The University of Jordan
School of Engineering
Department of Mechanical Engineering

Second examination 22-07-2018
Prof. M. Hamdan One hour

Thermodynamics II

Q2. A refrigeration system uses R 134a as a working fluid, which leaves the evaporator as saturated vapor and leaves the condenser as saturated liquid. The evaporator and the condenser operate at -10 ^{0}C and 40 ^{0}C. If the enthalpy of the fluid as it leaves the compressor is 279kJ/kg, calculate the COP of the system and sketch the T-S diagram with state one as it the fluid enters the compressor.

sat vapor $T_1 = -10^\circ C$

sat liquid $T_3 = 40^\circ C$

$h_2 = 279$ kJ/kg

state 1

$h_1 = h_g @ -10^\circ C = 244.55$ kJ/kg

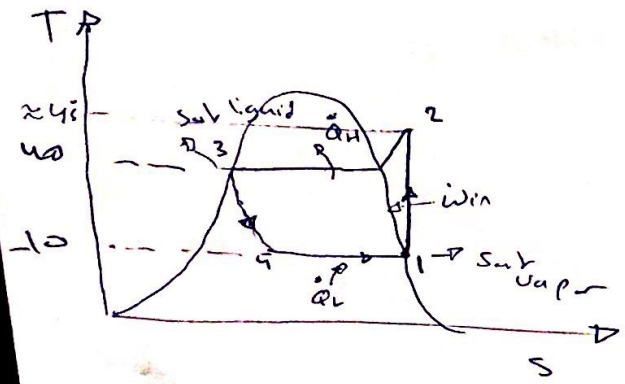
state 3

$h_3 = h_f @ 40^\circ C = 108.28$ kJ/kg

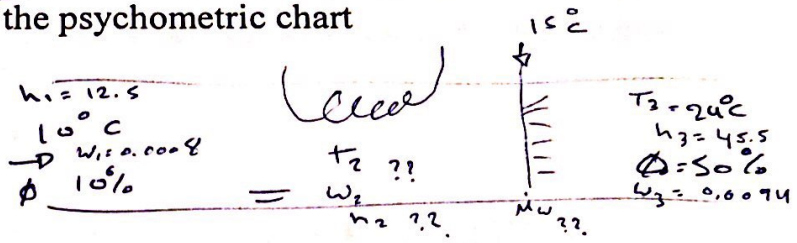
$h_4 = h_3$ isenthalpic throttling

$$COP_R = \frac{Q_L}{W_{in}} = \frac{h_4 - h_4}{h_2 - h_1}$$

$$= \frac{244.55 - 108.28}{279 - 244.55} = 3.955$$



Q2. Air enters humidifier-heater at 10 °C and 10% relative humidity, while it leaves at 24 °C and 50% relative humidity. If the mass flow rate of air is 0.75 kg/sec. and the water enters the humidifier at 15 °C, calculate the heat and mass of the water added to air. Also sketch the process on the psychometric chart



$\omega_2 = \omega_1$

$\omega_2 = \omega_1 = 0.0008$

$h_1 = 12.5$ kJ/kg dry air

$h_w = h_f$ @ 15°C

$\omega_3 = 0.0094$

$h_3 = 45.5$ kJ/kg dry air

$\dot{m}_f = \dot{m}_a(\omega_3 - \omega_2)$

$\dot{m}_f = 0.75(0.0094 - 0.0008) = 0.00645$ kg/s

$h_2 = h_3 - (\omega_3 - \omega_2)h_{f_2}$

$= 45.5 - (0.0094 - 0.0008)$ 62.98

$= 44.95$ kJ/kg dry air

$Q_{in} = \dot{m}_a(h_2 - h_1)$

$Q_{in} = 0.75(44.95 - 12.5)$

$= 24.34$ kJ/s

24.34 kW ≈ 24.4 kW

Process

Q3. A after a hard working day in Summer, you decided to have a canned cold drink from the refrigerator , which is maintained at 5 ^{0}C. If the refrigerator is located in space at 30 ^{0}C and a relative humidity 55%, will water condensates along the outside surface of the can. Show your work.

is $T_{dp} \overset{?}{=} 5^\circ C$??

$\phi = \frac{P_v}{P_g}$

$P_{g\,@\,30^\circ C\ sat} = 4.2469\ kPa$

$0.55 = \frac{P_v}{4.2469}$

$P_v = 2.3357\ kPa$

$T_{dp} = T_{sat\ @\ P_v}$

$T_{dp} = 20^\circ C$

since temp of surface less than dewpoint

water will condensate on surface (sweat)

$5^\circ C < 20^\circ C$

$T_{can} < T_{dp\ atmosphere}$ #