EXAMPLES: Wet scrubber

Unsaturated air entering a wet scrubber has: t_1 (dbt$_{emp}$)= 20°C; RH, relative humidity = 50% (v/v). Calculate: h_1, h_2 (sat.), $t_{wetbulb}$, x_1 , and x_2.
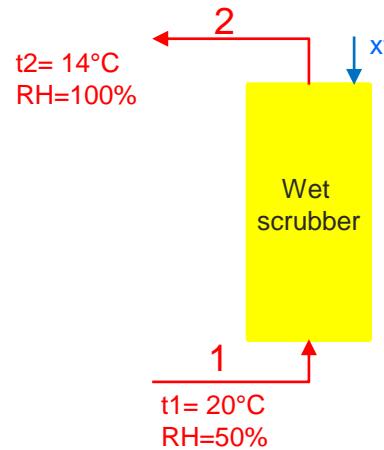

t2= 14°C
RH=100%

xf

Wet scrubber

2

1

t1= 20°C
RH=50%

ANSWERS:

h1=1.005 * t1 + x1(1.84 t1+2501)

t1=20°C

$x_1 = m_{H2O}/m_{dry\ air} = 18*p_{H2O}/29*(p-p_{H2O})$

Where:

- p_{H2O} = partial pressure of water vapor
- p = total gas pressure =1 atm= 98070 Pa

The partial preassure of water vapour can be estimated by the information of RH=100*($p_{H2O}/p_{v,H2O}$)

The $p_{v,H2O}$ at 20°C is tabulated and equal to 2265 Pa (<u>see next slide</u>), therefore p_{H2O} is equal to 1132 Pa.

x_1=(18*1132)/(29*(98070-1132))

x_1= 0,0073 kg $_{water\ vapor}$/kg $_{dry\ air}$

h_1= 38.7 kJ/kg; h_2= 38.7 kJ/kg;

t_{wb}= 13.72 ~ 14°C (from psychrometric calculator);

x_2=0.0098 kg$_{water\ vapor}$/kg$_{dry\ air}$

<u>H$_2$O abs for saturation</u>: 0.0098 – 0.0073= 2.5 g w /kg dry air

<u>ΔT air flow</u> = 14 – 20 = - 6°C

Water saturation pressure

Temperature	Water saturation pressure		
[°C]	[kPa], [100*bar]	[atm]	[psi]
0.01	0.61165	0.0060	0.088712
2	0.70599	0.0070	0.10240
4	0.81355	0.0080	0.11800
10	1.2282	0.0121	0.17814
14	1.5990	0.0158	0.23192
18	2.0647	0.0204	0.29946
20	2.3393	0.0231	0.33929
25	3.1699	0.0313	0.45976
30	4.2470	0.0419	0.61598
34	5.3251	0.0526	0.77234
40	7.3849	0.0729	1.0711
44	9.1124	0.0899	1.3216
50	12.352	0.122	1.7915
54	15.022	0.148	2.1788
60	19.946	0.197	2.8929
70	31.201	0.308	4.5253
80	47.414	0.468	6.8768
90	70.182	0.693	10.179
96	87.771	0.866	12.730
100	**101.42**	**1.001**	**14.710**
110	143.38	1.42	20.796
120	198.67	1.96	28.815
130	270.28	2.67	39.201
140	361.54	3.57	52.437
150	476.16	4.70	69.061
160	618.23	6.10	89.667
180	1002.8	9.90	145.44
200	1554.9	15.35	225.52

https://www.engineeringtoolbox.com/water-vapor-saturation-pressure-d_599.html

Psychrometric calculator

State 1

h1=h2

Enthalpy conservation

State 2

http://www.sugartech.co.za/psychro/index.php