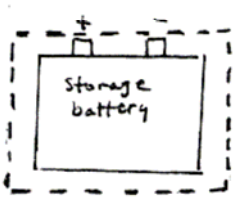
PROBLEM 2.62

KNOWN: Data are provided for the charging and discharging of a storage battery.

FIND: Determine the time rate of change of energy during charging and discharging periods. Determine the overall change in energy of the battery.

SCHEMATIC & GIVEN DATA:



Charging: 1st 12 hrs. $\dot{W} = -15\,kW$, $\dot{Q} = -1.5\,kW$

Discharging: 2nd 12 hrs. $\dot{W} = +5\,kW$, $\dot{Q} = -0.5\,kW$

ENGR. MODEL

1. The storage battery is the closed system.
2. The $\dot{W}$ and $\dot{Q}$ rates are each constant with time.

ANALYSIS:

(a) $$\frac{dE}{dt} = \dot{Q} - \dot{W}$$
$$= -1.5\,kW - (-15\,kW) = +13.5\,kW \leftarrow$$

(b) $$\frac{dE}{dt} = \dot{Q} - \dot{W}$$
$$= -0.5\,kW - (5\,kW) = -5.5\,kW \leftarrow$$

(c) The change in system energy in the charging phase is

$$\Delta E = \int \frac{dE}{dt}\,dt = (+13.5\,kW)(12h)\left|\frac{1\,kJ/s}{1\,kW}\right|\left|\frac{3600s}{1h}\right| = 5.832 \times 10^5\,kJ$$

The change in system energy in the discharging phase is

$$\Delta E = \int \frac{dE}{dt}\,dt = (-5.5\,kW)(12h)\left|\frac{1\,kJ/s}{1\,kW}\right|\left|\frac{3600}{1h}\right| = 2.376 \times 10^5\,kJ$$

So, the overall change in energy over 24 hours $= (5.832 - 2.376)10^5\,kJ$

$$= 3.456 \times 10^5\,kJ \leftarrow$$