Welcome

Vaisala Humidity 101 – Humidity Theory, Terms & Definitions
Part 1 of 3

Panelists: Bruce McDuffee, National Humidity Instructor
Yumi Shakya, Application Engineer

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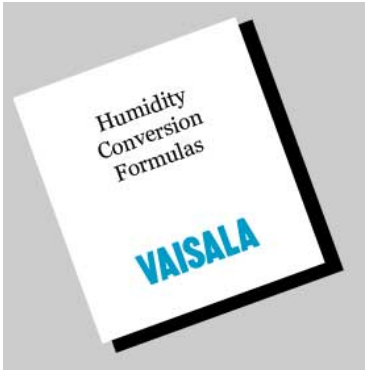
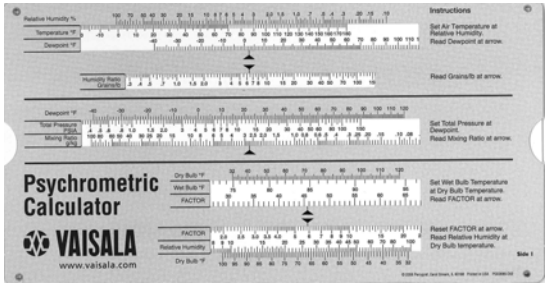
Agenda



1. Understand the basic theory of humidity
2. Dalton's Law
3. Vapor pressures
4. Relative humidity
5. At the end – give out some links to some great humidity resources



Humidity 101

\ webinar series

Humidity Theory, Terms & Definitions (Part 1 of 3)

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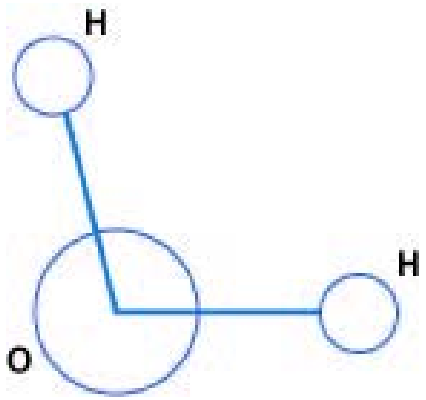
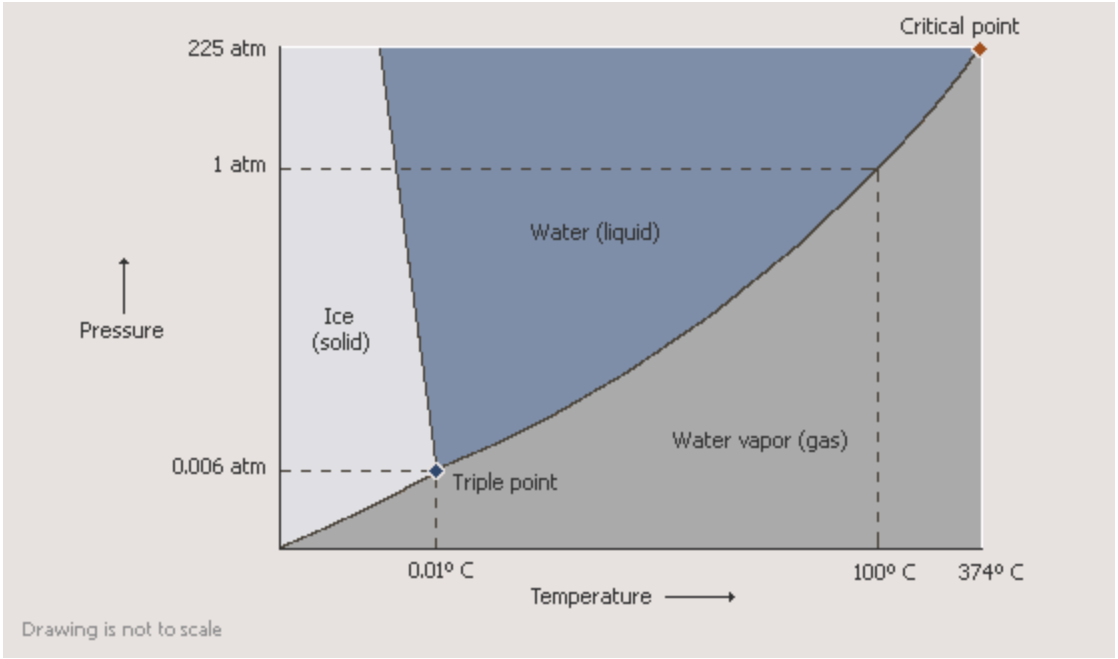
Water Vapor Theory - H_2O



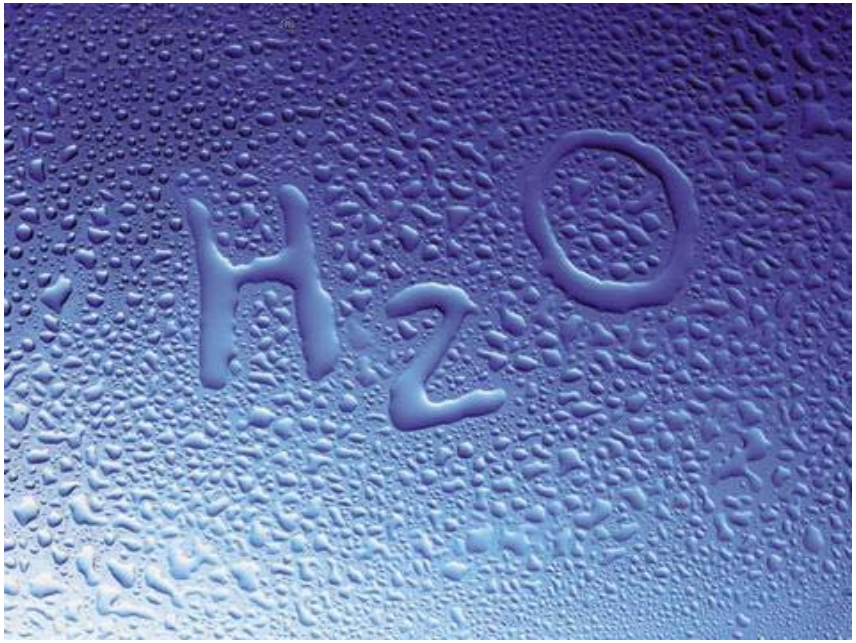


- Exists in the three phases
- Which phase depends on the amount of thermal energy that is present

American Meteorological Society Glossary Hu-mid-i-ty

Humidity

1. Generally, some measure of the water vapor content of air.



Dalton's Law

"*The total pressure of a gas is equal to the sum of the different gases' partial pressures*"

$$P_t = P_1 + P_2 + \ldots P_n$$

John Dalton

air around us

$$P_t = P_{N2} + P_{O2} + \mathbf{P_w} + P_{misc.}$$

Practical Example of Dalton's Law

Nitrogen.....	77%
Oxygen	21%
Water vapor	1%
Other gasses	1%

1000 mbar = 770mbar + 210mbar + 10mbar + 10mbar

In Denver

840 x 77% 840 x 21% 840 x 1% 840 x 1%

P_t = **840 mbar** **647** N2 + **177** O2 + **8** Pw + **8** Other

$$P_t = P_w + P_{dry}$$

Definitions

Psychrometry

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Partial Pressure of Water Vapor (psi,mbar,hPa,inhg…)

$$P_w$$

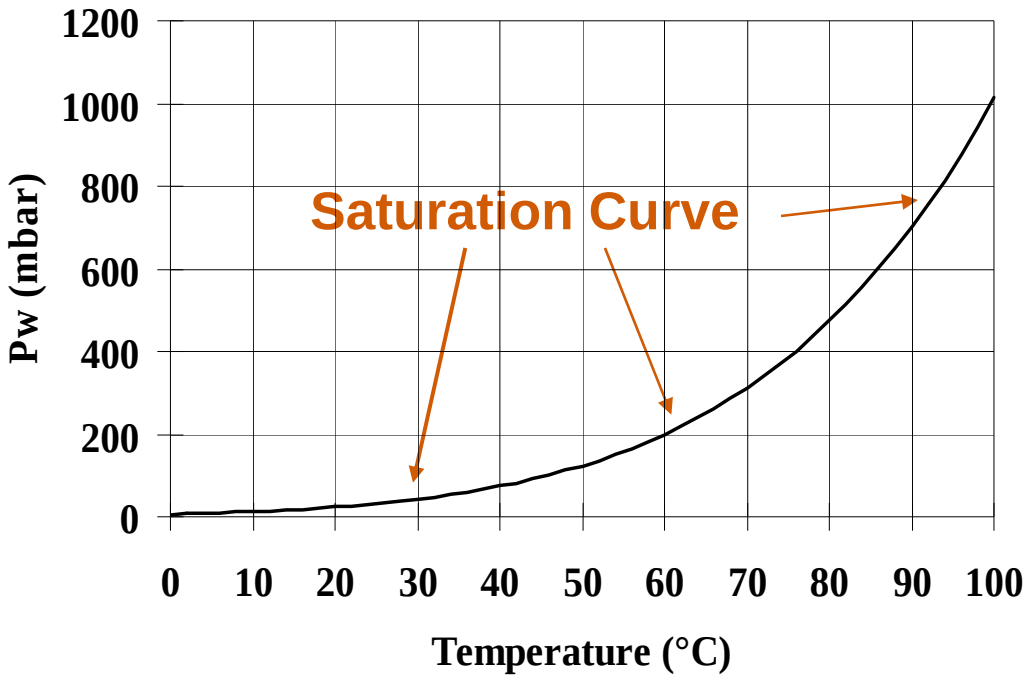
"The key parameter that affects all other humidity parameters"

Note: The only two properties that can affect a change in P_w

- adding or removing water vapor
- changes in system pressure

Saturation Vapor Pressure (psi,mbar,hPa,in hg…)

P_{ws}



On the saturation curve

- evaporation and condensation are in equilibrium and occur at the same rate
- $P_w = P_{ws}$
- dewpoint = temperature
- wet bulb = dry bulb
- RH = 100%

Note: The only property that affects P_{ws} is temperature

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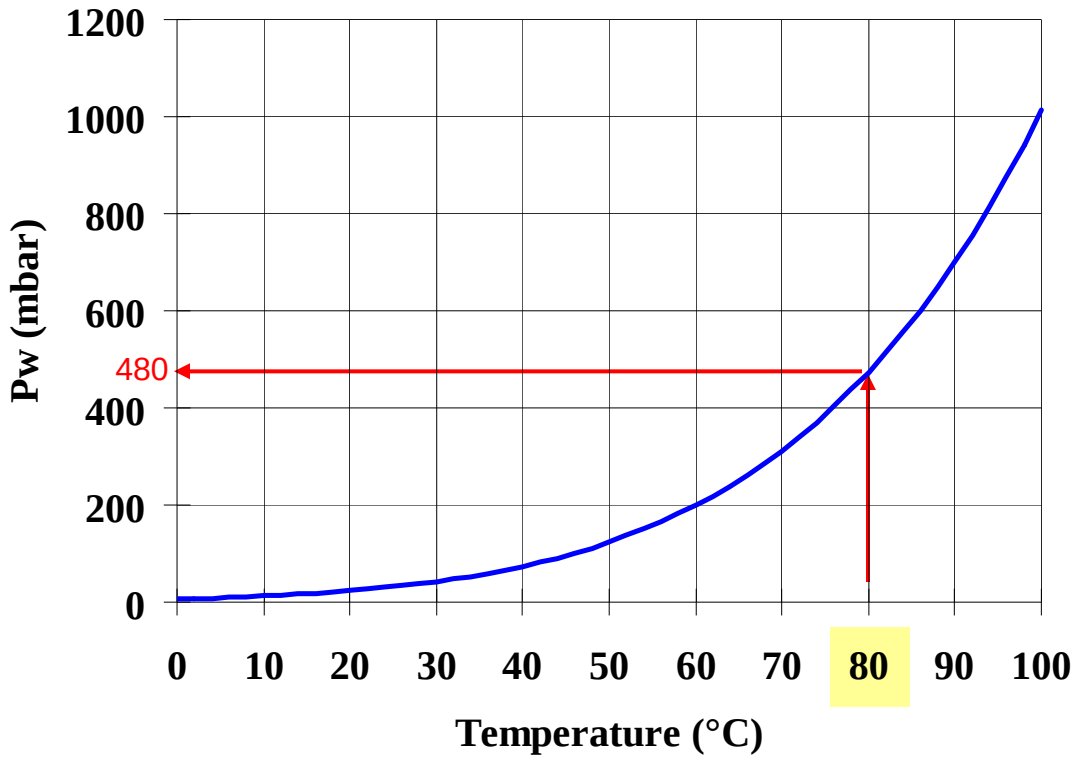
P_{ws} Saturation Vapor Pressure

P_{ws} - maximum vapor pressure or amount of water vapor that can exist at a given temperature. Expressed in units of pressure.

Pws = 480 mbar



Relative Humidity (%)

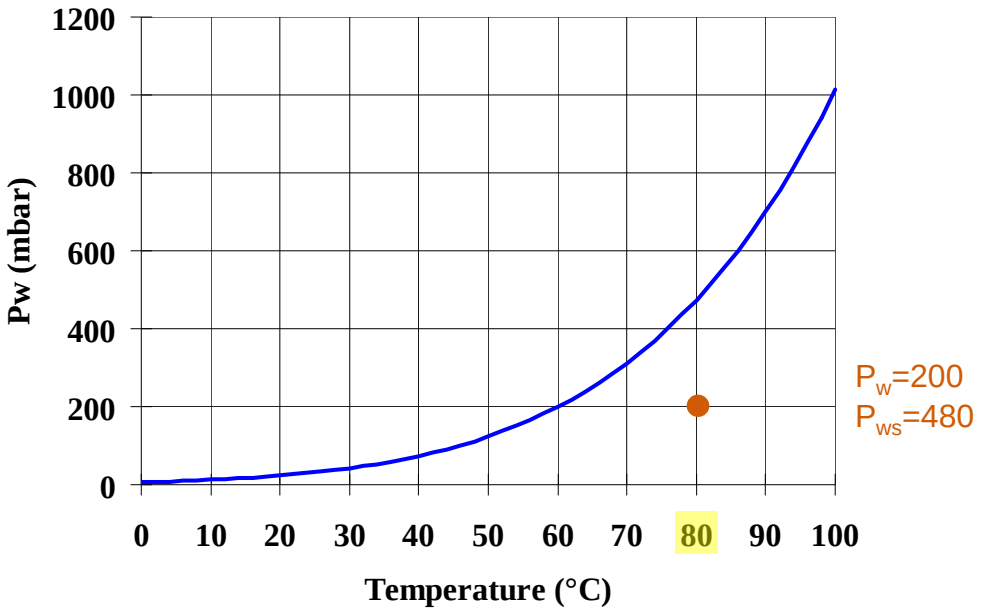
RH

Relative humidity is the ratio of water vapor partial pressure present in a gas (P_w) to the saturation vapor pressure of water at that temperature [$P_{ws}(t)$]

Relative humidity

$$\%RH = 100 \times \frac{P_w}{P_{ws}(t)}$$

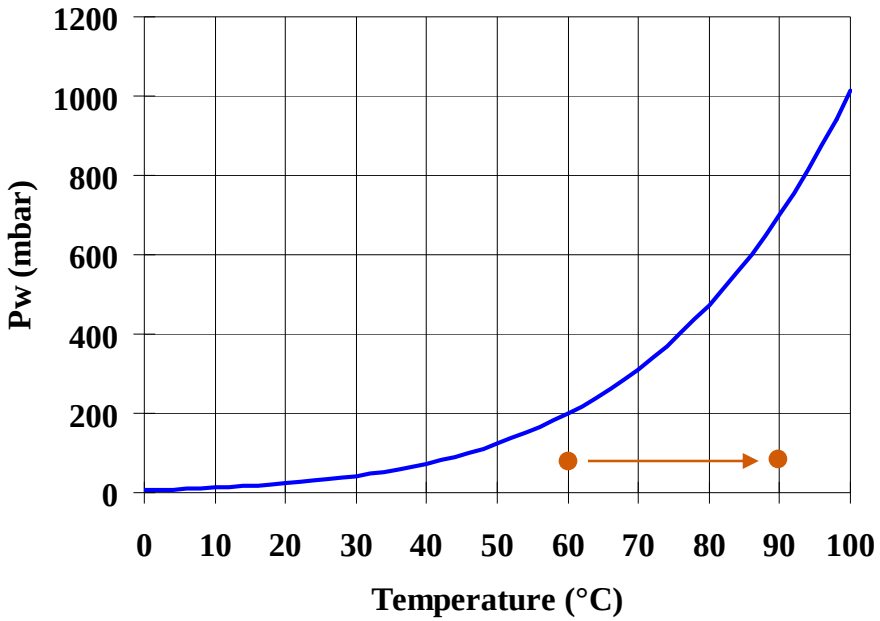
$$\%RH = 100 \times \frac{200}{480_{(t=80)}} = 42\%$$



Note: Relative humidity is strongly proportional to temperature and **its measurement is very sensitive to temperature differences.**

Temperature and Relative Humidity

$$\%RH = 100 \times P_w / P_{ws}(t)$$



Temperature and Relative Humidity

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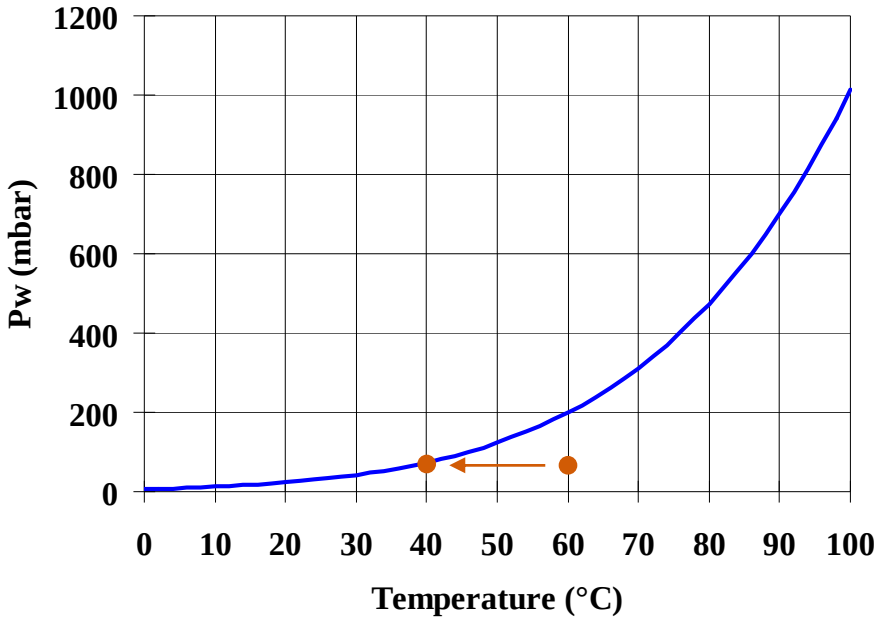

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Temperature and Relative Humidity – Rule of Thumb #1

Rule of Thumb #1*

-As temperature increases, air becomes drier (RH decreases)

-As temperature decreases, air becomes wetter (RH increases)

• drier and wetter are relative terms; applies to a closed system where pressure and water vapor content do not change

What about pressure and Relative Humidity?

Recall Dalton's Law of Partial Pressures $P_t = P_w + P_{dry}$

If double total pressure;

then $2(P_t) = 2(P_w + P_{dry}) = 2P_w + 2P_{dry}$

so P_w changes proportionately to overall pressure changes

remember that Pws remains unchanged because T is unchanged

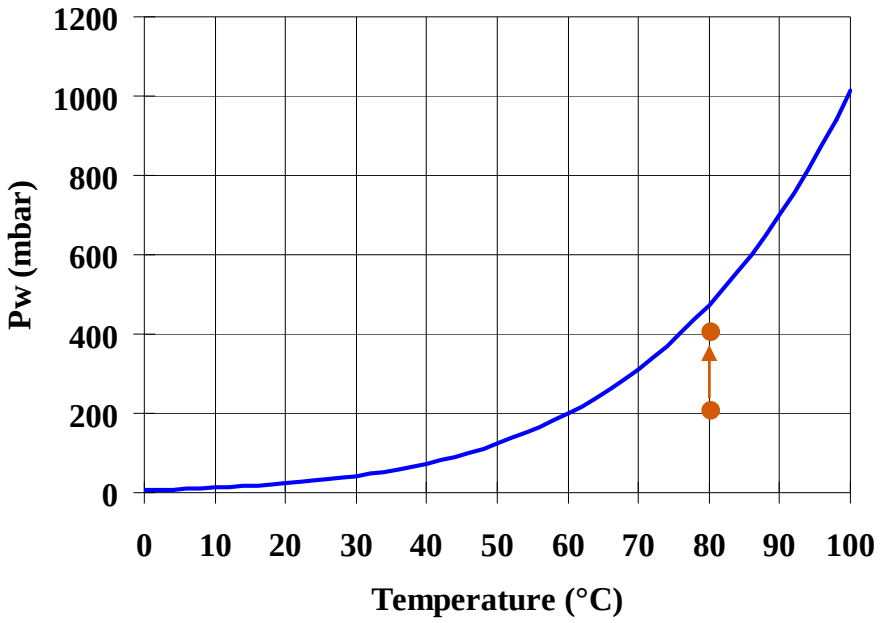
Pressure and Relative Humidity

P_t = 1000 mbar

We double the total pressure

so P_t = 2000 mbar

What happens to Pw? Pws?



Pressure and Relative Humidity – Rule of Thumb #2

Rule of Thumb #2*

-As pressure decreases, air becomes drier (RH goes down)

-As pressure increases, air becomes wetter (RH goes up)

* drier and wetter are relative terms; applies to a closed system where temperature and water vapor content do not change

Relative Humidity Application Example

Relative humidity is the common parameter in HVAC/DCV applications where comfort balanced with efficiency is the main concern.

Summary & Questions

1. Water vapor theory
2. Dalton’s law of partial pressures
3. Pw & Pws
4. RH = Pw/Pws
5. Temperature and RH – Rule of thumb
6. Pressure and RH – Rule of thumb

Vaisala GMP Humidity Resources

- On-line Humidity Calculator www.vaisala.com/humiditycalculator
- Slide Rule Calculator to order – http://forms.vaisala.com/forms/RequestSlideRule
- Psychrometric Chart - http://forms.vaisala.com/forms/RequestPsychChart
- Humidity Conversion Formulas - http://forms.vaisala.com/forms/humidity_conversion

For expert assistance with your humidity measurement

Email: instruments@vaisala.com

Direct telephone: 800-408-9454

Web: www.vaisala.com/instruments

Next Webinar – part 2 of 3

Thursday, April 14th, 10:00AM PDT

- Dewpoint & Frostpoint
- Humidity ratio or Mixing ratio
- ppm
- Absolute humidity
- Wet bulb temperature
- enthalpy

Everyone who registered for part 1will get the invitation for part 2 automatically.

You will receive a follow up email with all of the resource links & link to recording.

Thank you!
This concludes the webinar.

Follow-up email will arrive shortly with the resource links & further contact information.

Link to the recorded version.