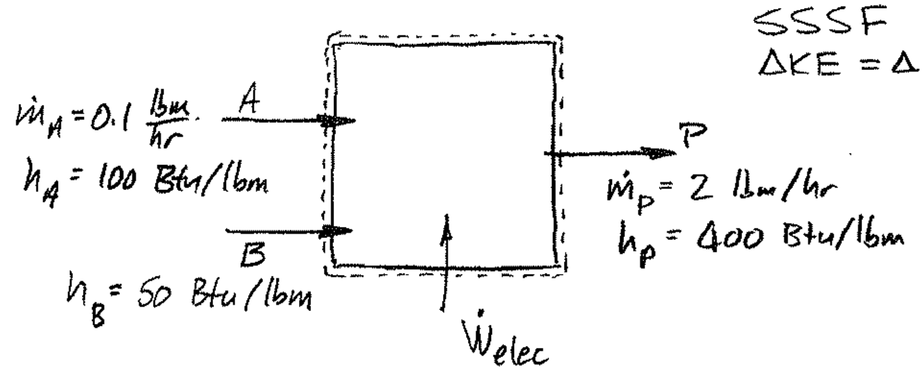
ME 322 | PROB. 6.3

<u>Given</u>: A process ocurring in a rigid, insulated reactor

SSSF

$\Delta KE = \Delta PE = 0$



<u>Find</u>: $\dot{W}_{elec}$

<u>Solution</u>: The First Law for this process is,

$$\cancel{\dot{Q}}^{\,0} - \dot{W} + \sum \dot{m}_i h_i - \sum \dot{m}_e h_e = 0$$

$$\dot{W}_{elec} = \dot{m}_A h_A + \dot{m}_B h_B - \dot{m}_P h_P$$

The mass flow rate of chemical B is found from the conservation of mass.

$$\dot{m}_A + \dot{m}_B - \dot{m}_P = 0$$

$$\therefore \; \dot{m}_B = \dot{m}_P - \dot{m}_A = (2 - 0.1)\,\frac{lbm}{hr} = 1.9\,\frac{lbm}{hr}$$

Then,

$$\dot{W}_{elec} = \left(0.1\,\frac{lbm}{hr}\right)\left(100\,\frac{Btu}{lbm}\right) + \left(1.9\,\frac{lbm}{hr}\right)\left(50\,\frac{Btu}{lbm}\right) - \left(2\,\frac{lbm}{hr}\right)\left(400\,\frac{Btu}{lbm}\right) = \underline{\underline{-695\,\frac{Btu}{hr}}}$$

$$\dot{W}_{elec} = -695\,\frac{Btu}{hr}\,\Bigg|\,\frac{hp \cdot hr}{2545\ Btu} = \underline{\underline{-0.273\ hp}}$$

<u>Reflection</u>:
- The power is negative, which means this is a power <u>input</u> to the reactor
- This problem is a first exposure to some really neat engineering! A calculation like this is used to size the electrical heater used in the process.