A collection of short pointed topical papers.

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Cold W·A·R·

Whether it's Air Conditioning or Refrigeration

SERVICING KNOW-HOW

SPORLAN

PHASE II 71

A Psychrometrics Reminder

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A Psychrometrics Reminder

Here is information on Psychrometrics that should help remind the hvac/r tech what this subject is all about… with perhaps a few tidbits the tech may not have known!

Psychrometrics: the study of the physical and thermal properties of dry air and water vapor mixtures.

COMMON PSYCHROMETRIC TERMS

Degree of saturation (μ): See relative humidity.

Dew point temperature (t_{dp}): Temperature at which water vapor starts to condense in the air.

Dry air: Air devoid of water vapor and pollutants. Dry air has relative humidity of zero.

Dry bulb temperature (t_{db}): Actual temperature of the air, as observed using a thermometer or temperature sensor.

Enthalpy (h): Total useful energy content in the air. It is the sum of the enthalpies of the dry air and water vapor.

Humidity ratio (W): The ratio of the water vapor in the air to the dry air. This value is often multiplied by 7000 grains/lb and expressed simply as humidity in grains of moisture.

Relative humidity (RH): The ratio of the mole fraction of water vapor to the mole fraction of water vapor with saturated air. If you don't like the term "mole fraction", it is also the ratio of the partial pressure of the water vapor to the partial pressure of water vapor with saturated air. If you don't like the term "partial pressure", it simply refers to the fact that both water vapor and dry air exert a component pressure that sums up to the total air pressure. If you want to think of relative humidity as the ratio of water vapor in the air compared to the water vapor in saturated air, that's ok, but it is not technically correct. This value is actually the degree of saturation, which happens to be close to the value of relative humidity.

Saturated air: Air having a relative humidity (and degree of saturation) of 100 percent. At this condition, air is also at its dew point temperature. See the "Concerning Dry Air and Water Vapor Mixtures" section below.

Specific heat ratio (SHR): The ratio of the sensible heat load to the total heat load. Matched air conditioning systems typically have SHRs in the 68% to 80% range. Systems having a low SHR will remove more moisture from the air than systems having a high SHR. SHR can also be used to determine the required supply air temperature to maintain a room at desired conditions.

Specific volume (v): The volume occupied by a unit mass of dry air.

Psychrometer: A device used to measure relative humidity. It consisting of two thermometers, one that measures wet bulb temperature, and the other dry bulb temperature.

Psychrometric state: The state of an air sample. It is represented as a point on a psychrometric chart.

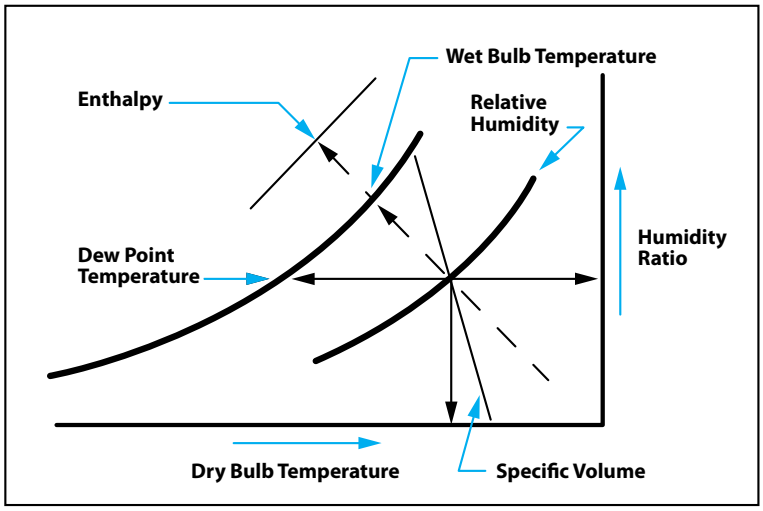
Standard air (for fan ratings): Air having a density of 0.075 lb/ft3 at 70°F and 14.696 psia (29.921 in. Hg) barometric pressure. Used to rate fans in standard cubic feet per minute (SCFM).

Standard atmosphere: Reference for estimating properties at various altitudes. It is air at 59°F and 14.696 psia (29.921 in. Hg) barometric pressure.

Wet bulb temperature (t_{wb}): Temperature of a wetted wick thermometer exposed to high velocity air. It is normally used with dry bulb temperature to determine relative humidity.

A Psychrometrics Reminder

ASHRAE Psychrometric Chart with selected terms listed



CONCERNING DRY AIR AND WATER VAPOR MIXTURES…

It is a misconception that water vapor is somehow held, absorbed, or dissolved in the air. Water vapor is only a resident in the air, somewhat like dust. Air acts as a "transporter" of water vapor. But unlike dust, atmospheric water constantly changes state, and it is a major regulator of air temperature.

The term "saturated air" is a bit of a misnomer as it suggests water vapor is absorbed or dissolved in the air. In this context, "saturation" simply refers to the state of water vapor, and that water vapor and dry air behave largely independent of each other.

COMMON PSYCHROMETRIC PROCESSES

Adiabatic mixing: Mixing of two or more air streams while maintaining constant enthalpy (no heat loss or gain).

Cooling and dehumidifying: Reducing both the dry bulb temperature and humidity ratio of the air.

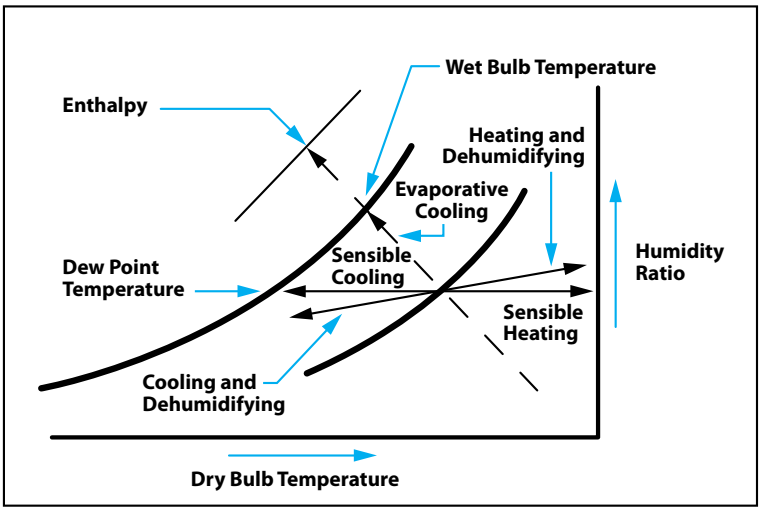
Evaporative cooling: Reducing the dry bulb temperature and increasing humidity ratio of the air while maintaining constant enthalpy (no heat loss or gain).

Heating and humidifying: Increasing both the dry bulb temperature and humidity ratio of the air.

Sensible cooling: Removing heat from the air without changing its humidity ratio.

Sensible heating: Adding heat to the air without changing its humidity ratio.

A Psychrometrics Reminder



USEFUL EQUATIONS

Sensible heat gain or loss may be calculated with the following equation:

$$Btu/h = 1.08 \cdot CFM \cdot \Delta t_{db}$$

where:
Btu/h = sensible heat gain or loss
CFM = air flow, ft^3/min
Δt_{db} = change in dry bulb temperature, °F

Total heat gain or loss may be calculated with the following equation:

$$Btu/h = 4.5 \cdot CFM \cdot \Delta h; \Delta h \approx \Delta t_{wb}$$

where:
Btu/h = total heat gain or loss
CFM = air flow, ft^3/min
Δh = change in enthalpy, Btu/lb. This value can be approximated by: Δt_{wb} = change in wet bulb temperature, °F

WHAT IS THE TYPICAL COMFORT ZONE FOR MOST OF US?

This is a complicated subject beyond the scope of this diatribe. But for those who wish to study this subject, consider reading ANSI/ASHRAE Standard 55-2004.

Listed below are general comfort zone temperature and relative humidity guidelines.

	Dry Bulb Temperature (°F)	Relative Humidity
Summer	73 - 77	30 to 70 percent
Winter	67 - 72	

WHICH IS DENSER, DRY AIR OR WATER VAPOR?

For those who think the correct answer is water vapor, consider where clouds can normally be found.