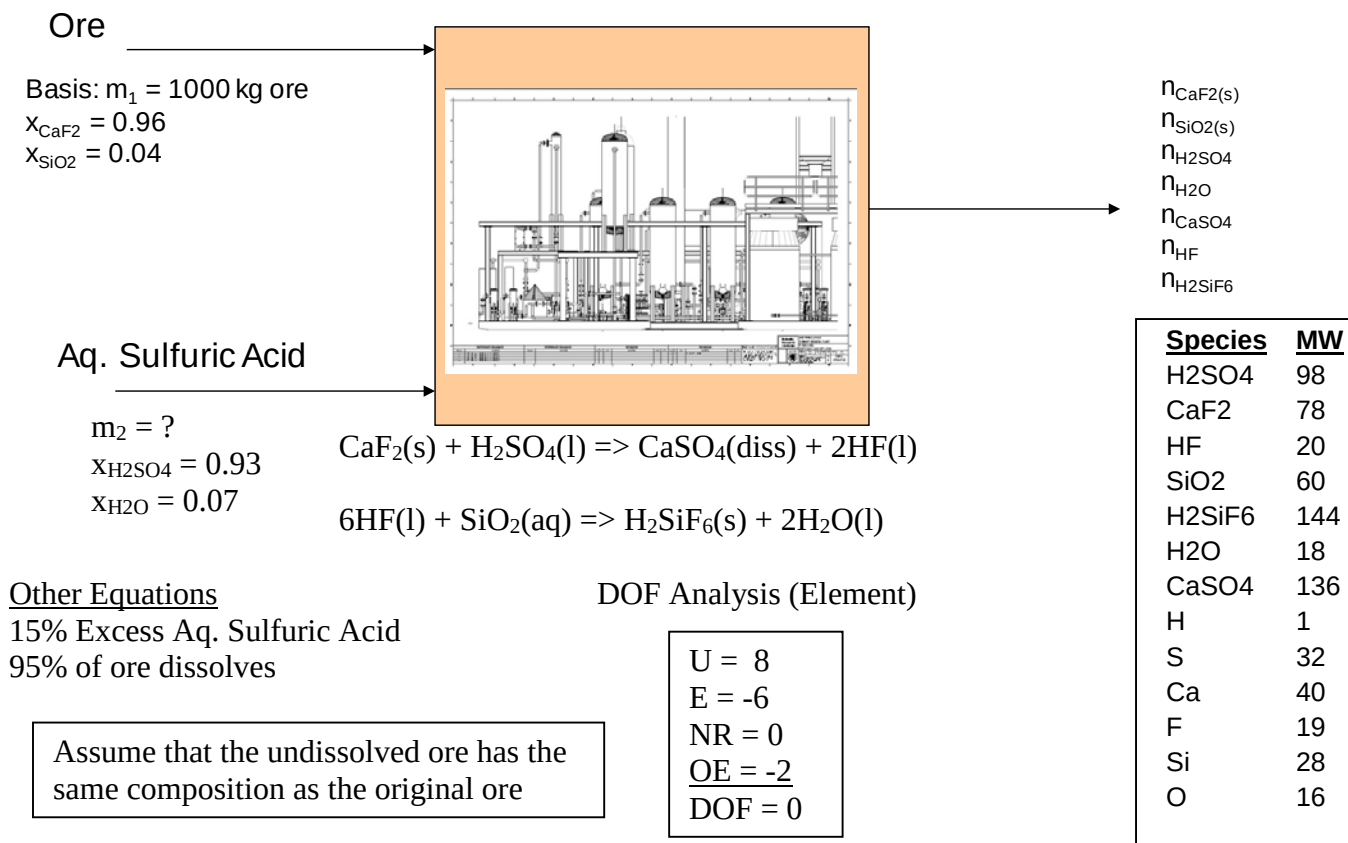


Problem 4-71 (4-52 in 3rd Ed.)



$$n_{\text{CaF}_2, \text{in}} = \frac{960 \text{ kg CaF}_2}{78 \text{ kg/mol}} = 12.3 \text{ kgmol CaF}_{2, \text{in}}$$

$$n_{\text{H}_2\text{SO}_4, \text{in}} = (12.3 \text{ kgmol CaF}_2) \left(\frac{1.15 \text{ H}_2\text{SO}_4}{\text{CaF}_2} \right) = 14.15 \text{ kgmol H}_2\text{SO}_{4, \text{in}}$$

$$m_{\text{H}_2\text{SO}_4, \text{in}} = (14.15 \text{ kgmol H}_2\text{SO}_{4, \text{in}}) \left(98 \frac{\text{kg}}{\text{kg mol}} \right) = 1387 \text{ kg H}_2\text{SO}_{4, \text{in}}$$

$$m_2 = (1387 \text{ kg H}_2\text{SO}_{4, \text{in}}) \left(\frac{\text{kg mix}}{0.93 \text{ kg H}_2\text{SO}_4} \right) = 1491.5 \text{ kg}$$

$$m_{\text{H}_2\text{O}, \text{in}} = (1491.5 \text{ kg})(0.07) = 104.4 \text{ kg} \quad \text{so } n_{\text{H}_2\text{O}, \text{in}} = \frac{104.4 \text{ kg}}{18 \frac{\text{kg}}{\text{kgmol}}} = 5.8 \text{ kgmol}$$

$$m_{\text{ore}, \text{out}} = (1 - 0.95)(1000 \text{ kg ore}_{\text{in}}) = 50 \text{ kg ore}$$

$$n_{\text{CaF}_2, \text{out}} = \frac{(50 \text{ kg})(0.96)}{78 \frac{\text{kg}}{\text{kgmol}}} = 0.6154 \text{ kgmol CaF}_{2, \text{out}}$$

$$n_{\text{SiO}_2, \text{out}} = \frac{(50 \text{ kg})(0.04)}{60 \frac{\text{kg}}{\text{kgmol}}} = 0.0333 \text{ kgmol SiO}_{2, \text{out}}$$

Ca balance (in = out)

$$(n_{\text{CaF}_2, \text{in}})(1) = (n_{\text{CaF}_2, \text{out}})(1) + (n_{\text{CaSO}_4, \text{out}})(1) \quad \text{so} \quad n_{\text{CaSO}_4, \text{out}} = 12.3 - 0.6154 = 11.692 \text{ kg mol}$$

Si balance

$$(n_{\text{SiO}_2, \text{in}})(1) = (n_{\text{SiO}_2, \text{out}})(1) + (n_{\text{H}_2\text{SiF}_6, \text{out}})(1) \quad \text{so} \quad n_{\text{H}_2\text{SiF}_6, \text{out}} = \left(\frac{40 \text{ kg SiO}_2}{60 \frac{\text{kg}}{\text{kg mol}}} \right) - 0.0333 \text{ kgmol SiO}_2 = 0.6333 \text{ kgmol}$$

F balance

$$(n_{\text{CaF}_2, \text{in}})(2) = (n_{\text{CaF}_2, \text{out}})(2) + (n_{\text{HF}, \text{out}})(1) + (n_{\text{H}_2\text{SiF}_6, \text{out}})(6) \quad \text{so} \quad n_{\text{HF}, \text{out}} = (12.3)(2) - (0.6154)(2) - (0.633)(6) = 19.6 \text{ kgmol}$$

S balance

$$(n_{\text{H}_2\text{SO}_4,\text{in}})(1) = (n_{\text{H}_2\text{SO}_4,\text{out}})(1) + (n_{\text{CaSO}_4,\text{out}})(1) \quad \text{so} \quad n_{\text{H}_2\text{SO}_4,\text{out}} = (14.15)(1) - (11.692)(1) = 2.5 \text{ kgmol}$$

H balance

$$(n_{\text{H}_2\text{SO}_4,\text{in}})(2) + (n_{\text{H}_2\text{O},\text{in}})(2) = (n_{\text{H}_2\text{SO}_4,\text{out}})(2) + (n_{\text{H}_2\text{O},\text{out}})(2) + (n_{\text{HF},\text{out}})(1) + (n_{\text{H}_2\text{SiF}_6,\text{out}})(2)$$

$$\text{So} \quad n_{\text{H}_2\text{O},\text{out}} = 0.5 * [(14.15)(2) + (5.8)(2) - (2.5)(2) - (19.6)(1) - (0.6333)(2)] = 7.07 \text{ kg mol}$$