Q6

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Mechanical Engineering Department

MEE 4571 Advanced Thermodynamics

Quiz 6

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1- Air is cooled and dehumidified as it flows over the coils of refrigeration system at 100 kPa from 40 ˚C and relative humidity of 70% to 20 ˚C and relative humidity of 90%. The mass flow rate of dry air is 0.4 kg/s. Using the formula and not the Psychrometric chart, determine a) the mass flow rate of water, b) the heat removal from the air.

$\phi_1 = 0.7$
$\phi_2 = 0.9$
$\dot{m}_a = 0.4$ kg/s
$P = 100$ kPa

@ $T_1 = 40^\circ C \longrightarrow$ A2 $\rightarrow h_g = 2574.3$ KJ/kg, $P_{sat} = 7.384$ KPa

@ $T_2 = 20^\circ C \longrightarrow h_g = 2538.1$ KJ/kg, $P_{sat} = 2.339$ KPa

$$P_{v_1} = \phi_1 P_{SAT_1} = (0.7)(7.384) = 5.19 \text{ KPa}$$

$$P_{v_2} = \phi_2 P_{SAT_2} = (0.9)(2.339) = 2.10 \text{ KPa}$$

$$\omega_1 = 0.622 - \frac{P_{v_1}}{P - P_{v_1}} = \frac{5.19}{100 - 5.19} = 0.0340$$

$$\omega_2 = 0.622 - \frac{P_{v_2}}{P - P_2} = \frac{2.10}{100 - 2.10} = 0.0133$$

$$\dot{m}_v = \dot{m}_a (\omega_1 - \omega_2) = 0.4(0.034 - 0.0133) = 0.0083 \text{ kg/s}$$

$$\dot{Q} = \dot{m}_a (h_1 - h_2) + \dot{m}_v h_v$$

$$h_1 = c_p T_1 + \omega_1 h_{g_1} = (1.005)(40) + (0.034)(2574.3) = 127.7 \text{ KJ/kg}$$

$$h_2 = c_p T_2 + \omega_2 h_{g_2} = (1.005)(20) + (0.0133)(2538.1) = 53.86 \text{ KJ/kg}$$

$$\dot{Q} = 0.4(127.7 - 53.86) + 0.0083(125.71) = 30.58 \text{ W}$$