AN EXAMPLE SHOWS YOU HOW TO USE IT IN YOUR APPLICATION

The Psychrometric Chart, Part 2

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Using psychrometric charts and empirical data obtained from the field will allow for a reasonably accurate model of a dryer to be built.

Continuing my discussion of the psychrometric chart and how to use it, in last month's column, I showed a psychrometric chart, plotting four points. Allow me to pick up the topic by picking up our ongoing example and taking it further, by putting that air inside a piece of process equipment such as a dryer or oven.

Suppose you have a fan that can deliver 10,000 standard cubic feet per minute (scfm). That is 10,000 cfm at sea level and 70°F (21°C). This translates to a specific volume of 13.33 ft^3 of air per pound. You would, of course, verify this volume by conducting a pitot traverse with a suitable manometer across a duct, or using an anemometer at the fan inlet; performing both a suitable number of diameters downstream of turbulence.

The density of standard air is 0.075 lb/ft^3. At our condition, 82°F and 60 percent relative humidity, the specific volume is 14 and the density is 0.0714 lb/ft^3. Thus, 10,000 ft^3/min of air at this density has a mass flow rate of 714 lb/min of air.

We do not change the mass flow rate of air, and hence at 200°F, you have energy available of

$$714 \text{ lb/min} \times 64 \text{ BTUs/lb} = 45{,}700 \text{ BTUs/min}$$

The amount of moisture in the inlet air is

$$714 \text{ lb/min} \times 0.014 \text{ lb}_{water}/\text{lb}_{air} = 10 \text{ lb/min of water}$$

The amount of moisture in the exhaust is

$$714 \text{ lb/min} \times 0.029 \text{ lb}_{water}/\text{lb}_{air} = 20.7 \text{ lb/min of water}$$

This system is evaporating approximately 10 lb/min of water. If the inlet and discharge moisture content of the product are known, data relating to rate can be developed.

Things get more complicated when there is recycled air, the dryer is multistage, or a direct heat source is used. There is obviously moisture carryover in recycled air, and one of the byproducts of combustion is water.

It is useful to trace the dryer. Take measurements of the wet and dry bulb temperatures at various points along the air path. Perform pitot traverses in ducts to obtain volumetric flow rates and convert these to mass flow rates. Use the chart shown in last month's column to define the operating conditions in the dryer. Compare these with the theoretical and specified conditions.

IT IS USEFUL TO TRACE THE DRYER.

Using psychrometric charts and empirical data obtained from the field will allow for a reasonably accurate model of a dryer to be built. I must reiterate that psychrometric charts are a graphical representation of known formulae and that exact calculations using those formulae can be performed if desired. PH

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