As I explained in my column last month, the initial and constant drying rates may affect the falling rate and offer benefits or advantages as well as limitations. Most commonly, the elapsed time for this falling rate period is frequently directly dependent on the drying criteria achieved during the constant rate period. That is, if materials are dried rapidly in the high moisture range, they may continue to dry relatively quickly in the low moisture range. This can be attributed to the formation of a porous structure (capillaries), which favors more rapid diffusion and increases the exposed surface area of the product.

The levels of initial drying rates also may enhance and modify the quality of the final product. For example, rehydration rates for products such as instant coffee or milk tend to follow the drying rate pattern.

Certain products skin, crack or shrink at elevated temperatures. In this case, high initial drying rates will be detrimental to the drying process by encapsulating moisture within the product, retarding movement of moisture from the inside to outside of the product. In instances where cracking or shrinking occurs, it also may reduce product quality and disfigure certain materials.

Product density also relates to drying rate and, in general, the faster the drying rate, the lower the density.

The temperature curve for the product increases from the feed temperature (most commonly ambient temperatures) to approximately the wet bulb temperature during the constant rate period and then to almost dry bulb temperatures as it nears the end of the drying cycle. During the constant rate period, the product temperature remains reasonably constant due to the effects of evaporative cooling.

As the drying process proceeds through to the falling rate period, the moisture content progressively reduces and the rate of moisture removal decreases markedly. The product temperature starts to increase more rapidly because the effects of evaporative cooling are reduced. As a result, temperature-sensitive products become in danger of thermal degradation. The falling rate period is dependent on the desired final moisture content and is typically longer than the constant rate period. Hygroscopic products or products with high bound moisture contents will have an extended falling rate period to achieve low final moisture contents.

Figure 1 also illustrates the relative temperature profiles of the carrier stream for co- and counter-current drying systems. Higher inlet temperatures can be used for co-current systems, and there is a lower potential for thermal damage to the product because the final product temperature approaches the controlled exhaust temperature.

Darren A. Traub is executive vice president of Drytech Engineering, Irvine, Calif., a company specializing in thermal drying and related system technologies. He has engineered and managed the project execution of numerous drying and bulk materials-handling systems in the United States, Africa, the Middle East and China. He can be reached at (949) 262-1222 or e-mail darren@drytecheng.com.