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| * **CMGT 235 – Electrical and Mechanical Systems** | | |
| **Discussion No. 3** | **Unit 1 - Mechanical Systems** | **Fall 2022** |

***Properties of Air-Water Mixtures***

**Definitions and Concepts**

* HVAC – Heating, Ventilation, and Air conditioning
* Psychrometrics –The behavior of mixtures of air and water vapor under varying conditions of heat
* Enthalpy = Total heat in the air = Sensible plus Latent heat
* Sensible Heat – Changes in temperature that do not alter the moisture content of air
* Latent Heat – Related to level of moisture in the air
* BTU (British Thermal Unit) – The amount of heat that must be added to or subtracted from a pound of water at 60°F to affect a temperature change of 1°F
* BTUH or BTU/H – BTU’s per hour
* MBTUH – 1000 BTUH
* Ton
* 1 Ton equals the amount of heat needed to melt 1 ton of ice in one day
* 12,000 BTUH’s
* Drybulb Temperature – The temperature reading given by a dry thermometer that gives a direct indication as to the sensible heat content of air
* Wetbulb Temperature – The temperature reading from a wetted bulb that gives a direct indication as to the total heat content of air
* Dew Point Temperature – Temperature at which air will begin to release moisture.
* Relative Humidity (RH)
* The actual amount of moisture in the air expressed as a percentage of the amount of moisture the air is capable of holding.

More technically:

* The amount of water vapor in the air divided by the amount of water vapor the air can hold (at the same temperature and pressure.)
* The ratio of the air's vapor pressure to its saturation vapor pressure.
* Example: An air sample that is at 50% RH is holding half the moisture it is capable of holding at the same temperature (at dew point or saturated.)
* RH is inversely relational to temperature for the same moisture level (grains of moisture per pound of dry air) – warm air can hold more moisture
* RH is what we sense
* High RH: Sticking, mold
* Low RH
* Affects electronics, promotes static
* Low RH air is seeking saturation, absorbing moisture wherever it can
* Specific Humidity or Humidity Ratio
* The weight of the water vapor in each pound of dry air
* Typically grains of moisture/pound of dry air
* Grain = 1/7000 pound
* Density – Unit weight of dry air at a given temperature and moisture content, lb/ft3
* Specific Volume – Space occupied by dry air at a given temperature and moisture content (the reciprocal of density), ft3/lb

**The Psychrometric Chart [SEE PAGE 4 FOR PSYCHROMETRIC CHART]**

* Constant Drybulb Temperature: Vertical Lines

➋ Constant Wetbulb temperature: Upward left sloping lines

➌ Relative humidity: Curving lines (100% line is the saturation curve or correlates with Dew Point)

➍ Left hand scale: Constant Dew Point (°F):   
Right hand scale: Humidity Ratio (grains of moisture/lb of dry air) and Vapor Pressure (in of Hg)

➎ Enthalpy or total heat, BTU/lb of dry air: Staggered scale left of saturation curve and left sloping lines

➏ Constant specific volume, ft3/lb of dry air: Sloping lines

➐ Saturation Curve: 100% RH Curve (or the point at which an air mixture can hold no additional moisture at a given temperature); temperature on the curve is the Dew Point

**Latent vs. Sensible Changes**

* Latent Changes move in the direction of the y-axis
* Sensible changes move in the direction of the x-axis

**Relationship of Drybulb (DB), Relative Humidity (RH), Dewpoint (DP) , and Wetbulb (WB)**

**Impact to Relative Humidity from Sensible Changes**

Temperature and Relative Humidity are inversely related:

* the higher the temperature, the lower the RH
* the lower the temperature, the higher the RH

**Example 1. See Psychrometric Chart, next page**

If the air temperature of 75°F at 40% RH is warmed to 90°F without adding moisture, what is the new RH?

RH = 25%

What is the RH is the air is cooled to 55°F?

RH = 80%

**Dehumidification**

**It Rains! Saturation**

What happens when the RH is 100%? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* As air cools, it eventually reaches its dewpoint and moisture begins to appear.

If the air is continued to be cooled, at what temperature will the saturation point be reached?

DB = 49°F

What happens if the air is continued to be cooled below 49°F?

Cooling below 49°F removes water i.e. The air can be de-humidified by over cooling it.

**Humidification**

If the air temperature of 75°F at 40% RH what is the new RH if 12 gr/lb of moisture is added to the air?

RH = 50%

What is the new DP?

DP = 55°F

**Enthalpy Changes**

* Enthalpy = Total heat in the air = Sensible plus Latent heat
* Sensible Heat – Changes in temperature that do not alter the moisture content of air
* Latent Heat – Related to level of moisture in the air
* Enthalpy is measured in BTU/lb dry air

What is the change in enthalpy when air at 75°F at 40% RH changes to 80°F at 60% RH?

@75°F Hi = 26.2 BTU/lb DA

@80°F Hf = 33.8 BTU/lb DA

Δ Enthalpy = ΔH = 33.8 – 26.2 = 7.6 BTU/lb DA

**Example 2.**

A space at sea level is 70°F and RH = 50%. Find the other properties of the air in that space.

Solution. Use Psychrometric Chart

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| --- | --- |
| DB = | 70°F |
| RH = | 50% |
| WB = | 58.5°F |
| Humidity Ratio= | 55 gr/lb of dry air |
| VP = | 0.37 in Hg |
| Enthalpy = | 25.5 BTU/lb of dry air |
| Vs = | 13.5 ft3/lb of dry air |
| Dew Point = | 50.5°F |

**Example 3.**

A saturated mixture contains 100 lb of dry air. How much heat is required (Btu) to raise the dry bulb temperature from 30°F to 70°F?

Solution. Use Psychrometric Chart

@30°F Hi = 10.9 BTU/lb DA

@70°F Hf = 20.8 BTU/lb DA

ΔH = 20.8 – 10.9 = 9.9 BTU/lb DA

Q = m ΔH = 100 lb x 9.9 BTU/lb DA = 990 BTU