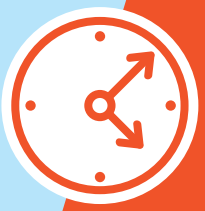
SPRAY DRYING GUIDE



Extends Shelf Life

Fast and Efficient Microencapsulation

Powders are Free-Flowing and Easy to Scale

Protects Product from Damage and Potency Loss

Watson

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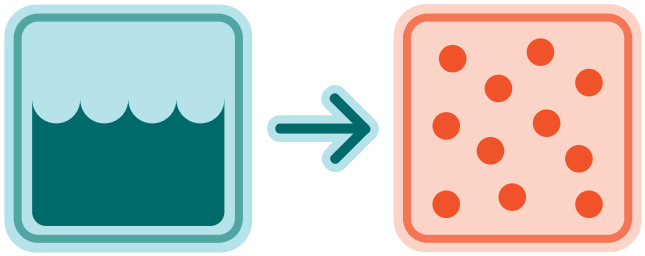
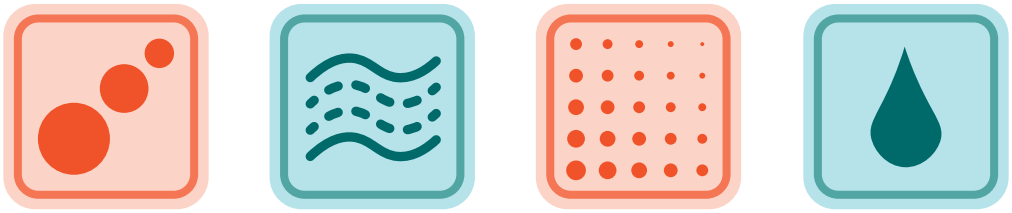
What Is Spray Drying?

Spray drying converts a liquid into a dry powder.

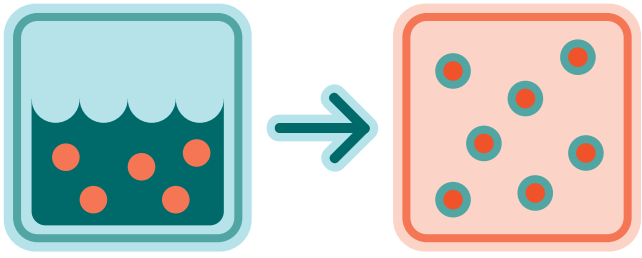


Spray dried powders are free-flowing, and are therefore easy to handle and scale in production. Liquid ingredients can be dried and incorporated into powder blends and premixes. Spray drying allows for control over particle size, particle density, flow characteristics, and moisture content of the product.

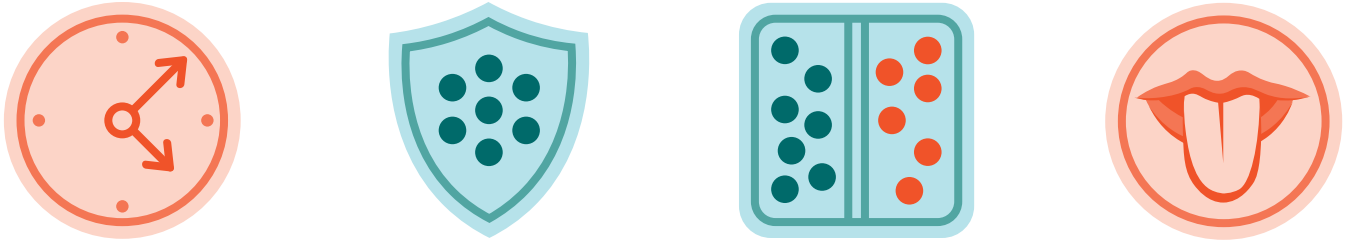


Particle Size | Flow Characteristics | Density | Moisture Content

Spray drying can be used as a microencapsulation method. In microencapsulation the product is mixed with a carrier and then spray-dried so that the carrier protects the product. Spray drying does not encapsulate a product as completely as other methods: some product will always be exposed on the surface of the particle. However, spray drying is by far the fastest and most efficient microencapsulation method available, and is used for many applications.



Microencapsulation extends the shelf life of a product and protects it from degradation or flavor loss. It can also be used to separate components of a mix that would otherwise react with each other.



Extends Shelf Life | Protects Product | Prevents Reactions between Components | Minimizes Flavor Loss

Spray Dried Products

Spray drying is useful for a variety of situations and products that require free-flowing powders. Common spray-dried products include flavors, colorings, milk and egg products, protein powders, sweeteners, beverages, and vitamins.

Milk and Cheese Powders

Protein Powders

Juices

Flavorings and Sweeteners

Vitamin Blends

BetaClear™

Watson's BetaClear™ is a free-flowing powder of encapsulated beta-carotene. When dissolved in water, BetaClear™ forms a colloidal crystalline dispersion and appears clear due to its light-scattering properties.

Clear-E™

Watson's Clear-E™ is a fine, free-flowing form of Vitamin E spray dried within a modified starch matrix. When mixed into a solution, Clear-E™ forms a micellular dispersion, producing a clear solution.

Gummy Vitamins

Spray drying allows oil soluble vitamins such as Vitamin A or D to be added to a gummy formulation.

Oils

Nutrition Bars

Nutritional oils, juices, and vitamins can be spray dried into powders for use in meal replacement and snack bars.

Bakery Ingredients

Spray drying can convert ingredients like soy bean oil or lecithin into a powder for ready mix applications.

MCTs

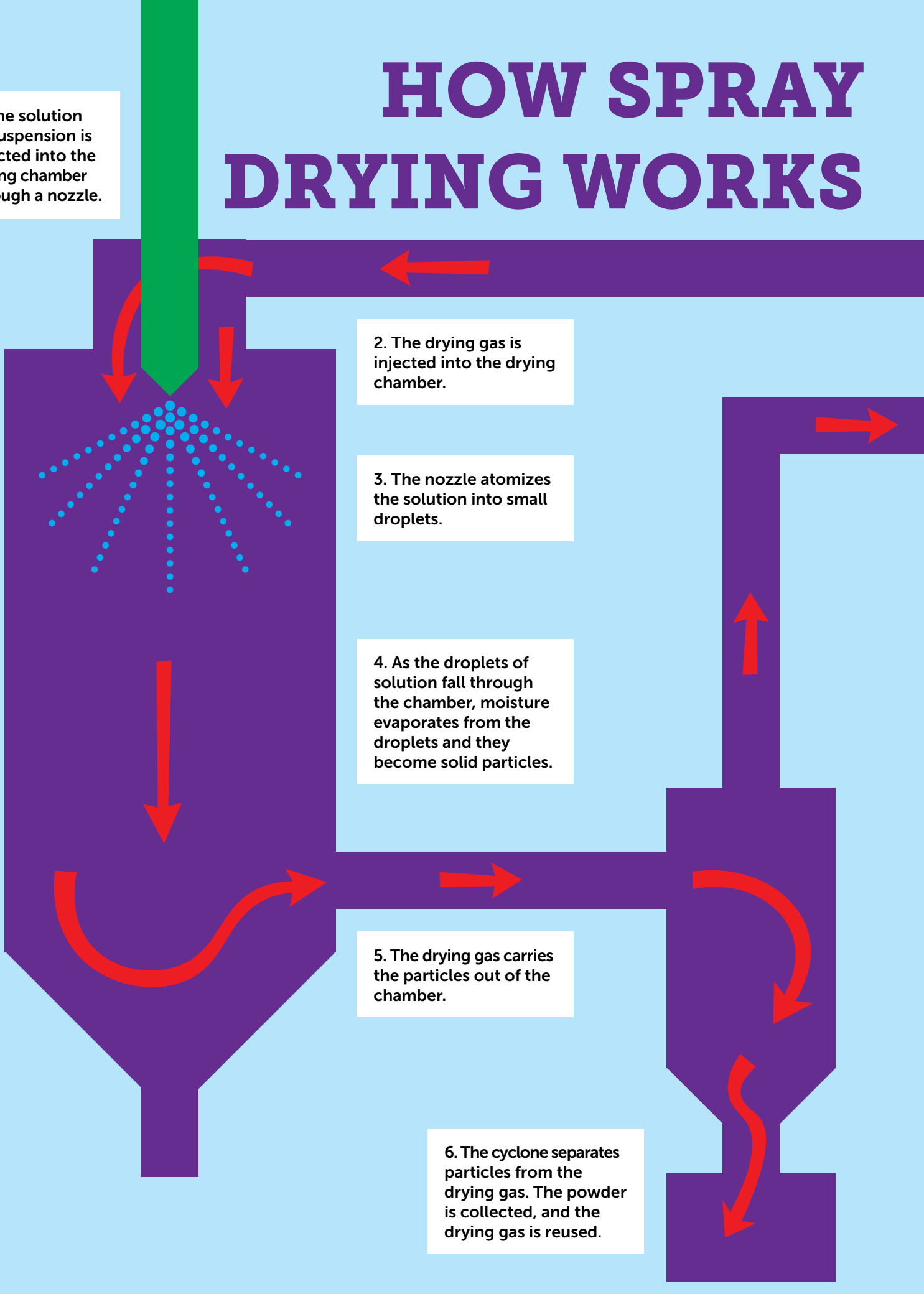
Watson's Spray Dried MCTs (medium-chain triglycerides) have applications in medical foods, supplementation, and sports nutrition drinks.

Nuts and Bolts

A Detailed Look Inside the Spray Drying Process

This section covers the spray drying process in more detail, and addresses some of the considerations that technicians work with while spray drying. Our technicians are happy to take on your spray drying challenge and work to make the impossible a reality!

HOW SPRAY DRYING WORKS



1. The solution or suspension is injected into the drying chamber through a nozzle.

2. The drying gas is injected into the drying chamber.

3. The nozzle atomizes the solution into small droplets.

4. As the droplets of solution fall through the chamber, moisture evaporates from the droplets and they become solid particles.

5. The drying gas carries the particles out of the chamber.

6. The cyclone separates particles from the drying gas. The powder is collected, and the drying gas is reused.

FORMULA

Water

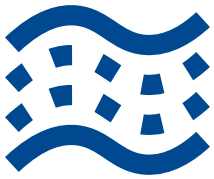
Less water means a shorter drying time, and therefore a less expensive product, so it is best to minimize the amount of water as much as possible.

Solid

Fifty percent Solid is optimal. Any less can make the product difficult to dry.

Sugar

Too much sugar in the formula can make the formula stick to the inside of the dryer, and certain ingredients can be added to counteract this.



Viscosity

The viscosity of the formula must be appropriate for the pump that is used to homogenize the formula. To affect the viscosity, the formula may be thinned out or heated.

Carrier Type

Below are three of the most common carriers used in spray drying microencapsulation.

Food starch

- Can hold up to 30-40% oil load
- Corn starch and modified corn starch are good for low oil and high oil percentage formulas
- Similar price to gum arabic

Gum Arabic

- Encapsulates well
- Works as an emulsifier as well as a carrier
- Similar price to food starch

Maltodextrin

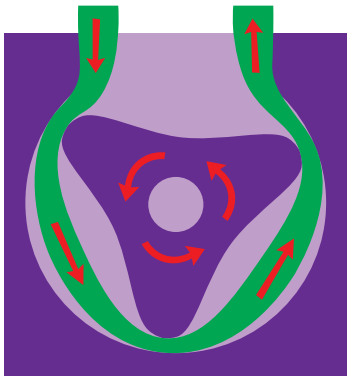
- Most economical carrier of the three
- Improves flow of the material
- Is a sugar, so may need to be avoided in some circumstances
- Does not work well for high oil loads
- Can use a maltodextrin with a high DE (Dextrose Equivalent Value) for a sugary taste

Emulsifier

Emulsifiers are used to stabilize mixtures of oil and water, or other liquids that are normally not blendable. Gum arabic can be used as an emulsifier in addition to being a carrier. If a different carrier is used, an emulsifier must often be added to the formula.

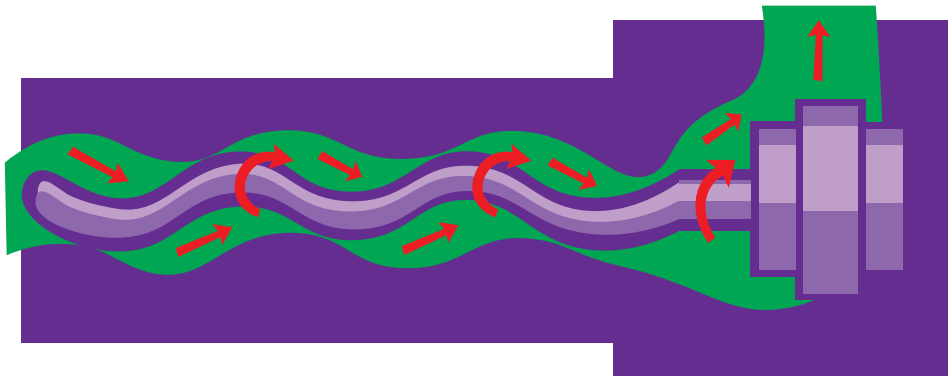
Pump Types

When spray drying a mix of oil and water, a pump is required to homogenize the mixture immediately before it is fed into the drying chamber. A pump is selected based on the viscosity and temperature of the mixture (temperature is often changed to alter the viscosity).



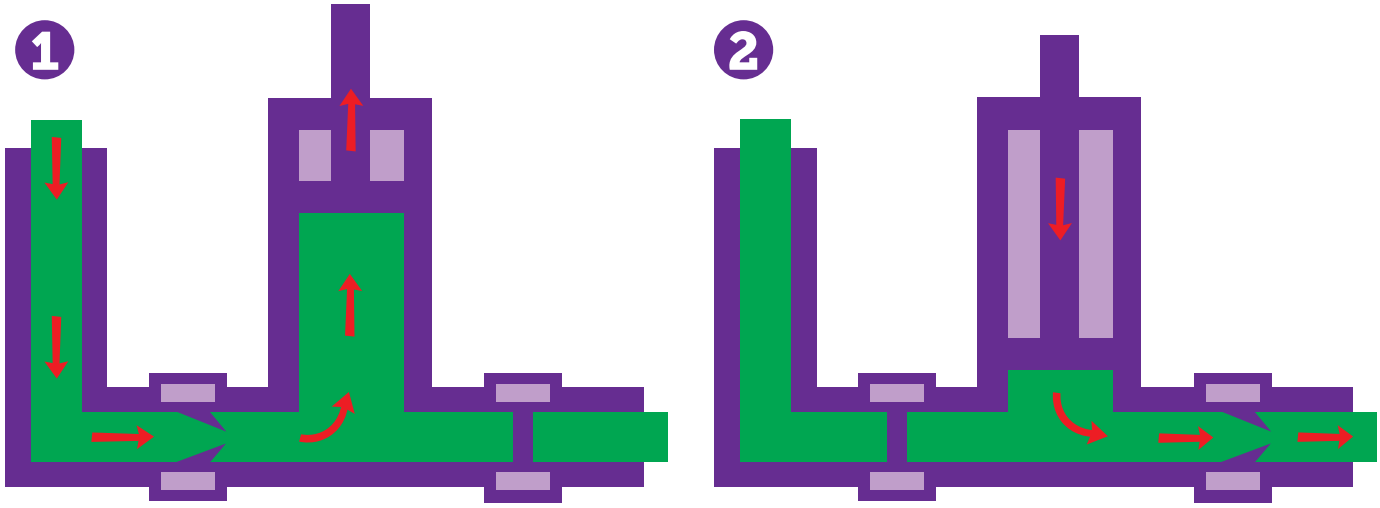
Peristaltic Pump

The wheel of the peristaltic pump causes the diameter of a pipe to increase and decrease by turns, pushing the mixture in the pipe forwards.



Moyno Pump

The moyno pump uses a rotating screw to drive the mixture forward through the cavity.



Diaphragm Pump

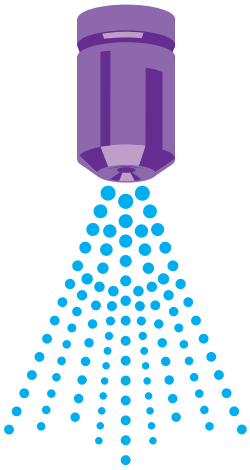
In a diaphragm pump, the plunger first moves upwards and pulls the mixture in through the inlet check valve. The inlet check valve closes and the outlet check valve opens. The plunger moves downwards and mixture is pushed out through the outlet check valve. The cycle is repeated.

Feed

The order of addition of raw materials can affect the final product.

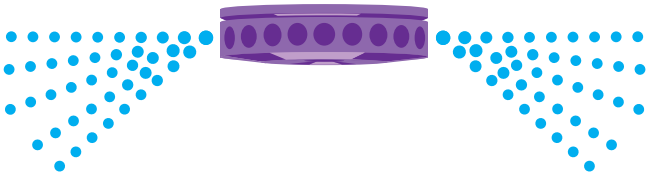
Nozzle

Nozzles allow for fine control of particle size. The distribution of particle sizes created by a nozzle has a small standard deviation, so particle size can be set more accurately and consistently than with other feed types.



Atomizer Wheel

Atomizer wheels can be run at varying speeds. The faster the wheel spins, the faster the droplets enter the drying chamber. This allows spray dryers with atomizer wheels to increase flow and thus throughput, which results in a broad range of particle sizes. This can often decrease the cost of a product.



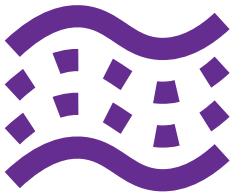
Drying Time

Drying time changes particle size and moisture. Residence Time is the time the product spends in the drying chamber from the time the formula hits the nozzle until it exits into the collector. A longer drying time causes the product to be more expensive.

Drying time is altered by:

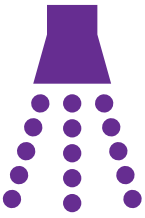
Pump speed

Viscosity



Temperature

Feed Type



Percent Solid

The less solid and more water in the formula, the longer the product will take to dry.

Flow in the Drying Chamber

The flow changes the time the particles spend in the dryer.

Co-Current Flow

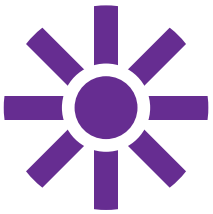
The drying gas flows in the same direction as the material so that the hottest drying gas comes into contact with the coldest product. The product rapidly increases in temperature.

Counter-Current Flow

The drying gas flows from the opposite direction of the product. This causes the product to heat up gradually while moving through the chamber. This is often more energy-efficient.

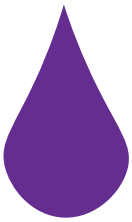
Packaging Concerns

Packaging is an important part of ensuring that the product is high quality and stable. Light, air, and moisture can all significantly impact the shelf life and potency of the product. To minimize the effect of these factors, consider using vacuum packaging, nitrogen flushing, heat sealing, and formulation improvements using antioxidants and overages. A spray dried product is only as good as its packaging.



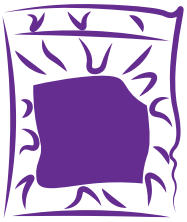
Light

Air



Moisture

To minimize the effect of these factors, consider using vacuum packaging, nitrogen flushing, heat sealing, barrier films such as mylar, and formulation improvements using antioxidants and overages. A spray dried product is only as good as its packaging.



Vacuum Packaging

Nitrogen Flushing

Heat Seal

Mylar and Other Barrier Films

Antioxidants

Antioxidants improve stability: for example, Vitamin C and E can protect Vitamin A.

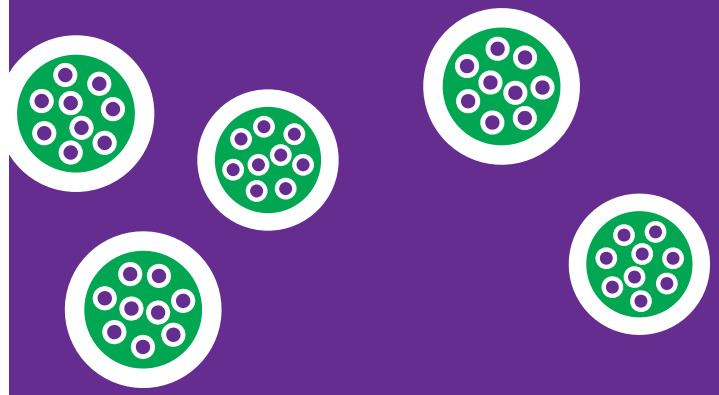
Overages

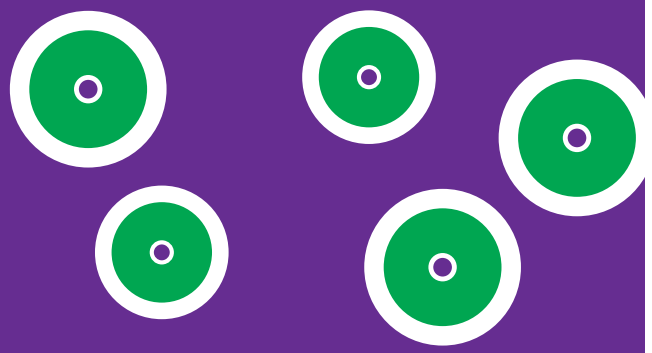
Building in overages determines the shelf life of nutritional products.

Micellular and Colloidal Dispersions

Typical Emulsion

A typical spray dried emulsion consists of multiple particles encapsulated in one beadlet of matrix. The size of the particles will affect the color of the product, and if the emulsion is dissolved in a liquid then the liquid will be cloudy due to the particulate size.



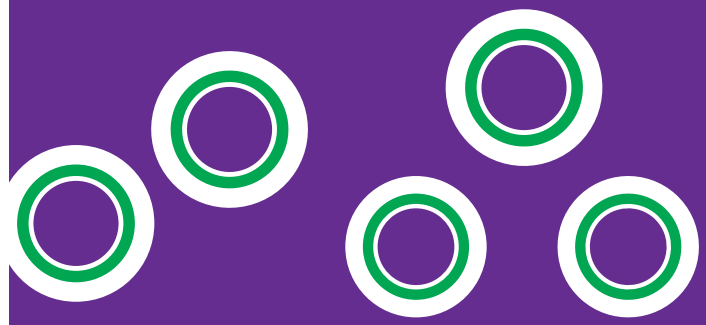


Micellular Dispersion

A micellular dispersion consists of a small particle encapsulated in a much larger beadlet of matrix. The beadlets in a micellular dispersion can be as small as one-tenth the size of the beadlets in a typical emulsion, and since each beadlet contains only a small colored particle the dispersion has very little color. When the micellular dispersion is dissolved in liquid, this results in an optically clear solution with no cloudiness. Watson's Clear-E™ is a micellular dispersion of Vitamin E.

Colloidal Dispersion

A colloidal dispersion consists of a large particle encapsulated in a small quantity of matrix. While this would usually result in significant color contribution, the colloidal dispersion is instead light scattering. As a result, the eye is tricked and the product appears optically clear with no cloudiness. Watson's BetaClear™ is a colloidal dispersion of beta carotene, or Vitamin A.



Spray drying converts liquids into free-flowing powders which are easy to scale. Spray drying can combine oil with water, extend the shelf-life of products, and even render colored ingredients invisible. This guide covers the advantages of spray drying, common spray dried products, and the details of the spray drying process.

Watson is a leader in developing quality products and ingredient systems for the food and supplement industries. Expertise in microencapsulation, agglomeration, micronizing, spray drying, and film technology allow us to develop unique formulations and products using Watson manufactured value-added ingredients. Watson produces a full line of industry standard and custom spray dried ingredients, including BetaClear™ and Clear-E™.These free-flowing vitamin mixes each deliver a burst of nutrition and form a crystal clear solution when dissolved in water.

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