mae 439/539 Spring 2012 Quiz 1

$T_{db} = 45\,C, \quad T_{wb} = 35\,C, \quad p_{atm} = 80$

An air water vapor mixture is at 45 C dry bulb temperature, 35 C wet bulb temperature and an atmospheric pressure of 80 kPa. Calculate the 5 properties specific humidity, enthalpy, relative humidity, specific volume and dew point temperature for the mixture.

$p_v(T_{wb}) = 5.63\,kPa$

$h_l(T_{wb}) = 146.4\,kJ/kg$

$h_{fg}(T_{wb}) = 2564.4 - 146.6 = 2582.3$

$h_v(T_{db}) = 2582.3$

$$\omega_{wb} = \frac{18}{29}\frac{P_{wb}}{p_{atm} - p_{wb}} = .622 \times \frac{5.63}{80 - 5.63} = .047$$

$$\omega = \frac{\omega_{wb} \times h_{fg}(T_{wb}) - c_p \times (T_{db} - T_{wb})}{h_v(T_{db}) - h_l(T_{wb})} = \frac{.047 \times 2417.8 - 1.005 \times (45 - 35)}{2582.3 - 146.4}$$

$$\omega = \frac{113.61 - 10.05}{2435.9} = .04251\,kg\ water/kg\ dry\ air$$

$$h = c_p \times T_{db} + \omega \times h_v(T_{db}) = 1.005 \times 45 + .04251 \times 2582.3 = 155\,kJ/kg\ dry\ air$$

$$\omega = \frac{18}{29} \times \frac{p_v}{p_{atm} - p_v} = .04251$$

$p_v = 5.127$

$$\phi = \frac{p_v}{p_{sat}(T_{db})} = \frac{5.127}{9.59} = 53.47\,\%$$

$$v = \frac{R_a \times T}{p_a} = \frac{.287 \times (45 + 273.15)}{80 - 5.127} = 1.215\,m^3/kg\ dry\ air$$

$$v = \omega \times \frac{R_v \times T}{p_v} = .04251 \times \frac{.4619 \times (45 + 273.15)}{5.127} = 1.218\,m^3/kg\ dry\ air$$

$T_{dp} = T@p_g = p_v = 33\,C$

Grade	No
100	2
90	2
80	2
70	3
60	3
50	7
40	6
30	7
20	5
10	6

ave 47.2

mae 439/539 Spring 2012 Quiz2

What is the local solar time on August 21 at a north latitude of 35^{O} when the angle between a projection of the suns ray and a normal to a vertical South West facing surface is 10^{O} and the angle between the suns ray and this surface is 60.9^{O}.

$l = 35$

$ɔ = 10$

$ɗ_v = 60.9$

$ŭ = 12.3 August 21$

$\psi = 235$

$\cos ɗ_v = \cos ɓ \times \cos ɔ$

$\cos ɓ = \cos ɗ_v / \cos ɔ$

$\cos ɓ = \cos 60.9 / \cos 10$

$\cos ɓ = .4863/.9848 = .4938$

$\beta = 60.4$

$$\sin ɲ = \frac{\cos l \times \cos h \times \cos ŭ + \sin l \times \sin ŭ}{\cos ɓ}$$

$$\sin 60.4 = \frac{\cos 35 \times \cos h \times \cos 12.3 + \sin 35 \times \sin 12.3 \times}{\cos 60.4}$$

$\cosh = .9298$

$h = 21.6^{o}$

$hr = 21.6/15 = 1.22 \text{ hrs}, 1:26$

$LST = 13:26 \text{ pm}$

ALTERNATE

$360 - ɣ - \varphi = ŭ$

$\varphi = ?$

$$\cos ű = \frac{\sin ŭ \times \cos l - \cos ŭ \times \sin l \times \cos h}{\cos ɓ}$$

$\cosh =$

$h =$

$hrs = h/15$

$LST = 12 + hrs$

Grade	No
100	4
90	1
80	5
70	5
60	4
50	4
40	1
30	5
20	
10	2
0	4
Ave	58.8

mae 439/539 HVAC Spring 2012 Quiz 3

On May 21, at a location in the morning, β, the angle between the suns ray and the horizontal, is 57.62 ^{O} and ϕ, the angle between a projection of the sunôs ray and the North , is 118.69 ^{O}. At this time and location calculate for a horizontal surface the direct and diffuse radiation in Btu/hr ft^2 and calculate for a North facing surface inclined at 45 ^{O} to the horizontal the direct, diffuse and reflected radiation in Btu/hr ft^2. Assume a reflectivity of .2 and C_N =1.

May 21

$A = 350.6,\ B = .177,\quad C = .13$

$\gamma = |\gamma - \phi| = |0 - 118.89| = 118.89$

$\cos\theta_A = \cos\beta \times \cos\times\gamma \sin Z + \sin\beta \times \cos\alpha$

$\cos\theta_A = .5355\times -.483\times .707 + .8445\times .707$

$\cos\theta_A = .414$

$\theta_A = 65.63$

$\cos\theta_H = \sin\beta$

$\theta_H = 32.38$

$$G_{ND} = A/\exp\left(\frac{B}{\sin\beta}\right) = 350.6/\exp(.177/.8446)$$

$G_{ND} = 284.35\ \text{But/hr ft}^2$

$G_{DH} = C_N \times G_{ND} \times \cos\theta_H = 284.35\times .8445$

$G_{DH} = 240.1\ \text{But/hr ft}^2$

$G_{dH} = C_N \times C \times G_{ND} = 284.35\times .13$

$G_{dH} = 36.97$

$G_{DA} = C_N \times G_{ND} \times \cos\theta_A$

$G_{DA} = 284.35\times .4142 = 117.78\ \text{Btu/hr ft}^2$

$F_{ws} = (1+\cos Z)/2 = 1.707/2 = .8535$

$G_{dA} = C_N \times C \times G_{ND} \times F_{ws}$

$G_{dA} = .13\times 284.35\times .8535 = 31.55$

$F_{wg} = (1-\cos Z)/2 = .1465$

$G_{RA} = (G_{DH} + G_{dH}) \times \beta \times F_{wg}$

$G_{RA} = (240.1 + 36.97)\times .2\times .1465$

$G_{RA} = 8.11\ \text{Btu/hr ft}^2$

Grade	No
100	6
90	4
80	5
70	4
60	3
50	6
40	4
ave	71

mae 439/539 Spring 2012 Quiz 4

The pressure drop in a duct duct system has been measured at 1.5 in water at a flow rate of2000 cfm. If a fan with the following performance, which can be expressed by the equation, pressure drop=.8-(6.255x10^{-}6) x $Q^{1.5}$, is installed with this duct system what will be the flow rate ?

Q, cfm	100	300	500	700	900	1100	1300	1500	1700	1900
Pressure drop, in H2O	.794	.767	.730	.684	.631	.572	.507	.437	.362	.282

mae 439/539 Spring 2012 Quiz 4

The pressure drop in a duct duct system has been measured at 1.5 in water at a flow rate of2000 cfm. If a fan with the following performance, which can be expressed by the equation, pressure drop=.8-(6.255x10^{-}6) x $Q^{1.5}$, is installed with this duct system what will be the flow rate ?

Q, cfm	100	300	500	700	900	1100	1300	1500	1700	1900
Pressure drop, in H2O	.794	.767	.730	.684	.631	.572	.507	.437	.362	.282

$$\Delta p_{duct} = C \times Q^2$$

$$1.5\,\text{in H2O} = C \times 1200^2$$

$$C = 1.5/1200^2 = 3.75 \times 10^{-7}$$

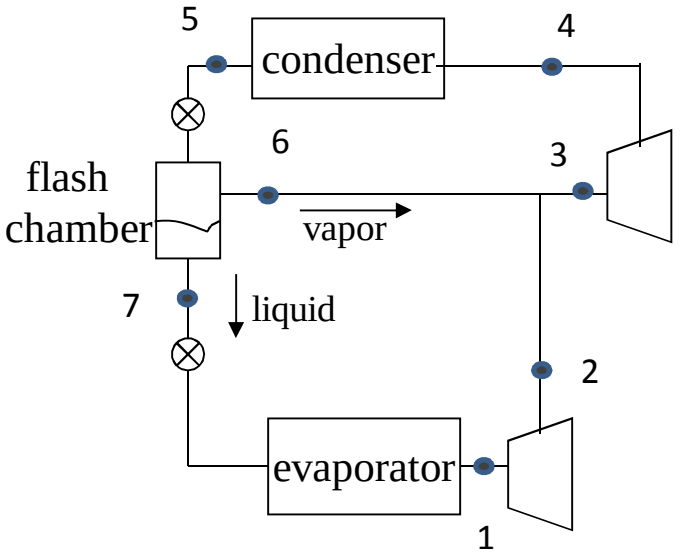
$$\Delta p_{duct} = 1.5 \times \left(\frac{Q_{duct}}{1200}\right)^2 = 3.75 \times 10^{-7} \times Q_{duct}^2$$

the system will operate where $Q_{fan} = Q_{duct}$ and $\Delta p_{fan} = \Delta p_{duct}$

Q	Δp_{duct}	Δp_{fan}
900	.304	.6311
1100	.454	.5718
1200	.54	.54
1300	.634	.5068

mae 439/539 Spring 2012 Quiz 5

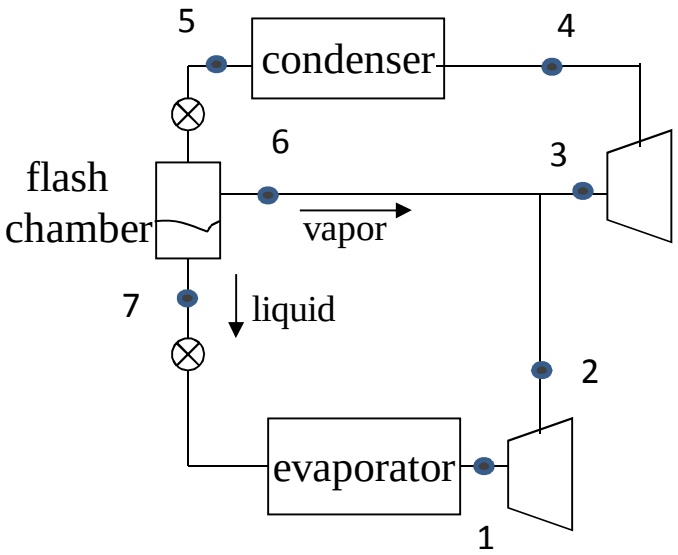
With the cycle shown operating at the tabulated conditions what is the HP/ton? Sketch a pressure enthalpy diagram for the cycle.

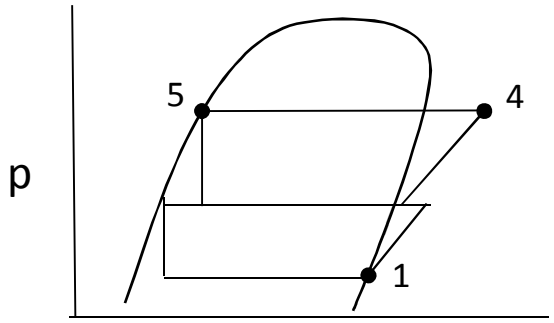


Pt	T,F	Quality	h,Btu/lb
1	40	1	
2			112.9
3			111.5
4			117.8
5	95	0	
6	60	1	
7		0	

mae 439/539 Spring 2012 Quiz 5

For the cycle shown operating at the tabulated conditions what is the HP/ton? Sketch a pressure enthalpy diagram for the cycle.





Pt	T,F	Quality	h,Btu/lb
1	40	1	108.71
2			112.9
3			111.5
4			117.8
5	95	0	43.179
6	60	1	111.38
7		0	31.239

Evaporator Energy Balnce

$mbottom = (200\,Btu/min/ton)/(h1 - h7)$

$mbottom = 200/(108.7 - 31.239) = 2.58\,lb/min/ton$

Flash Chamber Energy Balance

$mtop \times h_5 = (mtop - mbottom) \times h_6 + mbottom \times h7$

$mtop \times 43.179 = (mtop - 2.58) \times 111.376 + 2.58 \times 31.239$

$mtop \times 43.179 = mtop \times 111.376 - 287.35 + 80.6$

$206.75 = 68.197 mtop$

$mtop = 3.031\,lb/min/ton$

Compressor Energy Balance

$Wtop = mtop \times (h_4 - h_3) = 3.031 \times (117.8 - 111.5) = 19.1\,Btu/min/ton$

$Wbottom = mbottom \times (h_2 - h_1) = 2.58 \times (112.9 - 108.7) = 10.386\,Btu/min/ton$

$HP/Ton = (Wtop + Wtop)/42.41\,Btu/min/HP = .695\,Hp/ton$

Grade	No
70	6
60	2
50	3
40	4
30	7
20	2
10	7
Ave	41