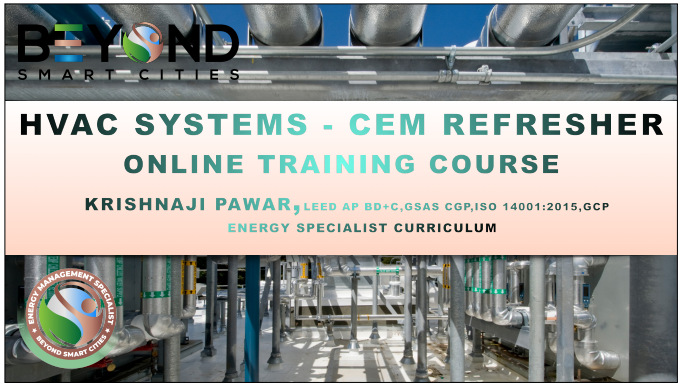
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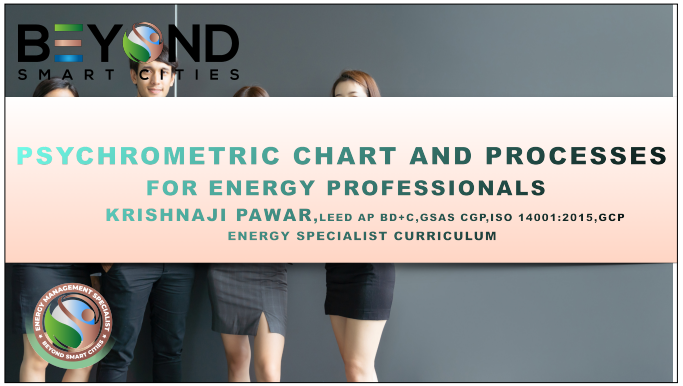
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SMART CITIES
PSYCHROMETRIC CHART AND PROCESSES
FOR ENERGY PROFESSIONALS
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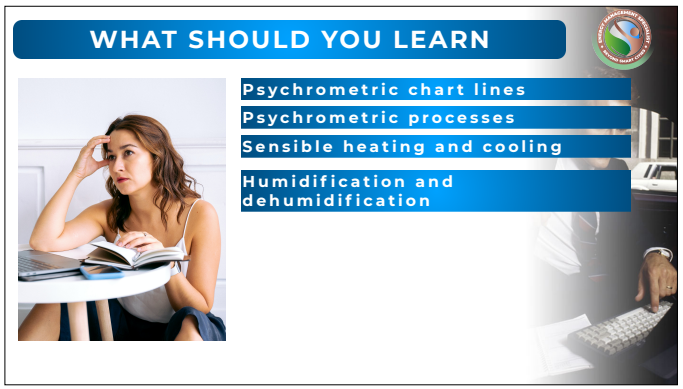

WHAT SHOULD YOU LEARN
Psychrometric chart lines
Psychrometric processes
Sensible heating and cooling
Humidification and dehumidification

PSYCHROMETRIC CHART

Psychrometric chart presents physical and thermal properties of moist air in a graphical form. It can be very helpful in troubleshooting and finding solutions to greenhouse or livestock building environmental problems

- The Psychrometric Chart is a key tool used by HVAC & Refrigeration engineers in many situations. It is used in calculating cooling loads and selecting mechanical equipment like enthalpy wheels, heat exchangers (air), air handlers and fan coils.
- The leading companies worked in air conditioning field have prepared their own psychrometric chart. There is slight variation in the charts but overall nature of all the charts are same.

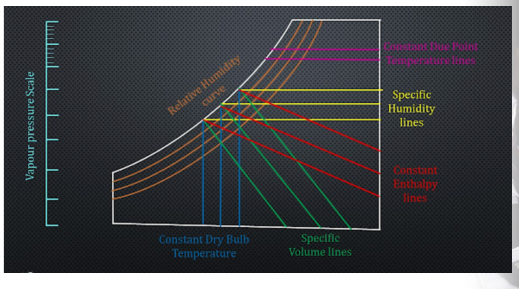
PSYCHROMETRIC CHART

By knowing any two properties state off air can be plotted on the chart and and all of the remaining property can be measured by the chart. It eliminates number of complicated calculations.

- All the charts are drawn at 760 mm of HG . On x axis dry bulb temperature is taken while on y-axis specific humidity is taken (generally to the the right side of the). Saturated condition of air at various temperatures are plotted and joining of this all points a smooth curve is obtained. It is known as saturated curve.

On saturated curve dry bulb temperature =weight bulb temperature=Dew Point temperature

PSYCHROMETRIC CHART AND ALL LINE STRUCTURE



PSYCHROMETRIC CHART +

Psychrometric chart contains following lines.

1. Dry bulb temperature lines: This are vertical uniform space lines range from 5 to 45 , sometimes 55.
2. Specific humidity lines: This are horizontal and equal spacing lines.It Ranges from 0 to 33 gm/kg dry air.
3. Relative humidity lines These are the curves identical to saturation curve distance between curves increases on right hand side.
4. Wet bulb temperature lines: These are inclined and non equally spaced lines.
5. Dew Point temperature: let 1 with state of year Dew Point temperature of this year can be measured by drawing horizontal line up to saturation curve. Intersection of this line and saturation curve gives Dew Point temperature.
6. Enthalpy lines: Enthalpy lines are incline lines and extended up to enthalpy screen these lines are coincides with wet bulb temperature lines.
7. Vapour pressure lines: This are horizontal lines not drawn on main chart but scale showing vapour pressure in mm of HG given on extreme left of the chart.
8. Specific volume lines: These are inclind line they show volume of dry air in m3/kg(metre cube per kg).

PSYCHROMETRIC PROCESSES

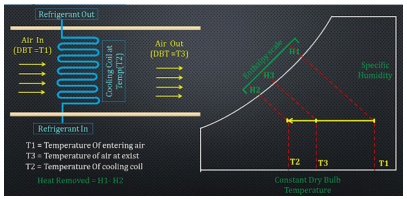
Various processes are conducted on atmospheric air to change its state to a desired one. These processes are called psychrometric processes. List of various psychrometric processes:

1. Sensible heating
2. Sensible cooling
3. Humidification a) heating and humidification b)cooling and humidification
4. Dehumidification a) heating with humidification b) Cooling with humidification
5. Evaporative cooling (cooling with adiabatic humidification)
6. Mixing of two streams
7. Heating and dehumidification of chemical type (chemical dehumidification)

Some basic terms:

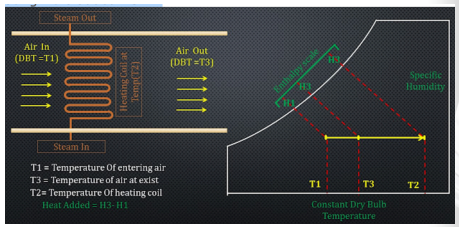
- Sensible heat: The heat which causes a change in the temperature is called sensible heat. It is called sensible because it sense by thermometer.
- Latent heat: The heat required to change the phase of substance is called latent heat.during change of phase or state there will be no change in temperature. amount of heat required to change the liquid into vapour or vice-versa is called latent heat of vaporization. The amount of heat required to change the solid into liquid are liquid into solid is called heat of fusion.
- Total heat: It is the sum of sensible heat and latent heat.

SENSIBLE COOLING



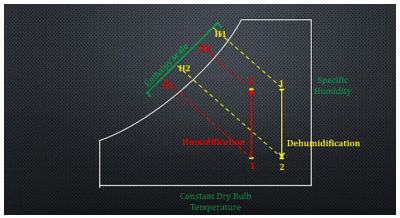
cooling of air without any change in its specific humidity is called sensible cooling. In perfect cooling entering air at temperature T1 will be cooled down to temperature T2, but perfect cooling is not possible in a practice because of loss of cooling effect due to some reason such as conduction,Convection and Bypass hence air leaving will not be called from T1 to T2 but for some higher temperature T3. Heat rejected= H1 - H3

SENSIBLE COOLING



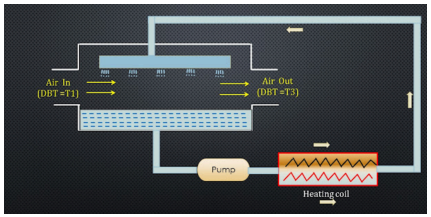
Heating of air without change in its specific humidity is called sensible heating. It is added H3-H1

HUMIDIFICATION AND DEHUMIDIFICATION



Addition of moisture to air without change in its a dry bulb temperature is known as humidification. similarly removal of moisture without change in dry bulb temperature is known as dehumidification. H2 - H1 does not involving change in temperature but actually practice absolutely modification and humidification is not possible. It is always accompanied by heating or cooling.

HEATING WITH HUMIDIFICATION



As shown in the figure spraying hot water in air increases DBT and specific humidity of incoming air .This process is called heating and humidification and it generally used in winter air conditioning. Total heat added = H3-H1

THE PSYCHROMETRIC CHART

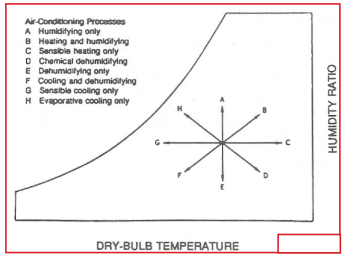
The Psychrometric Chart graphically represents the steam tables for moisture in air at conditions we encounter in HVAC work.

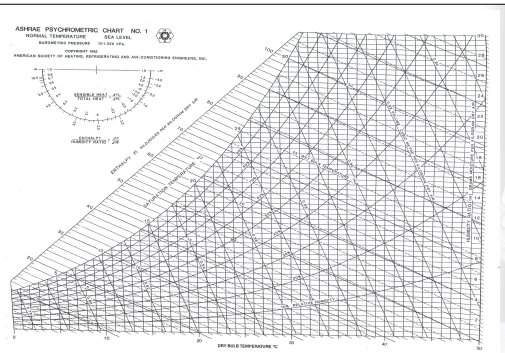
The Psych Chart allows complex problems to be worked out easily, and provides a feel for common HVAC processes that we are interested in.

The standard ASHRAE Psych Chart has a horizontal axis for dry bulb temperature, and a vertical axis for humidity ratio in pounds of moisture per kg of dry air.

Other parameters on the chart are: relative humidity, wet bulb temperature, enthalpy, specific volume, and saturation temperature.

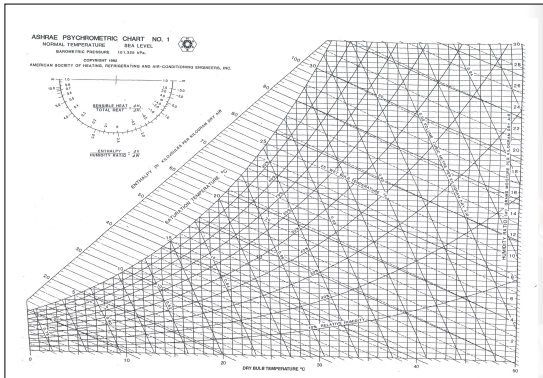
COMMON HVAC PROCESSES





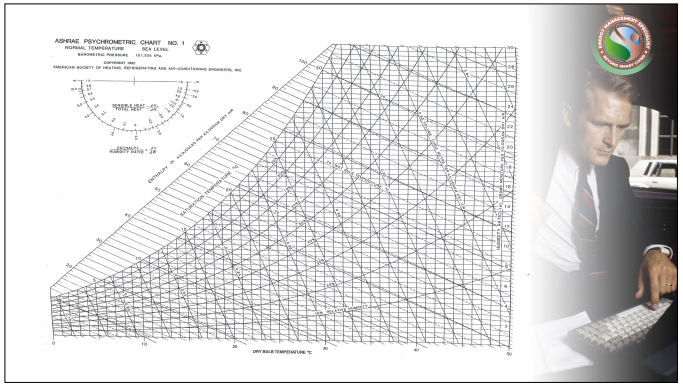
HEATING EXAMPLE

- For air, $q = LPS \times 1.2 \times \Delta h \quad [W]$
- Air at 20°C dry bulb and 50% relative humidity flows at 3200 LPS and is heated to 32°C dry bulb and humidified to 40% RH. Approximately how many kW is required in this process?
  - (A) 61 kW
  - (B) 96 kW
  - (C) 183 kW
  - (D) 351 kW



COOLING EXAMPLE

- How many kW of air conditioning is required to cool 500 LPS of air at 32 °C and 60 % relative humidity (RH) to 15 °C and 100 % RH?


ASHRAE PSYCHROMETRIC CHART NO. 1
NORMAL TEMPERATURE
SEA LEVEL

BEYOND
SMART CITIES
ENERGY MANAGEMENT SPECIALIST
BEYOND SMART CITIES
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