For each and every product, there is a representative curve that describes the drying characteristics for that product at specific temperature, velocity and pressure conditions. This curve is referred to as the drying curve for a specific product. Variations in the curve will occur principally in rate relative to carrier velocity and temperature.

The curve is extremely valuable in understanding idiosyncrasies associated with the drying of each unique product. This file will discuss these aspects, giving the reader a fuller and rounder understanding of the drying process.

Before I discuss the curve, though, let me explain two fundamental temperatures to you. The dry bulb temperature is the temperature of a body or air as measured with a conventional thermometer. It is the daily high and the daily low you get on your local weather forecast. In process applications, it typically is the process control setpoint of your dryer. It is also referred to as just “temperature.”

Wet bulb temperature is a different animal. It gets its name because a permeable membrane such as wet gauze is used in conjunction with a regular thermometer to obtain the reading. The gauze is wrapped around the bulb of the thermometer and inserted into the gas stream. Because the water is evaporating off the gauze in the gas stream, evaporative cooling ensures that the temperature is lower than a dry bulb thermometer in the same gas stream. Physically obtaining this reading is tricky because the reading is meaningful only at a constant rate of evaporation. Too much or too little water will affect the reading, and it takes practice to obtain the correct value.

The dry and wet bulb temperatures are fundamentals in defining the properties of the air. This topic is referred to as psychrometry and is a topic for a future column.

BACK TO THE DRYING CURVE

Figure 1 represents a typical drying curve for virtually any product. Drying occurs in three different periods, or phases, which can be clearly defined.

The first phase, or initial period, is where sensible heat is transferred to the product and the contained moisture. This is the heating up of the product from the inlet condition to the process condition, which enables the subsequent processes to take place. In some instances, pre-processing can reduce or eliminate this phase. For example, if the feed material is coming from a reactor or if the feed is preheated by a source of waste energy, the inlet condition of the material will already be at a raised temperature.

The rate of evaporation increases dramatically during this period with mostly free moisture being removed.

During the second phase, or constant rate period, free moisture persists on the surfaces and the rate of evaporation alters very little as the moisture content reduces. During this period, drying rates are high, and higher inlet air temperatures than in subsequent drying stages can be used without detrimental effect to the product. There is a gradual and relatively small increase in the product temperature during this period.

Interestingly, a common occurrence is that the time scale of the constant rate period may determine and affect the rate of drying in the next phase.

The third phase, or falling rate period, is the phase during which migration of moisture from the inner interstices of each particle to the outer surface becomes the limiting factor that reduces the drying rate.

In my next column, I’ll explain what that all means to your process. 

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