Elementary Mass Balances

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Problem: A chemical plant produces an aqueous solution of sodium hydroxide that is 20.0% NaOH by mass. The company desires to produce a stream of 8.0% NaOH solution by diluting a stream of the 20.0% solution with a stream of pure water. What flow rates of the pure water and 20.0% solution stream will produce 2310 lb$_m$/min of the 8.0% solution?

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Q_1 lbm/min

$\dfrac{0.20\ \text{lbm NaOH}}{\text{lbm total}}$

$0.80\ \dfrac{\text{lbm } H_2O}{\text{lbm total}}$

Q_2 lbm/min

H_2O

MIX

2310 lbm/min

$\dfrac{0.08\ \text{lbm NaOH}}{\text{lbm total}}$

$0.92\ \dfrac{\text{lbm } H_2O}{\text{lbm total}}$
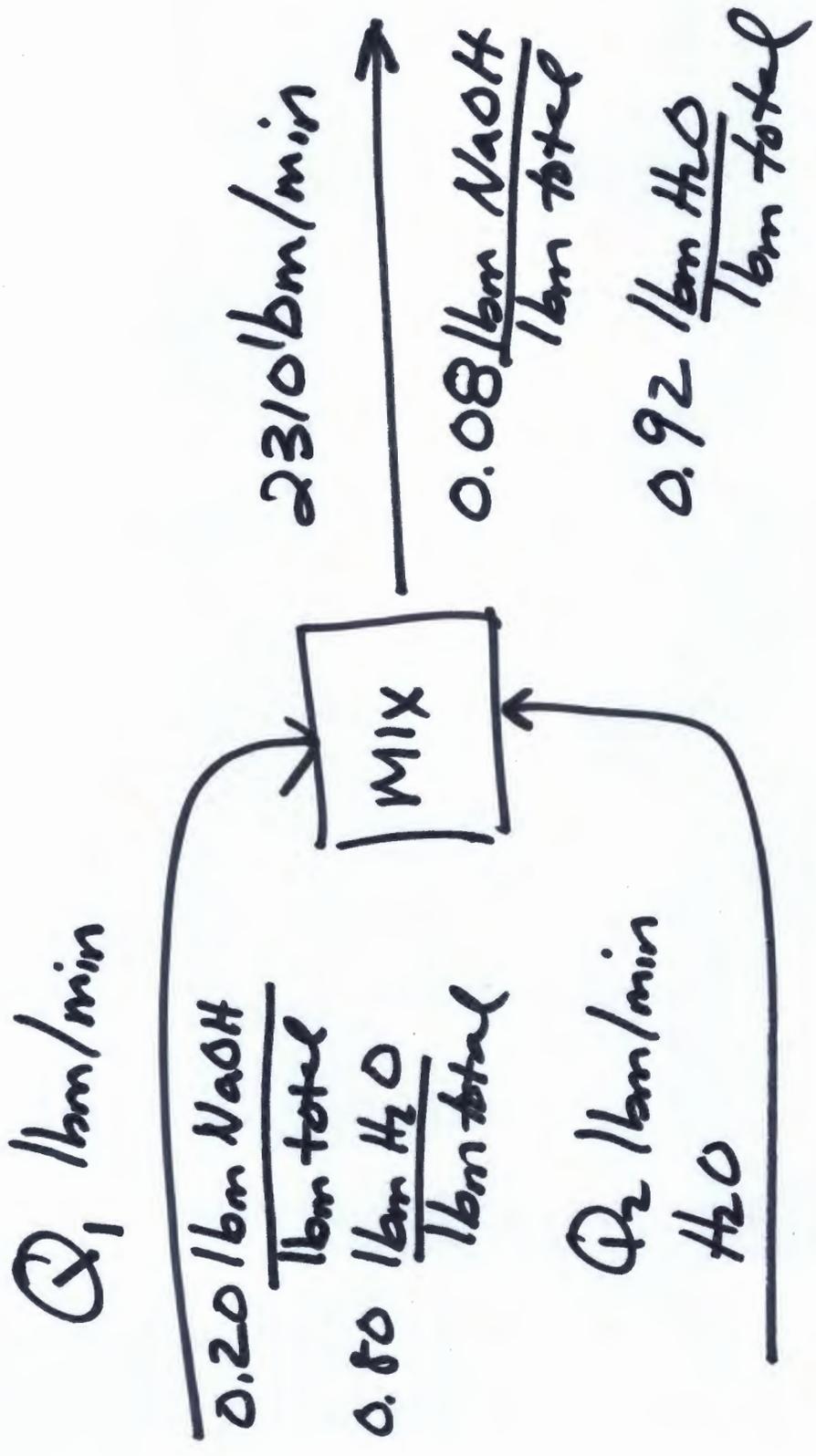
OVER ALL MASS BAL:

$$Q_1 + Q_2 = 2310\ \dfrac{\text{lbm}}{\text{min}}$$

NaOH BALANCE

$$\left(0.2 \frac{lbm\, NaOH}{lbmobose}\right)\left(Q_1 \frac{lbm}{min}\right) = \left(0.08 \frac{lbm\, NaOH}{lbmobose}\right) 2310 \frac{lbm}{min}$$

$$0.2\, Q_1 = (0.08)\, 2310$$

$$Q_1 = \frac{(0.08)(2310)}{0.2} = \boxed{924 \frac{lbm}{min}}$$

Recall Overall Bal:

$$Q_1 + Q_2 = 2310$$

$$Q_2 = 2310 - 924 = \boxed{1386 \frac{lbm}{min}}\; //$$