



# How to prevent lumping during dispersion of powdered ingredients

Uniform blending of poorly dispersible powdered ingredients boosts plant productivity and food quality

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# How to prevent lumping during dispersion of powdered ingredients

Uniform blending of poorly dispersible powdered ingredients boosts plant productivity and food quality

When adding powdered ingredients into food processing lines, the use of the right mixing equipment not only can prevent lumping, but can also increase productivity, enhance product quality and reduce energy costs. Powders are common ingredients of the modern food industry. Difficult-to-disperse powders pose challenges for food manufacturers due to formation of lumps or “fish-eyes”. Alfa Laval has developed a versatile new system for high-speed dispersion of powdered ingredients, even the most challenging ones, which maximizes uptime while reducing initial investment, operating and maintenance costs.

## Introduction

Powdered ingredients are widely used in the manufacture of food products. In particular, the use of powder additives and functional ingredients, such as texturizing additives, nutrients, flavours and colourants, has increased tremendously over the past decades. While these ingredients bring flexibility and consistency to food products, they also present challenges with regard to incorporating powder dispersion units into processing lines.

Most powder mixing technologies require several motors for the supply pump, booster pump, agitator, discharge pump and tank cleaning device. This generally results in higher investment and energy costs. To address these issues, Alfa Laval has developed an innovative dispersion system that combines two individual types of equipment. This compact, highly reliable system features a single motor that handles all of the tasks of conventional powder mixing systems, yet delivers up to 50% in energy savings, superior mixing efficiency, reliable and repeatable mixing quality, and product homogeneity.

## The challenges of dispersing powdered ingredients

There are various types of powdered ingredients added to food processing lines.

*Easy-to-disperse powdered ingredients*, such as granulated sugar or skimmed milk powder, generally do not pose lumping problems because moderate shear is sufficient to ensure rapid dispersion and dissolution of the individual powder particles. However, moderate shear proves challenging when dispersing texturizing additives and water-binding powdered ingredients, such as hydrocolloids or concentrated protein powders.

*Texturizing additives in powder form* are used in many food formulations to optimize texture and mouthfeel. These include, for example, xanthan in vinaigrette, pectin in yoghurts and fruit preparations, sodium carboxymethyl cellulose (CMC) in beverages, and alginates in desserts and ice cream. Due to the exceptionally high water-binding properties of these hydrocolloids, the dosing level is very low, typically between 0.1 and 0.5 percent of the formulation and sometimes even less. However, these high water-binding properties also pose problems during dispersion. When the powder comes into contact with water or

other liquids, its outer surface immediately forms a gel layer, which then prevents water from penetrating and hydrating the core of the powder mass. If the dispersion method proves inadequate, it causes the formation of small gelatinous lumps, called 'fish eyes' (Image 1), which are very difficult to disintegrate. These lumps usually are retained in filters along the processing line, but may also end up in the final product. This lost fraction of texturizing additives impacts the quality of the food product, reducing the desired effect in the final product.

Image 1. Lumps, or 'fish eyes', formed during dispersion of a pectin slurry.



*Protein ingredients in powder form* generally contain between 70% and 90% protein and are added for their nutritional and texturizing properties. Typical protein ingredients include caseinates, whey protein concentrates or vegetable protein isolates. During dispersion, these protein ingredients present issues that are similar to those of hydrocolloids; the core of the powder mass hydrates very slowly. Some manufacturers, in fact, put the mixture into cold storage overnight under moderate agitation in order to ensure complete hydration before further processing.

#### **Optimal powder dispersion methods for small and large food processing plants**

One of these two methods is typically used to disperse powdered ingredients into a liquid phase, such as water or milk:

(1) *Dispersion onto the surface of a liquid in a tank*, by pouring the powdered ingredient directly over the surface of the liquid in a dispersion tank during agitation.

(2) *Dispersion using a powder mixer*, either in-line while transferring the liquid between two tanks or, more commonly, during recirculation in a dispersion tank until the entire amount of powder has been dissolved.

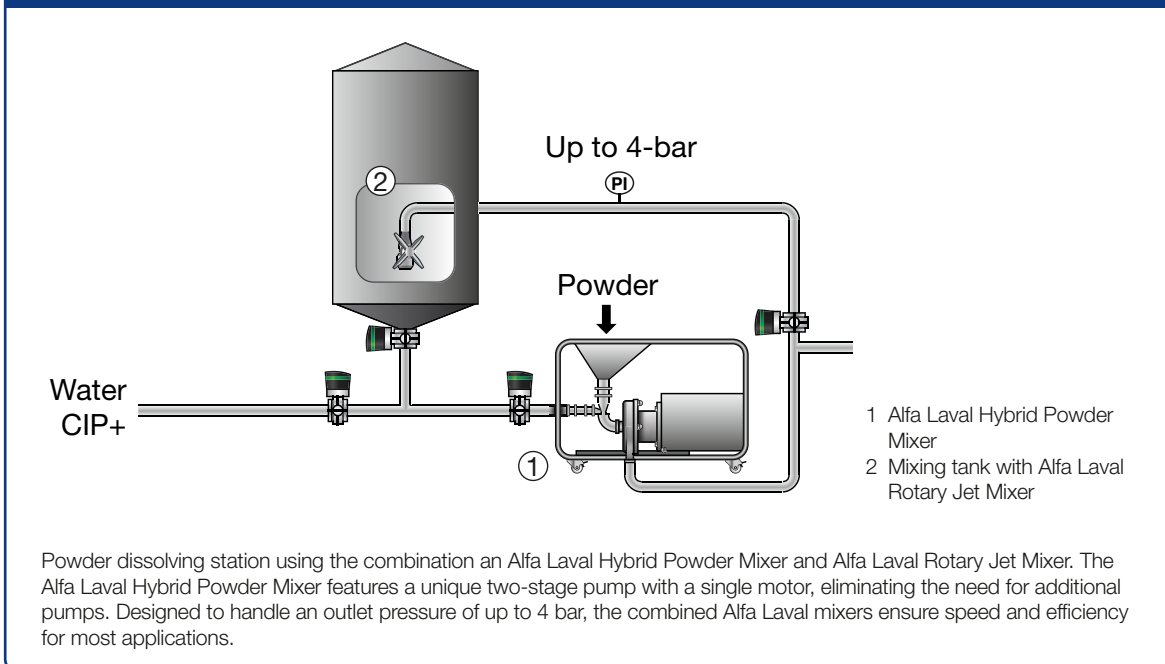
Using an inadequate powder dispersion method and inadequate mixing equipment results not only in productivity losses, but also in inferior product quality. To prevent lumping and achieve complete hydration of the powdered ingredients, extra buffer tanks may be required.

To better understand the requirements for efficient powder dispersion, let's take a closer look at the two powder dispersion methods.

*Dispersion onto the surface of a liquid in a tank.* To prevent or minimize lumping, the dispersion of hydrocolloids onto the liquid surface in a tank is best accomplished using a turbine mixer to ensure strong mixing. This method, however, poses the risks of air entrapment and foam formation. After the dispersion phase, additional agitation at slow speed is generally required in order to completely hydrate any lumps that form and to get rid of unwanted foam. In addition, when the size of the mixing tanks exceeds a few cubic meters, the energy requirements to maintain high shear throughout the entire volume of a viscous mixture generally leads to designs with oversized turbine mixers. This is why dispersion of powdered ingredients onto the surface of a liquid in a tank is primarily used in small food processing plants.

*Dispersion via a powder mixer.* As soon as the capacity of a powder dispersion system becomes a bottleneck in a food processing line, a dedicated powder mixer is the preferred solution. This type of equipment generally consists of a modified centrifugal pump, where powder is aspirated through a funnel and dispersed into the circulating fluid. A grid with perforations, or slots, at the periphery of the pump stator helps break up any lumps that form prior to mixing with the fluid.

Image 2. Powder dissolving station



There are essentially two types of powder mixers designed for food applications:

- Single-motor powder mixer. This type of mixer features a pump designed to provide a good flow pattern for powder dispersion. With its relatively low investment cost, this mixer is well suited for use with non-lumping powders and when the end-product viscosity does not exceed 300 - 400 cP. Should viscosities exceed this limit or if the interstitial air trapped between the powder particles becomes entrained in the loop, both the circulation speed and output pressure rapidly decline. This results in a sharp decrease, or complete stop, of the flow of powder from the funnel, making single-motor powder mixers unsuitable for difficult-to-handle powders, such as texturizing additives or concentrated, high-viscosity solutions.
- Double-motor powder mixer. To overcome the limitations of single-motor powder mixers, some food manufacturers equip the single-motor powder mixers with an additional pump. This use of two pump motors ensures uniform flow and constant suction, even as the

viscosity of the mixture increases. This type of powder mixer is generally well suited for dispersion of texturizing additives. However, the addition of a second pump has a significant impact on investment costs and doubles energy costs as well.

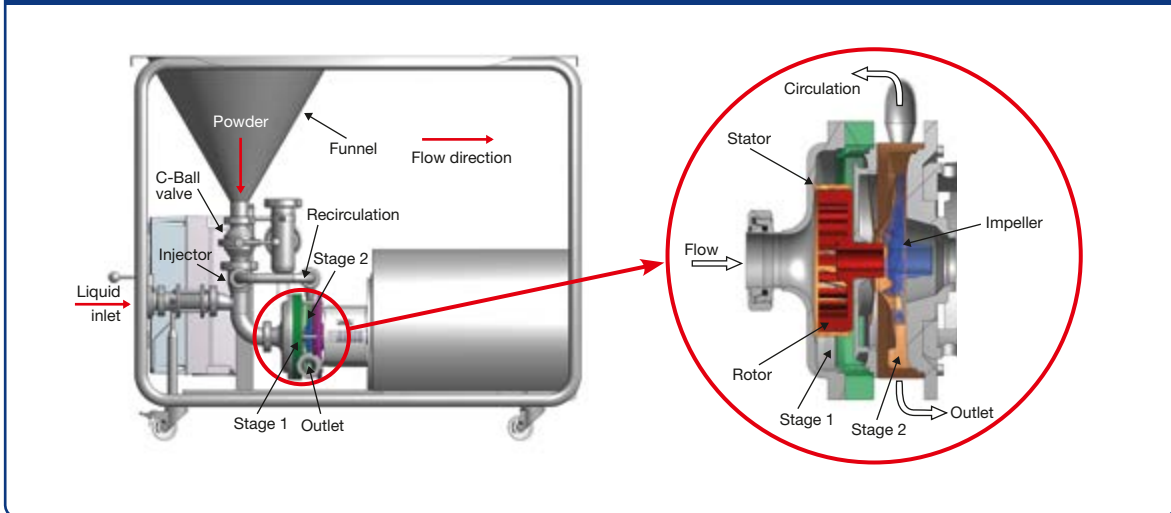
#### Innovative and energy-efficient powder dispersion technique

The Alfa Laval Hybrid Powder Mixer used in combination with the Alfa Laval Rotary Jet Mixer offers an innovative way to deal with powder dispersion issues. Food manufacturers can now take advantage of optimal mixing efficiency and low cost of ownership. By combining the two units into a single, highly efficient system, Alfa Laval enables instant and uniform dispersion of even the most challenging powdered ingredients using a single motor. After completion of the mixing cycle, the same system may also be used to drain and clean the tank (Image 2).

#### *Alfa Laval Hybrid Powder Mixer*

Unlike conventional powder mixers, the Alfa Laval Hybrid Powder Mixer creates high dynamic shear in three steps using a single motor shaft

Image 3. Alfa Laval Hybrid Powder Mixer; how it works



(Image 3). This requires less energy to ensure complete dissolution of the powder.

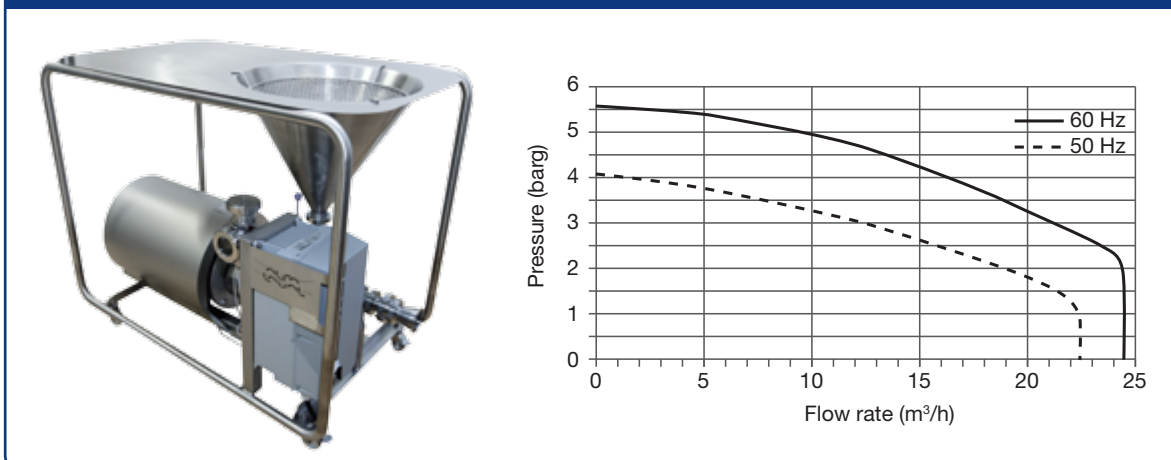
- Step 1: The injector pre-blends the powder and liquid
- Step 2: The rotor/shaft provides the main shear
- Step 3: The impeller provides additional shear and pumps out the mixture under high pressure

These three steps provide high flow velocity, thereby reducing the risk of blockage. This is particularly relevant when processing shear-thinning

texturizing additives because energy consumption can be kept low even when blending high-viscosity food products.

The Alfa Laval Hybrid Powder Mixer features a uniquely designed two-stage pump, one rotor-stator stage and one pump stage fitted with a motor with a frequency converter. The pump enables an output pressure of up to 4 bar without requiring an additional pump. It also drives the circulation loop to the mixing tank (Image 4). Due to its high output pressure, the Alfa Laval Hybrid Powder Mixer may also be used as a

Image 4. Alfa Laval Hybrid Powder Mixer M15 with pump curve (water).





discharge pump to empty the mixing tank after powder dispersion has been completed.

The Alfa Laval Hybrid Powder Mixers is available in two models:

- Alfa Laval Hybrid Powder Mixer M15. This premium M15 model comes mounted on a mobile frame and equipped with a frequency transformer. Extremely versatile, it enables the flow rate to be easily adjusted between duties. It can therefore handle easy-to-disperse or hard-to-handle powders with ease, recirculate liquid to the dispersion tank, discharge liquids from the tank, or help conduct Cleaning-in-Place.
- Alfa Laval Hybrid Powder Mixer S15. This cost-optimized S15 model comes mounted on a static frame without a frequency transformer. The flow rate can be adjusted using either the inlet valve or an external transformer.

*The Alfa Laval Rotary Jet Mixer*

Installed inside the mixing tank on the circulation loop, this rotating four-nozzle device is powered by the product flow and pressure from the Hybrid Powder Mixer (Image 5).

Image 5. Alfa Laval Rotary Jet Mixer.



- Efficient powder dispersion. The Rotary Jet Mixer actually provides a fourth step for additional shear. When it flows through the nozzles, the product experiences substantial shear, which promotes the disintegration of any remaining lumps. This speeds the dispersion of the most challenging powdered ingredients and ensures product homogeneity without having to add an agitator.
- Self-cleaning system. In addition to providing efficient powder-dispersion, the Alfa Laval Rotary Jet Mixer can also be used as highly effective tank cleaning machine for the mixing tank.
- Time- and energy-efficient dissolution. Powdered ingredients are therefore already dissolved when entering the tank, making recirculation unnecessary. This saves time, reduces energy consumption and boosts production capacity.

**Outstanding performance with energy savings**

Alfa Laval Hybrid Powder Mixer has been successfully tested and installed for use in various food and beverage applications – both as a stand-alone mixer and as part of a complete powder dissolution station in combination with the Alfa Laval Rotary Jet Mixer. Combining the Alfa Laval Hybrid Powder Mixer with the Alfa Laval Rotary Jet Mixer provides high-speed mixing efficiency and ensures gentle handling. The efficient mixing pattern ensures dispersion of the powder in individual particles and immediate hydration in the fluid mass.

The combination has proven especially efficient in achieving product homogeneity when dispersing texturizing additives such as CMC, pectin, xanthan or carrageenan. As versatile as it is reliable, the mixing system easily handles high-viscosity fluids, such as a 3% solution of high-viscosity CMC, but can also handles rapid dispersion of sugar and milk powder at several tons per hour.

For more information or to set up an on-site factory trial with a mobile Alfa Laval mixing unit, contact [frederic.liot@alfalaval.com](mailto:frederic.liot@alfalaval.com).

## **Optimal mixing efficiency from Alfa Laval**

The combination of the Alfa Laval Hybrid Powder Mixer and Alfa Laval Rotary Jet Mixer provides food manufacturers with optimal mixing efficiency and these unique benefits:

- Easy installation: Combine both the pumping and powder-mixing functions into a single unit.
- Reduced operating and maintenance costs: Unlike conventional mixing systems that require up to four motors (supply pump, discharge pump, Cleaning-in-Place pump, agitator motor), a single electric motor from one pump powers the complete Alfa Laval mixing system.
- Pump, pressure and tank cleaning versatility
  - No need for an additional pump: A single pump creates pressure of up to 4 bar while aspirating the powder.
  - No need for a separate discharge pump: The Alfa Laval Hybrid Powder Mixer pump can also be used as a discharge pump to empty the mixing tank.
  - No need for separate tank cleaning equipment: The Alfa Laval Rotary Jet Mixer can be used as tank cleaning machine since this device is a reengineered rotary jet head tank cleaning machine.

## About Alfa Laval

Alfa Laval is a leading global provider of specialized products and engineered solutions that help customers heat, cool, separate and transport products such as oil, water, chemicals, beverages, foodstuffs, starch and pharmaceuticals.

Alfa Laval's worldwide organization works closely with customers in nearly 100 countries to help them stay ahead in the global arena. Alfa Laval is listed on Nasdaq OMX, and, in 2015, posted annual sales of about SEK 39.7 billion (approx. 4.25 billion Euros). The company has about 17 500 employees.

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With more than 25 years of experience in food industry, Frédéric brings vast experience in the product development, upscaling and start up of new productions, process optimization, innovation and new business development. During his career, he has focused on food ingredients, food science and technology. He holds a Masters of Science degree in Food & Agronomy from ENSA Rennes, France.

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### Michael Stenderup Portfolio Manager, Mixers and Agitators, Alfa Laval



With vast experience in the food, pharmaceutical, energy industries, Michael manages Alfa Laval's mixer and agitator portfolio. Prior to joining Alfa Laval, he served in various sales, marketing and management capacities for technology sales and industrial automation companies where he focused on business development and strategy, key account management and international sales. Michael holds bachelor degrees from the University of Southern Denmark (Graduate Diploma in Business Administration) and the Copenhagen School of Marine Engineering and Technology Management.

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