Mid-Term Test

Evaporation and Proc. cooling.

EVAPORATION

PART 2.

Q 13 NaCl. The blue line is drawn through the NaCl marker

Q 14 BPE = 6.7°C

BPE from Duhring Chart is 12°F. (red line).

Convert 12°F to °C. $\frac{5}{9} \times \Delta °F = \Delta °C$

$\frac{5}{9} \times 12 = 6.7°C$.

Q 15 Solution temperature is 106.7°C.

Blue line shows solution temperature is 224°F. Convert this to °C.

$°C = \frac{5}{9}(°F - 32) = \frac{5}{9}(224 - 32)$

$= 106.7°C$.

Q 16 Solution concentration is 24 wt%.

Red line cuts concentration indicator at 24 wt%.

PART 3

Q 17 (a) The flowrate of the concentrate m_L is 0.03 kg/s

$m_F x_F = m_L x_L$

rearrange and substitute.

$$m_L = \frac{m_F x_F}{x_L} = \frac{0.2 \times 0.04}{0.267} = 0.03 \text{ kg/s}$$

Q 17 (b) The vapour flowrate, m_V, is 0.17 kg/s.

$m_F = m_V + m_L$

$0.2 = m_V + 0.03$

$m_V = 0.17$ kg/s.

Q 18 Calculate the total energy, Φ.

$$\eta = \frac{m_V h_{fg\,vap}}{\Phi}$$

$m_V = 0.185$
$\eta = 0.95$
$\theta_{sat} = 109.3°C$.

At 109.3°C (Sat) $h_{fg} = 2232$ kJ/kg.

$$\Phi = \frac{0.185 \times 2232}{0.95} = \underline{434.65 \text{ kW}}$$

Q19. The temperature of the steam supplied is 116.9°C.

Rate of heat transfer is 420 kW

$U = 1974\ W/m^2\,°C = 1.974\ kW/m^2\,°C.$

$\theta_1 = 109.3°C.$ $\qquad A = 28\ m^2$

$\phi = UA(\theta_s - \theta_1)$

$420 = 1974 \times 28\,(\theta_s - \theta_1)$

Rearrange: $\underline{\theta_s = 116.9°C}$

Q20 The specific enthalpy of the steam ~~as~~, h_g, is 2683 kJ/kg.

Steam pressure 20 kPa gauge = 120 kPa abs.

$= 0.120$ MPa

From steam tables, $h_g = 2683$ kJ/kg.

PART 4

Q 21 The temperature of the boiling liquid and vapour in the second effect, θ_2 is 85°C.

$$\theta_1 - \theta_2 = \frac{\frac{1}{U_2}}{\frac{1}{U_1} + \frac{1}{U_2} + \frac{1}{U_3}} (\theta_s - \theta_3)$$

$$(100 - \theta_2) = \frac{\frac{1}{850}}{\frac{1}{975} + \frac{1}{850} + \frac{1}{800}} (113.1 - 69)$$

Rearrange: $\underline{\theta_2 = 85 \ °C}$