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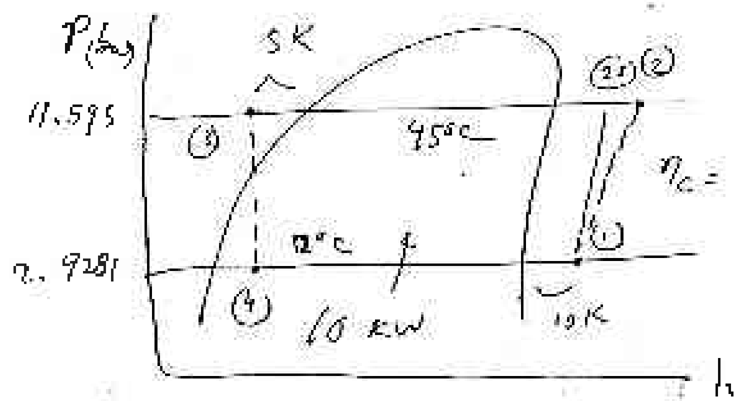
(2008-2009-01)
sme 1/33

(1)



$\eta_c = 90\% = \frac{h_{2s} - h_1}{h_2 - h_1}$

← diagram 2

2.9281 bar

$h_1 = 407.40 \frac{kJ}{kg}$ ✓ ; $s_1 = 1.7587 \frac{kJ}{kg K}$ ✓ 1

$h_{2s} = 433.06 + \left(\frac{1.7587 - 1.7449}{1.7781 - 1.7449}\right)(444.13 - 433.06)$

$= 437.66$ ✓ 3

$\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1} \rightarrow h_2 = h_1 + \frac{h_{2s} - h_1}{\eta_c}$

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$= 407.40 + \frac{437.66 - 407.40}{0.90}$

$= 441.02$ ✓ 3

$t_{sat,cond} = 45°C$; $t_3 = 45 - 5 = 40°C$

$h_3 = h_{f, 40°C}$ ✓ 1

$= 256.38 \; kJ/kg$ ✓ 2

$h_4 = h_3 = 256.38 \; \frac{kJ}{kg}$ ✓ 1

(i) $q_{ref} = h_1 - h_4 = 407.40 - 256.38 = 151.02 \; \frac{kJ}{kg}$ ✓ 2

(ii) $\dot{m}_{ref} = \frac{\dot{Q}_{41}}{q_{41}} = \frac{10}{151.02} = 0.0662 \; \frac{kg}{s}$ ✓ 2

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(iii) $\dot{W}_{12} = \dot{m}_{ref}(h_2 - h_1)$
$= 0.0662(441.02 - 407.40) = 2.226 \; kW$ ✓ 2

(iv) $\dot{Q}_{23} = \dot{Q}_{condenser} = \dot{Q}_{41} + \dot{W}_{12}$
$= 10 + 2.226$
$= 12.226 \; kW$ ✓ 2

(v) $COP = \frac{\dot{Q}_{41}}{\dot{W}_{12}} = \frac{10}{2.226} = 4.492$ ✓ 2 given:

(2) $t = 30°C$

$t_{wb} = 25°C$

$p = 101$ KPa

4 (i) $P_v' = 3.1698$ KPa @ $t_{wb} = 25°C$ — 2

$\therefore P_v = 3.1698 - 0.000666\,(101)\,(30 - 25)$ 1

$= 2.8335$ KPa

3 (ii) $P = P_a + P_v \rightarrow P_a = P - P_v$ 2

$= 101 - 2.8335$ 1

$= 98.167$ KPa

4 (iii) $\phi = \frac{P_v}{P_{s,tdb}}$; 30°C $\rightarrow P_{s,tdb} = 4.2469$ KPa 1 2

$= \frac{2.8335}{4.2469} = 0.6672$ @ 66.72 % 1

4 (iv) $w = 0.622 \frac{P_v}{P - P_v}$ 2

$= 0.622 \left(\frac{2.8335}{98.167}\right) = 0.02886$ 0.01795 2

4 (v) $v = \frac{RT}{P_a} = \frac{0.287\,(30+273)}{98.167}$ 2 2

$= 0.8858$ $\frac{m^3}{kg}$

3 (vi) $h = c_p t + w\,(h_{fg_{0°C}} + c_v t)$ 2 1

$= 1.005 \times 30 + 0.01795\,(2501 + 1.83 \times 30)$

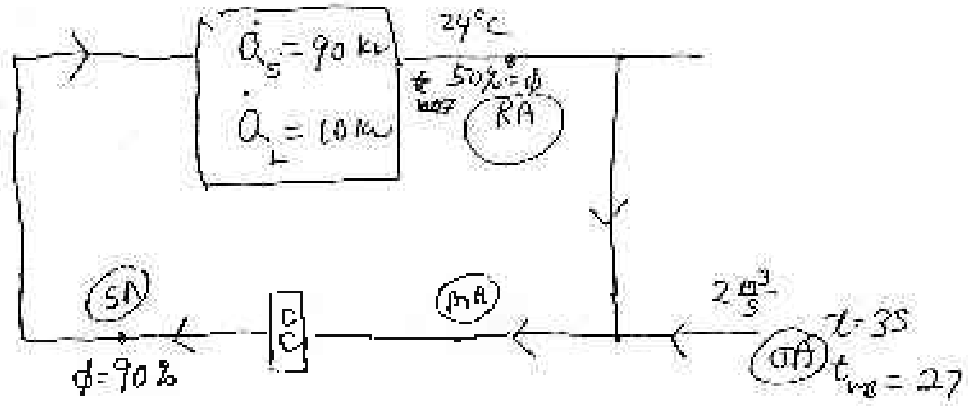
$= 76.02$ $\frac{KJ}{kg}$

3 (vii) t_{dew} = saturation temperature at $P_v = 2.8335$ KPa

$t_{dp} = 20 + \left(\frac{2.8335 - 2.3392}{3.1698 - 2.3392}\right)(25 - 20)$ 3

$= 22.98°C$ KOK.

(3)



5 (i) from chart, $v_{OA} = 0.90\ \frac{m^3}{kg}$ ⟶ 2

$$\dot{m}_{OA} = \frac{\dot{V}_{OA}}{v_{OA}} = \frac{2}{0.90} = 2.222\ kg/s$$ ⟶ 3

5 (ii) $$SHF = \frac{\dot{Q}_S}{\dot{Q}_S + \dot{Q}_L} = \frac{90}{100} = 0.90$$ ⟶ 3.

from chart at intersection of SHF line and $\phi = 90\%$ RH curve :

$t_{SA} \approx 13.5°C$ ⟶ 2.

5 (iii) $$\dot{m}_{SA} = \frac{\dot{Q}_S}{c_{pm}(t_{RA} - t_{SA})} = \frac{90}{1.02(24 - 13.5)}$$ eqn 3. 2

$= 8.403\ \frac{kg}{s}$ ⟶ ans

5 (iv) $$\alpha = \frac{\dot{m}_{OA}}{\dot{m}_{SA}} = \frac{2.222}{8.403}$$

$= 0.264 \times 70$ mm $= 18.5$ mm ⟶ 3

From chart, $t_{MA} \approx 27°C$ ⟶ 2

2 (v) $\phi_{MA} \approx 54\%$ ⟶ 2

3 (vi) $$\dot{Q}_{coil,total} = \dot{m}_{SA}(h_{coil,in} - h_{coil,out})$$

$= 8.403(58 - 36)$

$= 184.866$ kW ⟶ 3

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(4) i) section (A) $\bar{V}_A = 7$ m/s , $Q_A = 800$ L/s ✓ (2)

from chart : $\Delta P \approx 1.5$ Pa/m [redacted] ✓

$D_A = \sqrt{\frac{4}{\pi} \cdot \frac{Q}{V}}$

$= \left(\frac{4 \times 0.8}{\pi \times 7}\right) = 0.381$ m [redacted] ✓ (1)

(2)

section (B) $Q_B = 600$ L/s ; $\Delta P = 1.5$ ✓

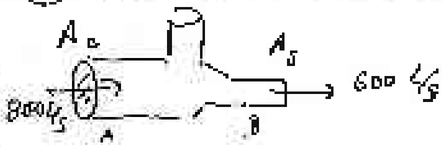
from chart : $\bar{V}_B = (6.5)$ m/s ✓ (1) $D_B = \sqrt{\frac{4 \times 0.6}{\pi \times 6.5}} \approx 0.343$ m [redacted]

(2)

section (C) $Q_C = 500$ L/s , $\Delta P = 1.5$ ✓

9 from chart ; $\bar{V}_C = (6.3)$ m/s ✓ (1) $D_C = \sqrt{\frac{4 \times 0.5}{\pi \times 6.3}} = 0.318$ m [redacted]

(ii) Fitting losses : (A—B)



2

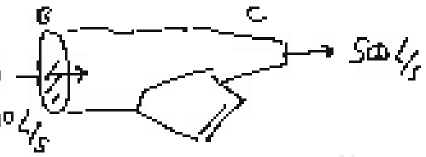
1 ✓ $\frac{A_S}{A_C} = \left(\frac{D_B}{D_A}\right)^2 = \left(\frac{0.343}{0.381}\right)^2 \approx 0.8$ [redacted] } $C_S = 0.13$ ✓ [redacted]

1 ✓ $\frac{Q_S}{Q_C} = \frac{Q_B}{Q_A} = \frac{600}{800} = 0.75$ [redacted]

Fitting loss (A–B) $= C_S \frac{1}{2} \rho \bar{V}_B^2$ [redacted] $= \frac{0.13}{2}(1.20)\, 6.5^2$ ✓ 2 1

$= 3.296$ Pa [redacted]

16 Fitting (B—C)



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1 ✓ $\frac{A_C}{A_B} = \left(\frac{D_C}{D_B}\right)^2 = \left(\frac{0.318}{0.343}\right)^2 = 0.86$ } [redacted] $C_S \approx 0.135$ [redacted] ✓

1 ✓ $\frac{Q_C}{Q_B} = \frac{500}{600} \approx 0.83 \approx 0.8$ [redacted]

$\therefore$ Fitting loss (B–C) $= C_S \frac{1}{2} \rho \bar{V}_C^2 = \frac{0.135}{2}(1.20)\, 6.3^2$ ✓ 2 2 1

[redacted] $= 3.215$ Pa [redacted]

[redacted]

Total pressure loss $= \Delta P (\Sigma L) + \Sigma$ Fitting loss [redacted]

$= \left(1.5 \frac{Pa}{m}\right)(35\,m) + 3.296 + 3.215$ ✓

$= 59.011$ Pa

2