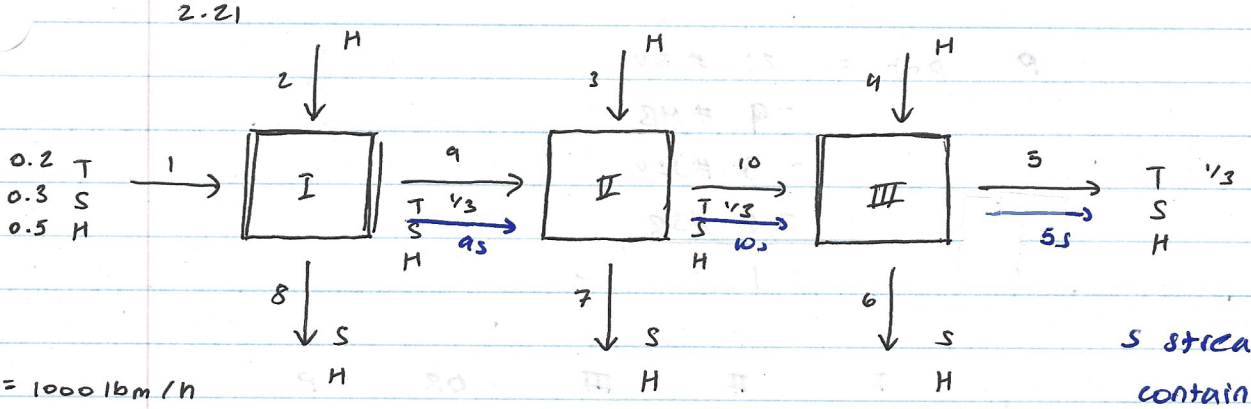
2.21




$F' = 1000$ lbm/h

S streams only contain S and H

(SR1) $m_s^8 = 0.80\, m_s^1$

$(m_s^9 = 0.20\, m_s^1)$

(SR2) $m_s^7 = 0.80\, m_s^9$

$(m_s^{10} = 0.20\, m_s^9 = 0.20^2\, m_s^1)$

(SR3) $m_s^6 = 0.80\, m_s^{10}$

$(m_s^5 = 0.20\, m_s^{10} = 0.20^3\, m_s^1)$

(SR4) $\omega_s^{9s} = \omega_s^8$

(SR5) $\omega_s^{10s} = \omega_s^7$

(SR6) $\omega_s^{5s} = \omega_s^6$

mechanical separation

DOF (not including basis)

I DOF = 9 #SV
- 3 #MB
- 3 #SSV
- 2 #SR (SR1 SR4)
= 1

II DOF = 9 #SV
- 3 #MB
- 2 #SSV
- 2 #SR (SR2 SR5)
= 2

III DOF = 9 #SV
- 3 #MB
- 2 #SSV
- 2 #SR (SR3 SR6)
= 2

OR DOF = 15 #SV
- 3 #MB
- 3 #SSV
- 3 #SR (SR1 SR2 SR3)
= 6

P  pof = 21 # SV
- 9 # MB
- 5 # SSV
- 6 # SR
1

| | I | II | III | OB | P |
|---|---|---|---|---|---|
| SV | 9 | 9 | 9 | 15 | 21 |
| MB | -3 | -3 | -3 | -3 | -9 |
| SSV | -3 | -2 | -2 | -3 | -5 |
| SR | -2 | -2 | -2 | -3 | -6 |
| | 1 | 2 | 2 | 6 | 1 |
| | -1 (basis) | | | | -1 (basis) |
| | 0 | | | | 0 |

→ well specified!

Unit I ($F' = 1000$ lbm/h)

(T) $0.2F' = \frac{1}{3} F^9$

$F^9 = 600$ lbm/h

(S) $0.3F' = m_S^8 + m_S^9$

$m_S' = 0.80 m_S' + m_S^9$ (SR 7)

$300 = 0.80 \cdot 300 + m_S^9$

$m_S^9 = 60 = \omega_S^9 F^{9S}$ ($F^{9S} = F^9 - m_T^9$)

$m_S^8 = 240$

$= \omega_S^8 F^8$ ← $\omega_S^9 = 0.15 = \omega_S^8$ (SR 4)

$F^8 = 1600$ lbm/h $\omega_H^9 = 0.85 = \omega_H^8$

(Total) $F^1 + F^2 = F^8 + F^9$

$F^2 = 1200$ lbm/h

Unit II

(T) $\frac{1}{3} F^9 = \frac{1}{3} F^{10}$

$F^9 = F^{10} = 600$ lbm/h

(S) $m_s^{10} = 0.20 m_s^9$ (SR 2)

$= 12 = w_s^{10} F^{10S}$ $(F^{10S} \equiv F^{10} - m_T^{10})$

$w_s^{10} = 0.03 = w_s^7$ (SR 5)

$m_s^9 = w_s^7 F^7 + w_s^{10} F^{10S}$

$m_s^9 = w_s^7 (F^7 + F^{10S})$ (SR 5)

$F^7 = 1600$ lbm/h

(Total) $F^3 + F^9 = F^7 + F^{10}$

$F^3 = 1600$ lbm/h

Unit III

(T) $F^5 = F^{10} = 600$ lbm/h

(S) $m_s^6 = 0.80 m_s^{10}$ (SR 3)

$= 9.6 = w_s^6 F^6$

$$M_S^{5} = 0.20\, M_S^{10}$$

$$= 2.4 = w_S^{5} F^{55} \quad (F^{55} = F^{5} - M_T^{5} = F^{10})$$

$$w_S^{5} = 0.006 = w_S^{6} \quad (5 \& 6)$$

$$\rightarrow \quad F^{6} = 1600 \text{ lbm/h}$$

$$\text{(Total)} \quad F^{4} + F^{10} = F^{6} + F^{5}$$

$$F^{4} = 1600 \text{ lbm/h}$$

∴ the wash water rates are

$$F^{2} = 1200 \text{ lbm/h}$$

$$F^{3} = 1600 \text{ lbm/h}$$

$$F^{4} = 1600 \text{ lbm/h}$$