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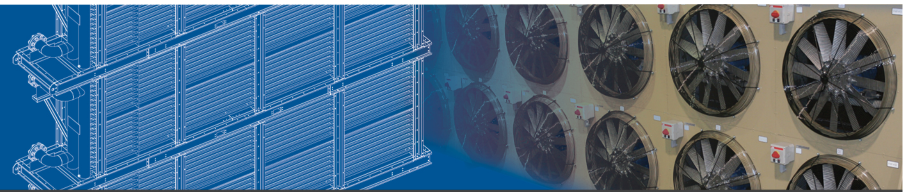


Technical Bulletin

By Carl E. Berg, Mechanical Engineer, Colmac Coil Manufacturing, Inc.

BACK TO BASICS: PSYCHROMETRICS AND THE PSYCHROMETRIC CHART

Introduction

An understanding of psychrometrics and use of the psychrometric chart is essential to the process of designing thermal systems and sizing the coils that are part of these systems. Whatever the type of coil, the air stream going through it can be plotted on the psychrometric chart, and important information learned about the air stream. With this knowledge, a designer can answer questions and make decisions during the coil selection process. This article will cover some of the basic principles and concepts of using the psychrometric chart.

A psychrometric chart is an attempt to show the relationships in many of the properties of moist air. The chart shows all of the following properties: dry bulb temperature, wet bulb temperature, relative humidity, dew point temperature, humidity ratio, total heat (enthalpy) and specific volume. If any two of the listed properties are known, those remaining can be obtained. Before one can understand the psychrometric chart, an understanding of each of the properties is required. The definitions and how they are plotted on a psychrometric chart are listed below. Refer to the skeleton chart shown to clarify the descriptions.

Dry bulb temperature (DB): The temperature of a substance as read by a common thermometer. The dry bulb temperature is an indication of the sensible heat content of the substance. Dry bulb temperatures are shown as vertical lines originating from the horizontal axis on the bottom of the chart.

Wet bulb temperature (WB): The wet bulb temperature is used to measure the water content of moist air. It is obtained by passing air over a thermometer that has a wet wick over its sensing bulb. The drier the air, the more water will evaporate from the wick which lowers the reading on the thermometer. If the air is saturated (100% relative humidity), no water will evaporate from the wick and the wet bulb temperature will equal the dry bulb temperature. Wet bulb lines originate from where the dry bulb lines intersect the saturation line and slope downward and to the right. Wet bulb lines are nearly but not exactly parallel to enthalpy lines.

Relative humidity (RH): The ratio of the amount of water vapor in a given sample of air to the maximum amount of water vapor the same air can hold. 100% RH indicates saturated air (the air cannot hold any more water vapor), and 0% RH indicates perfectly dry air. (Note: The above definition is accurate for all practical purposes. The correct definition of relative humidity is the ratio of actual water vapor pressure in a sample of air, to the water vapor pressure in saturated air at the same temperature.) The 100% RH line is the saturation line and lines of lesser RH fall below and to the right of this line.

Dew point temperature (DP): The temperature to which air must be cooled before condensation of its moisture will begin. As a sample of air is cooled, its RH climbs until it reaches 100% RH (saturated air). This is the dew point temperature. At saturation, dew point temperature equals wet bulb temperature equals dry bulb temperature, and the RH is 100%. If air is passed over a surface that is below the dew point temperature, moisture from the air will condense on the surface. It is the dew point temperature of air going over a cooling coil's fins that determines if the fins will be wet or dry. Dew point temperatures are shown on the saturation line.

Humidity ratio (W): Sometimes referred to as "Specific humidity", this is the actual weight of water vapor in a pound of dry air. Humidity ratio is expressed in pounds (or grains) of water vapor per pound of dry air. Humidity ratio lines are horizontal on the chart and originate from the vertical axis on the right hand side.

Enthalpy (H): This term is used to describe the total heat of a substance and is expressed in BTU per pound. For moist air, enthalpy indicates the total heat in the air and water vapor mixture and is shown as BTU per pound of dry air. Dry air at 0°F has been assigned an enthalpy of 0 BTU/lb. Enthalpy values are found on a scale above and to the left of the saturation line. Lines of constant enthalpy slope downward and to the right and nearly parallel the wet bulb lines.

Specific volume (SpV): The reciprocal of density, specific volume is expressed as cubic feet of air-water vapor mixture per pound of dry air. Lines of specific volume start on the horizontal axis and slope upwards and to the left.

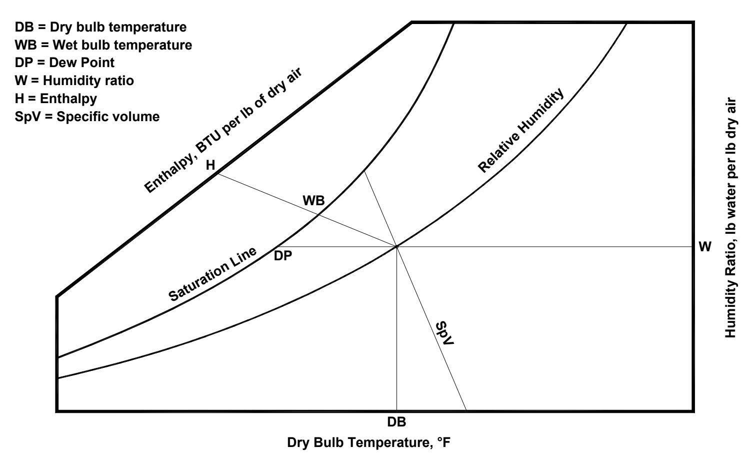
As stated earlier, if any two of the above seven properties are known for a sample of moist air, the state point of the air can be plotted on a psychrometric chart and the remaining five properties can be graphically determined. An example of this is shown on the skeleton chart below.

Any process that involves heating, cooling, dehumidifying or humidifying air can be plotted on the psychrometric chart. The following statements apply:

- Any sensible heating or cooling process is shown as a horizontal line on the chart. The humidity ratio and the dew point are constant in this process.
- Any latent heating or cooling process is shown as a vertical line. The dry bulb temperature is constant in this process.
- A typical cooling/dehumidifying process is represented as a line that goes down and to the left. This process would theoretically move horizontally to the left until the dew point is reached, and then follow the saturation line to the end point. The actual process is more accurately portrayed by a curved line moving down and to the left. This is due to the mixing process of some parts of the air stream that have reached the dew point with other parts that are still being sensibly cooled.
- A heating/humidifying process is represented by a line that rises and moves to the right. The actual process depends on the type of humidification involved, but the end point will always be above and to the right of the start point.

Conclusion

By using the proper equations and the information presented here on psychrometrics, the reader should have a clearer understanding of what happens on the air side of a heating or cooling coil. This understanding will be of value when using the Colmac CoilPRO software program in the selection of any type of coil.



SKELETON PSYCHROMETRIC CHART

For more information contact Colmac Coil Manufacturing, Inc.
www.colmaccoil.com | (800) 845-6778 | (509) 684-2595
P.O. Box 571, Colville, WA. 99114-0571

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