U.S. DEPARTMENT OF
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ENERGY EFFICIENCY & RENEWABLE ENERGY

Liquids to Powders Without Heat—No Heat Spray Drying Technology

Powders created with the energy-efficient DriZoom™ technology better preserve a number of desirable properties (e.g., solubility, color, and flavor) than powders produced by conventional processes that use heat. *Photos: ZoomEssence.*

Novel technology provides energy-efficient alternative to heat-based spray drying methods that may degrade certain high-value properties.

A variety of industries use heated spray drying to transform liquids with desirable properties into a more convenient powder form. The chemicals, pharmaceuticals, and food industries use this technology extensively to transform liquids into dry powders for use in tablets, capsules, paints, or dried foods. Disadvantages of this existing technology include the relatively high use of water and energy. In particular, current processes often involve drying with temperatures of up to 400°F, which can degrade the molecular structure of the original liquid—diminishing color, flavor, stability, potency, and/or solubility.

The innovative DriZoom™ technology atomizes liquids to powders at ambient temperature, saving energy and water while preserving key attributes of the liquid. This technology saves resources by using more viscous fluids, using no heat, and preserving properties. Based on analyses of powders produced with the DriZoom technology, the resulting powders tend to retain more of the flavor, color, and/or nutrients of the original liquids; dissolve more readily in water; and maintain those properties over longer periods—extending shelf life.

Spray drying of liquids into powders at ambient temperatures has not yet been validated at significant scale because of the significant challenges compared to heated spray drying —which provides up to two orders of magnitude greater drying force. The new technology addresses this challenge by starting with more viscous emulsions, atomizing the emulsion into finer droplets, and keeping the droplets suspended longer to enable drying. The DriZoom technology has been validated at prototype scale to prove its technical feasibility. During this project the process was scaled up to an integrated pilot scale as the next step toward advancing the technology.

Benefits for Our Industry and Our Nation

Atomizing liquids to powder at ambient temperature is expected to offer several benefits over heated spray drying, including the following:

- Reduces energy use by 40% or more
- Consumes about half as much water
- Improves product yield and shelf life
- Reduces capital system costs
- Produces powdered products with properties closer to those of the original liquid, such as flavor, color, and potency.

Applications in Our Nation's Industry

Initially, the DriZoom technology will be applied in the manufacture of dry flavors and food ingredients. The technology can potentially be applied across the pharmaceuticals, chemicals, and food industries to replace heated spray drying and freeze drying—the two most common techniques in use today. In addition, DriZoom has the potential to atomize and dry some emulsions previously deemed too viscous for spray drying.

Novel applications could potentially lead to new products and processes to boost U.S. competitiveness in global markets. Potential applications might include powdered inks (lighter for international shipping), vitamin-fortified milk powders, and probiotics for use in tablets or capsules. Future applications are also possible in polymers and ceramics.

Project Description

The goal of this project was to build and optimize an infrastructure that is scalable and has the capability to explore new applications. The outcome of this project was (1) improved ability to formulate emulsions for specific flavor groups and improved understanding of the relationship of emulsion properties to final dry particle properties, (2) a new production-scale atomizer, and (3) a dryer controls system.

Barriers

Scaling the DriZoom process to an integrated pilot system entailed overcoming several key barriers.

- Improving the air inlet design, air flow, and efficiency.
- Optimizing the pilot plant infrastructure to minimize energy use.
- Developing the control system to ensure consistent operation and reproducible dry products.

Pathways

ZoomEssence adapted the layout for validation-scale testing by expanding and optimizing the design for use in a multi-dryer facility. The resulting design provided a template for future capacity expansions to ensure an energy-efficient layout.

Milestones

This project began in December 2014 and was successfully completed in 2016.

- Testing of emulsions and dry particle sizes to preserve flavoring (Completed)
- Measurement of dynamic mechanical properties of dry particles (Completed)
- Design and modeling of an improved atomizer (Completed)
- Development of control system schematics (Completed)
- Installation and testing of control panel and software to verify narrow variability in output results (Completed).

Accomplishments

- Improved emulsion formulations to deliver double the concentration of actives per pound of powder, reducing overall use rates and increasing drying capacity two fold.
- Validated new generation atomizers with increased product throughput by up to 65%.

Technology Transition

At the conclusion of this project, the research team designed, constructed and validation tested an integrated, energy-efficient, pilot-scale facility featuring an 80 kg/hr robust atomizer and an agile control system. The team also better understands the relationship between emulsion formulations and key properties of the powders produced.

During this project, ZoomEssence developed over 130 new formulas. The company plans to continue drawing on its experience in the flavorings industry to provide production of flavorings and powdered food products and will then expand into additional markets.

The final report for the project is available at: *https://www.osti.gov/scitech/servlets/purl/1335837*

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