Toll processor | Considerations when spray drying specialty ingredients

The current shift in consumer purchasing behaviors is driven by the desire for more nutrient-rich and healthy products. In particular, consumers are demanding that specialty ingredients be formulated into their favorite foods and dietary supplements. As the food and dietary supplement industries continue to boom, companies increasingly are seeking contract manufacturers to help support that growth and keep up with demand.

In order to do this, companies are both sourcing and innovating these specialty ingredients but often find themselves seeking help with manufacturing. As a contract manufacturer, American Custom Drying (ACD) has been using spray drying to transform specialty ingredients into dry, shelf-stable powders for customers.

What are specialty ingredients?
Specialty ingredients are defined as those ingredients that are both unique and that command a high dollar value. Typically made in small, highly controlled batches, these ingredients can include enzymes, pro- or prebiotics, vitamins, minerals, phytonutrients, and nutraceuticals. Some of these ingredients, for example enzymes and minerals, aid in food processing, while others, including unique proteins, prebiotics, phytonutrients, and nutraceuticals, are used to add nutritive value to foods.

Transforming specialty ingredients into functional, stable, and free flowing powders requires rigorous quality control. Understanding the technical ingredient details helps contract manufacturers aid customers achieve the highest quality end product. Some ingredients have special processing requirements, such as limiting exposure to heat (both for powders and slurries), shear and fluctuations in pH, restrictions in final particle size and distribution, prefiltration, and flow-aid use. Certain classes of these ingredients, such as specialty lipids, may even need to be encapsulated on a gum or maltodextrin carrier in order to transform them into stable, powdered ingredients. These requirements make spray drying a suitable choice for these difficult applications.

An overview of spray drying
By definition, spray drying is a process in which a liquid or slurry is converted into a powder by evaporating the water with hot gas or air. In the food and pharmaceutical industries, this is the preferred method for drying heat-sensitive materials.

The spray dryer itself is typically a vessel fitted with feed- and air-handling components. One or more feed-atomizing devices are located in the dryer’s internal chamber. The feed solution or slurry is pumped to the atomizing device, which diffuses the feed as droplets into the drying chamber. A fan draws the hot air through an inlet into the chamber, where the air and droplets mix, drying the material via adiabatic heat and mass transfer. As the material dries, it typically forms spherical particles. Particles may drop to the vessel’s bottom and exit through the material outlet or exit with the exhaust and be removed by a cyclone or baghouse.
When transforming liquids into powders, there are a myriad of slurry attributes that must be considered. Seven of these critical factors are:

1. **Rheological properties**: Viscosity is a good first-order consideration. Another would be whether the slurry is a non-Newtonian fluid (viscosity changes under force), such as a shear-thinning or shear-thickening fluid. These factors will impact the batch process and the atomization, as well as the cleanup.

2. **Percent solids in liquid (%S)**: As long as the rheological properties are acceptable, %S will be important in relation to production throughput. The higher the %S, the less water evaporation and the higher the production throughput rate may be. Ensuring that the spray dryer’s evaporation capacity isn’t being exceeded is also important. This typically occurs during line trials.

3. **Specific gravity**: This is important when looking at throughput. Throughput is measured in units of volume per time and is used in production rate calculations to calculate mass production rate. Estimates can be made for throughput of a dryer based on the nozzle selection, the atomization method, and the feed pressure.

4. **Heat sensitivity**: Spray drying is a great option for heat-sensitive materials, but the situation depends upon the type of heat sensitivity. If the batch liquid can’t be heated to achieve a proper viscosity, or if the liquid needs to be refrigerated until it can be processed, this may limit the capacity for spray drying.

5. **Chemical properties**: Chemical properties of the batch liquid should be considered. Products at high and low pH are corrosive and can damage equipment if not properly handled. Products may be flammable or have a high Kst (explosion factor) or low MIE (minimum ignition energy), posing safety hazards that must be considered. Products that are abrasive will damage pumps, as well as piping and other points of contact down the line. Products that are hygroscopic may present additional drying barriers to overcome. Thermoplastic materials will have a lower glass transition temperature, thus posing challenges with conveying and buildup.

6. **Suspension stability and emulsion stability**: Many end products are an emulsion of some form or another. The product may also be a suspension or colloid. How stable these liquids are (how well they remain homogenous and well dispersed) will have a great impact on how well they can be spray dried. Excessive settling out for suspensions will produce uneven flow and plugging of atomizer nozzles, and negatively impact the final product’s characteristics. Emulsion coalescence also poses challenges.

7. **Foaming capacity**: If a product foams considerably when agitated, this must be taken into consideration and properly handled. It is important that foaming be controlled as it can cause overflow and waste. It can also cause possible issues with flow through the nozzles.

### Toll processing specifics

The ACD dedicated specialty ingredients spray dryer has a water evaporation capacity of 200 pounds per hour and requires 50 gallons (minimum) of material for a line trial. The dryer primarily uses high-pressure atomization and has adjustable nozzles to optimize consistency and production rates.

The unit also has a dehumidifier, which allows processing at lower temperatures by avoiding harsh drying temperatures that compensate for humidity fluctuations throughout the year; a heat recovery unit, which allows heat from the exhaust air to heat the inlet air, reducing gas usage and improving energy efficiency; an integrated static fluid bed, which is used to convey powder and create a uniform drying environment; a dual baghouse system, which retains a higher yield of quality product and avoids rewetting contamination risk; and a clean-in-place (CIP) system.
that uses spray ball assemblies in each portion of the dryer, allowing for more efficient cleanup and quick changeover during multiple product runs. The dryer is certified SQF 2000 Level 2, which is recognized worldwide for its implementation of a HACCP food safety plan. Certified SQF and HACCP practitioners are always on site.

Working with a specialized team is important when transforming specialty ingredients from liquids to powders. With experience in processing nutraceuticals, flavors, cosmetics, personal care products, and soft chemicals, ACD is positioned to help companies take these specialty ingredients from baseline evaluation and line trial to commercialization. PBE

Note:
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