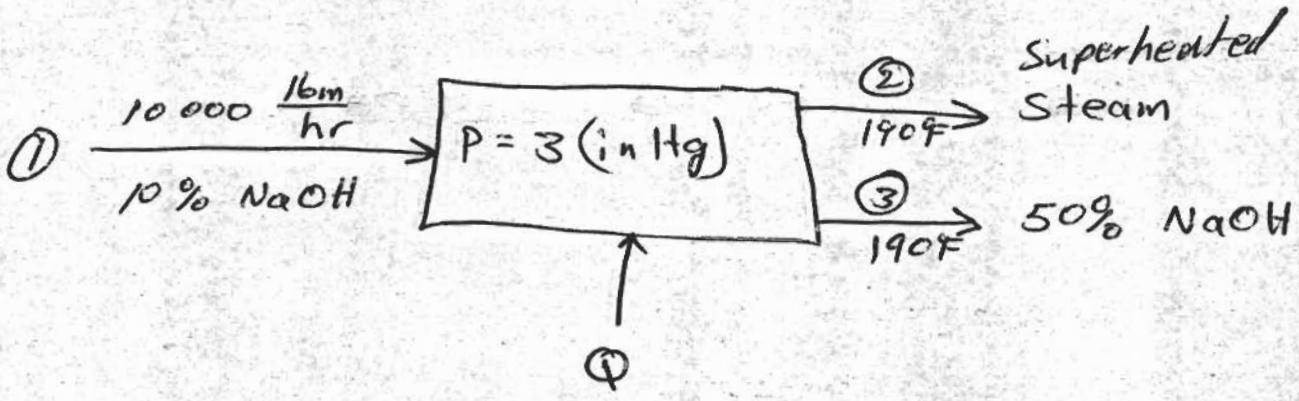
Example 12.6

A single-effect evaporator concentrates 10,000$(lb_m)(hr)^{-1}$ of a 10% (by weight) aqueous solution of NaOH to 50%. The feed enters at 70(°F). The evaporator operates at an absolute pressure of 3(in Hg), and under these conditions the boiling point of a 50% solution of NaOH is 190(°F). What is the heat-transfer rate in the evaporator?



mass balance:

$$0.1\,\dot{m}_1 = 0.5\,\dot{m}_3 + 0.0\,\dot{m}_2 \Rightarrow \dot{m}_3 = 2000\ \frac{lbm}{hr}$$

$$m_2 = \dot{m}_1 - \dot{m}_3 = 8000\ lbm/hr$$

$$H_2 = 1146\ \frac{Btu}{lbm}$$ (superheated steam tables)

$$H_1 = 34\ \frac{Btu}{lbm}$$ (Fig 12.19)

$$H_3 = 215\ \frac{Btu}{lbm}$$ (")

$$\dot{Q} = \dot{m}_2 H_2 + \dot{m}_3 H_3 - \dot{m}_1 H_1$$

$$= (8000)(1146) + (2000)(215) - 10000\,(34)$$

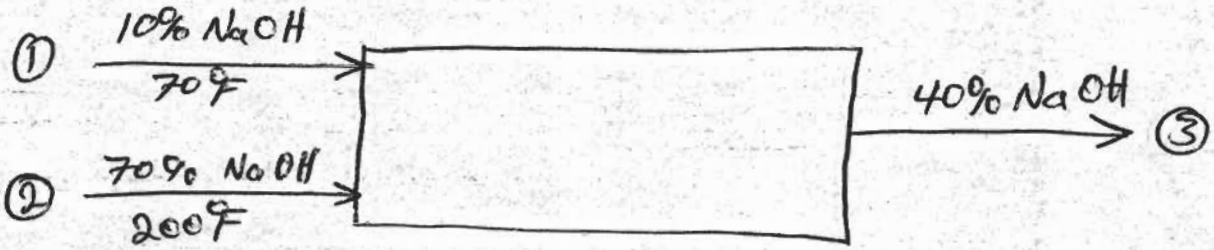
$$= 9.26 * 10^6\ \frac{Btu}{hr}$$

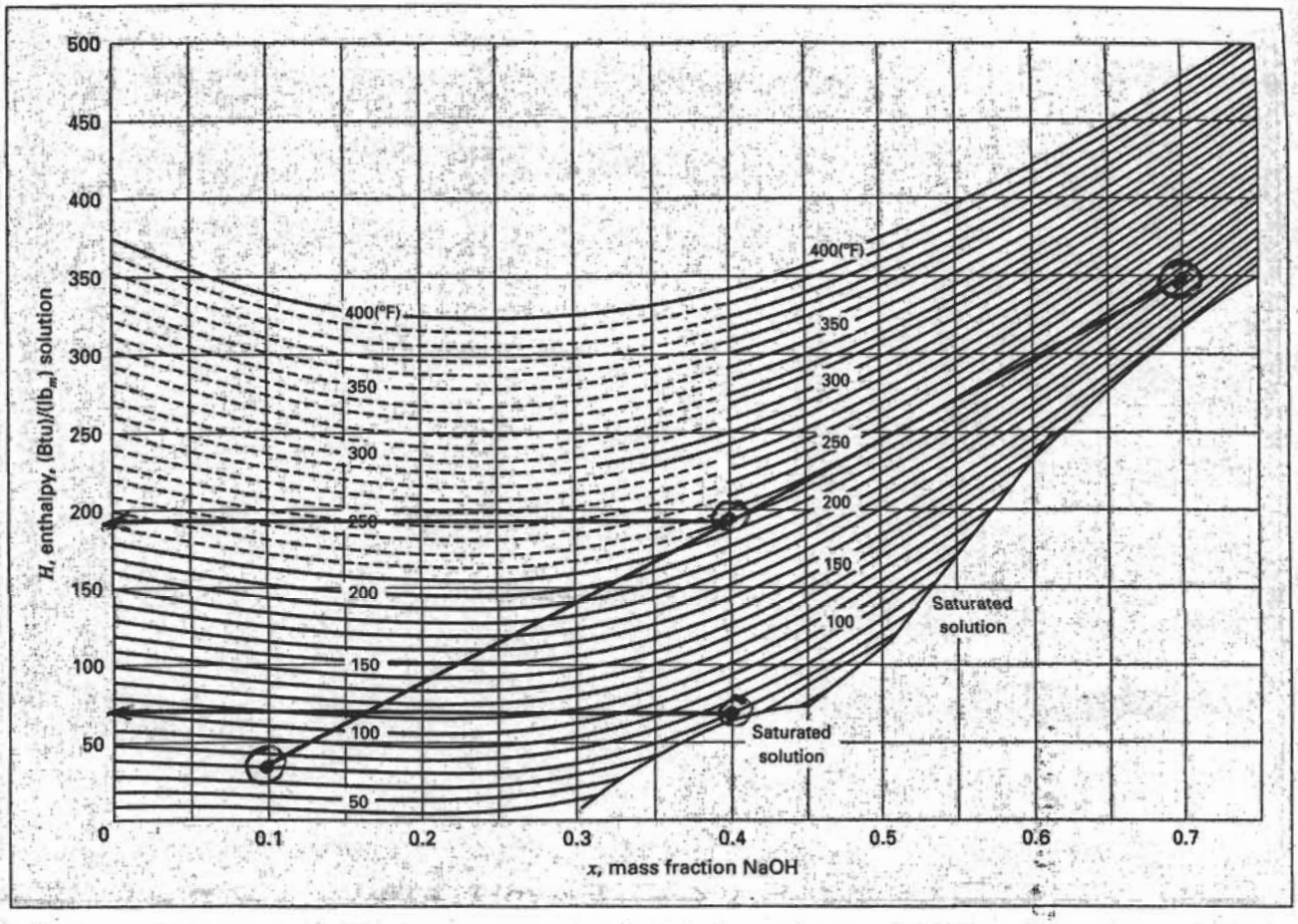
Example 12.7

A 10% aqueous NaOH solution at 70(°F) is mixed with a 70% aqueous NaOH solution at 200(°F) to form a solution containing 40% NaOH.

(*a*) If the mixing is done adiabatically, what is the final temperature of the solution?

(*b*) If the final temperature is brought to 70(°F), how much heat must be removed during the process?





(a) $T_3 = 220°F$, $H_3 = 190$ Btu/lbm

(b) @ 70°F 40% NaOH $H = 70$ Btu/lbm

$Q = \Delta H = 70 - 190 = -120$ Btu/lbm