Air-Conditioning & Refrigeration

BSc

Lecture 8

Course weekly Outline &

Ch.1 (Introduction to Air conditioning & Refrigeration)

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Example of Saturation efficiency

Q5- In an industrial application for winter air conditioning an air washer is used with heated water spray followed by a reheat . The room sensible heat factor may be taken as unity . The design conditions are :

Inside DBT =22 c , RH= 50% ,Outside DBT= 0.0 c and dry

Room heat loss = 703 kW

Ventilation air quantity = 1600 cmm

Supply air quantity = 2800 cmm

Spray water quantity = 500 kg/min

The air washer saturated efficiency is 90%

The make up water is available at 20 c ,

Calculate a) the supply conditions to the space

b) the entering and leaving conditions at the spray chamber

c) the entering and leaving spray water temperatures

d) the heat added to the spray water

e) the reheat if necessary .

Solution:

Find T_m = 9.43 c and plot the inside ,outside and mixing conditions on the chart

Plot SHR= 1.0 starting from the inside design conditions .

Calculate T_s using $Q_s = 1.22\ V_s (T_s - T_r)$, $T_s = 34.3$ c

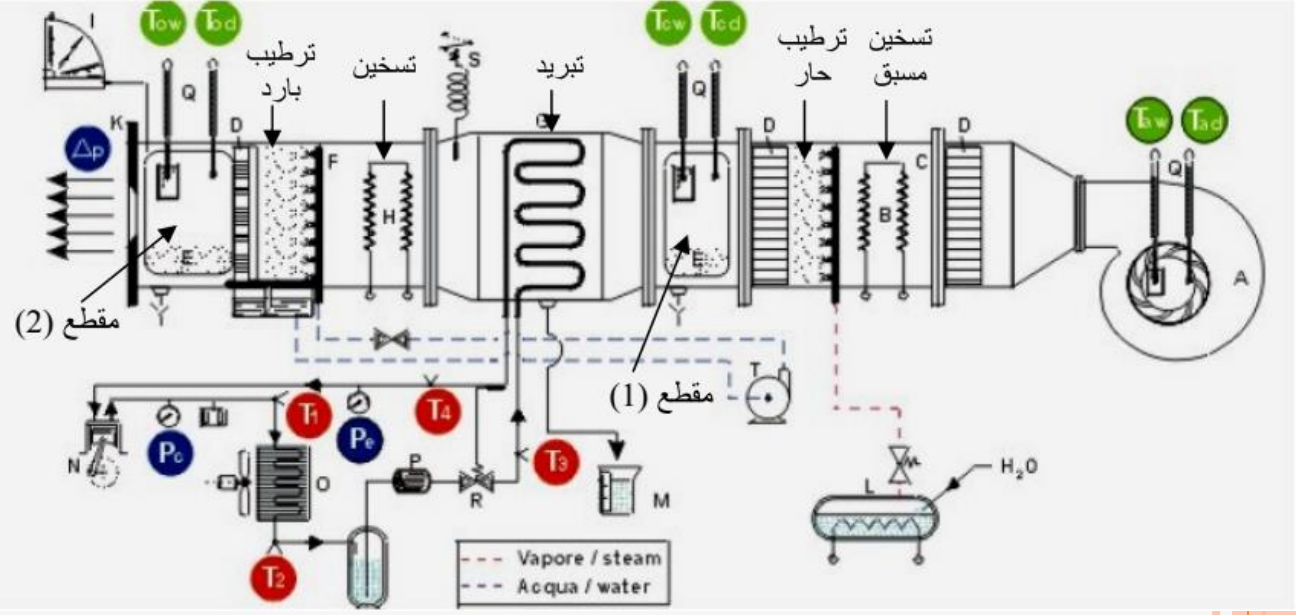
Plot T_s on the chart .

Saturation efficiency η

$\eta = (T_s - T_m) \setminus (T_{saturated} - T_m)$

or

$\eta = (g_s - g_m) \setminus (g_{saturated} - g_m)$



$\eta = (g_s - g_m) \setminus (g_{saturated} - g_m)$ Note that $g_s = g_1$ $g_{saturated}$ 8.72 g_{water} / $kg_{dry\ air}$

where the supply point (s) is the point between the mixing state and the saturation state that cut the SHR line say point (1) .

The location of point 1 on the chart gives the conditions of air entering air washer:

$T_1 = 11.6$ $WBT_1 = 11.5$ $h_1 = 33$ kJ/kg

At air washer the temperature of water may be assumed to be

$T_{water\ out} = WBT_1$

Use the heat balance in the air washer between air and water gives

$m_w\ cp_w\ \Delta T_w = m_a (h_1 - h_m)$ where $T_{water\ out} = 20\ ^oC$ and $cp_w = 4.18$ kJ/kg

$T_{water\ in} = 34.\ c$

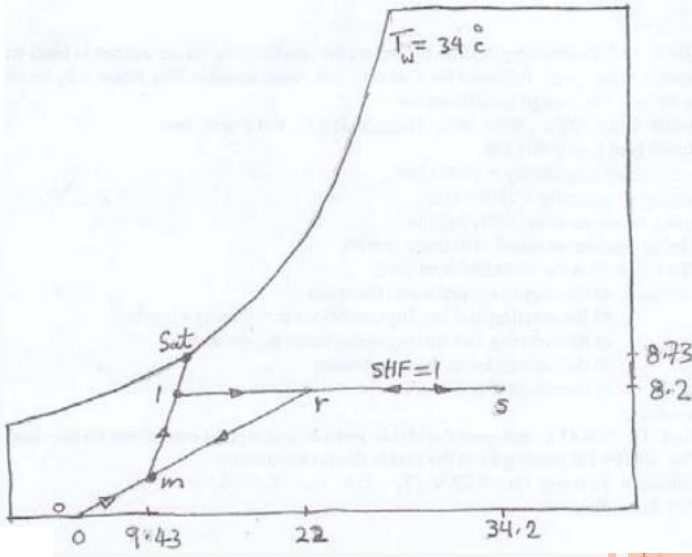
Make up water = $m_s (g_1 - g_m) = 0.25$ kg/s where $m_s = V_s * \rho$ of air = 47 *1.2

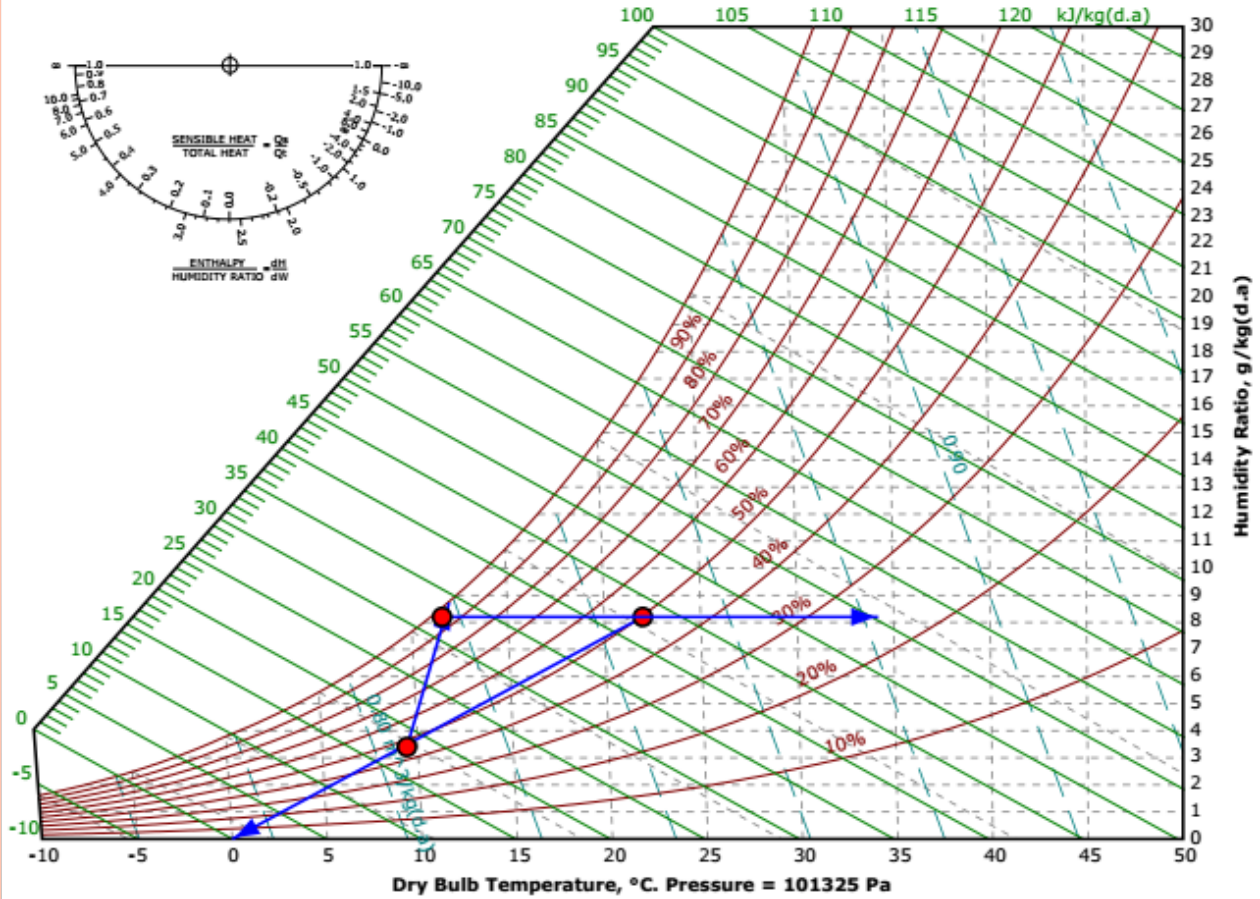
$$Q_{makeup} = m\ cp\ \Delta T_{makeup} \qquad \Delta T_{makeup} = 34 - 20$$

$$Q_{water} = m\ cp\ \Delta T_{water} \qquad \Delta T_{water} = 34 - 11.5$$

$$Q_{spray\ water} = Q_{makeup} + Q_{water}$$

$$Q_{rehet} = 1.22\ V_s\ (T_s - T_1) = 1290\ kw$$





Q4- The following data apply to an air conditioning systems :

Room sensible heat = 10 kW
Room latent heat =10 kW
The inside design conditions is DBT = 25 c , RH = 50 %
The outside design conditions is DBT = 35.0 , WBT = 27.8 c
The mixing ratio of room air to fresh air is 4: 1
The room air is mixed with the air after the cooling coil in the ratio of 1:4
The cooling bypass factor is 0.1
The air may be reheated if necessary before supplying to the room
The apparatus dew point temperature T_{ADP}= 10 c . Determine :

a) Supply air conditions
b) heat load due to reheat
c) coil capacity in Tones Refrigeration (TR)
d)the quantity of fresh air supplied
e)plot all the psychrometric processes.

Solution :
Find the first mixing point T_{m1}= 27. c
Find T_{s1} = 11.7 c from the BPF
Find the second mixing point T_{m2} = 14.4
Find SHF = 0.5
Find T_{s2} =21.8 c , you can see that this point need to be preheated .
Find V_s= 153.2 from Q_s= 1.22 V_s ($T_r - T_{s2}$)
Find the reheat load Q_{reheat} = 22.5 kW
and refrigeration load Q_{coil}= 64.7kW = 64.7/3.51 = TR