Thinking Ahead

How to improve pectin dispersion in fruit preparations

Selecting the right powder mixing equipment to ensure high productivity and top quality

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Improved pectin dispersion using Alfa Laval Hybrid Powder Mixer for fruit preparations

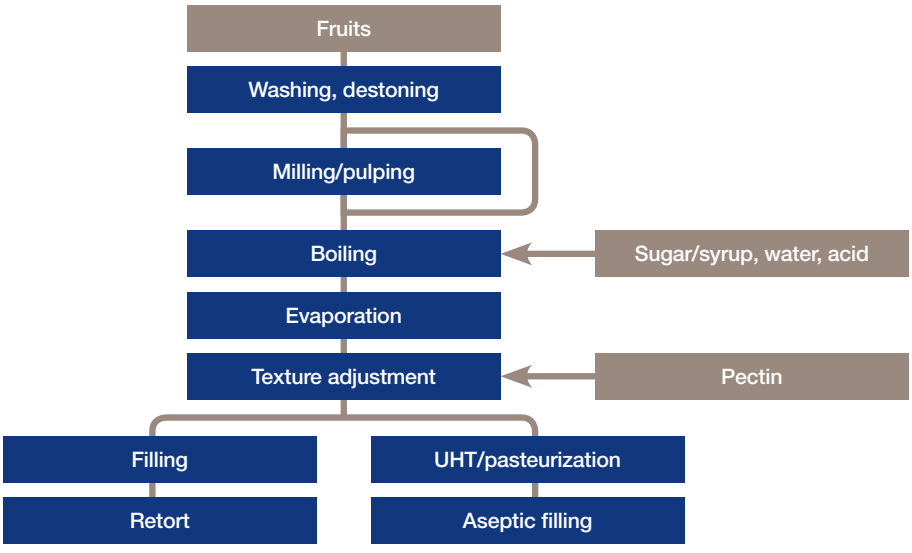
Preparing concentrated pectin solutions from pectin powder presents challenges to producers of jam, jelly, fruit spreads and industrial fruit preparations. Pectin powder is difficult to disperse and, once added to liquids, becomes highly viscous. It is therefore important to select the right powder mixing equipment to ensure high productivity and top quality. Alfa Laval has tested the Alfa Laval Hybrid Powder Mixer for these challenging applications. Test results indicate that this powder mixer can efficiently prepare fully hydrated pectin solutions at concentrations of 8% or higher, thereby ensuring optimal functionality.

Introduction

Worldwide production of fruit preparations in 2017 amounted to 2.1 million tons, according to Euromonitor. Over the past few decades, this industry has experienced solid growth – not only in retail segment through the sales of jams, jellies and fruit spreads, but even more pronounced in the food service and industrial fruit preparation segments. Fruit yoghurt accounts for approximately 72% of the fruit preparation volumes used by the food industry; the remaining volumes are used in biscuits, pastries, ice creams, desserts, sauces and other food items.

To adapt fruit preparations for use in the final products, food manufacturers must add texturizing agents such as hydrocolloids. Pectin,

Figure 1. Typical flow chart for industrial fruit preparation process.



preferably in the form of a concentrated solution, is the main texturant used by the food industry for fruit preparations. This fruit-derived hydrocolloid provides short texture and high body. Moreover, it enables the consistency to be fine-tuned to the specific application. In 2017, the food industry used a total volume of 60,000 tons of pectin as a gelling and stabilizing agent; since 2012, pectin used in the food industry has experienced an annual growth rate of 3.5%.

As with other hydrocolloids, preventing the formation of undissolved powder lumps during pectin hydration is a major challenge for fruit preparation producers. Proper dosing and mixing, for instance, is important to achieve the right texture of the fruit preparations. Specifying the right equipment and adhering to proper processing procedures are critical to the colour and flavour of the fruit preparations as well as to high productivity.

Figure 2. Whole fruit used in fruit preparations.

Figure 3. Alfa Laval Hybrid Powder Mixer.

Incorporating pectin in fruit preparations

Each fruit preparation has unique properties but generally shares a common sequence of processing steps (Figure 1). In a jacketed vat, the fruit is usually heated with sugar and other ingredients. For whole-fruit or cut-fruit preparations (Figure 2), gentle agitation is essential to maintain fruit integrity. During the heating process, equilibration between the fruit pieces and the matrix takes place. If necessary, the fruit then goes through an evaporation process to remove water, thereby achieving the desired dry matter. By using a concentrated pectin solution, this step can be either avoided or shortened, which has a significant positive impact on processing time and the quality of the fruit preparation in terms of flavour and colour preservation.

The addition of pectin, typically in the range 0.4% to 0.8%, takes place at the end of the process before standardization and cooling. The late incorporation is necessary for two reasons:

- First, the addition of pectin at an early stage may increase the viscosity, which reduces the heat transfer efficiency during boiling and evaporation.
- Secondly, although pectin is quite resistant to heat, the pectin molecule starts to hydrolyse when kept at elevated temperature for prolonged periods. Other more heat-resistant texturants such as guar, LBG or xanthan, may be added earlier in the process to improve hydration, or when hot viscosity is necessary to ensure proper distribution of fruit pieces in the vat.

However, incorporating pectin into the concentrated viscous fruit preparation at this late stage is a technical challenge. If added directly, it would form lumps of non-hydrated powder, which would remain in the final product as gelatinous beads (fish-eyes). Also, the shear required for dispersing the powder would damage whole or cut fruit pieces.

To prevent lumping, producers use one of following techniques:

1. *Dry blending pectin powder with sugar:* Before adding it to the vat, pectin powder is blended with two to four parts of granulated sugar to keep the pectin particles separated, thereby preventing lump formation.

   The upside: Dilution with water is not required.

   The downside: Dry blending is costly, requires a separate dry room, and the blend must be dosed as a powder from the top of the vat.

   As an alternative, pectin can be dispersed at 10% in fructose or glucose syrup, to become pumpable. However, in both cases, pectin hydration after dispersion is slow, and this method is only used for total solid content below 25%.

2. *Pre-dispersal in pure water as a concentrated solution.* This method ensures full pectin hydration and allows homogenous mixing with the fruit preparation at minimal shear in the vat.

   The upside: The pectin solution can easily be dosed and sent to several vats from a single pectin concentrate tank with a volumetric pump. Pre-dispersal in water is preferred by fruit preparation producers because it affords greater flexibility.

   The downside: To prevent dilution of the fruit preparation, the pectin solution must be as concentrated as possible, preferably 8% or above, which results in high viscosity. For this reason, selecting an efficient powder mixer for pectin dispersion is critical to ensure both high quality and productivity.

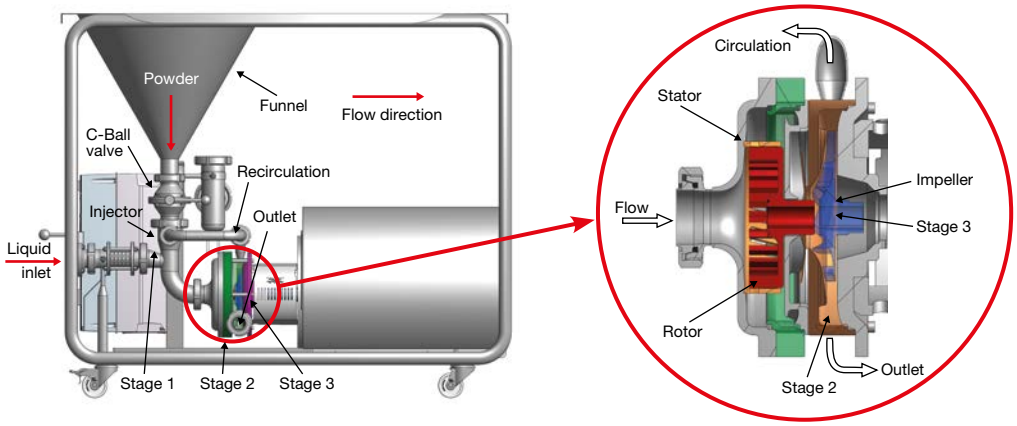
Innovative solution for high-efficiency powder dispersion

The Alfa Laval Hybrid Powder Mixer (Figure 3) is the only hygienic mixer capable of aspirating powder while simultaneously pumping out the viscous solution at pressures of 4 bar or more without requiring an additional pump. With its unique turbine design, this powder mixer uses a single standard motor to provide dynamic shear in three stages (Figure 4):

- Stage 1: The injector pre-blends the powder and the liquid.
- Stage 2: The rotor/stator creates the main dynamic shear.
- Stage 3: The impeller adds additional shear and pumps out the concentrated pectin solution at high pressure.

The combination of several shear stages and high outlet pressure provides high flow velocity, which makes the Alfa Laval Hybrid Powder Mixer especially well-suited for processing viscous products, such as hydrocolloid solutions.

Figure 4. Details of the turbine used in the Alfa Laval Hybrid Powder Mixer.



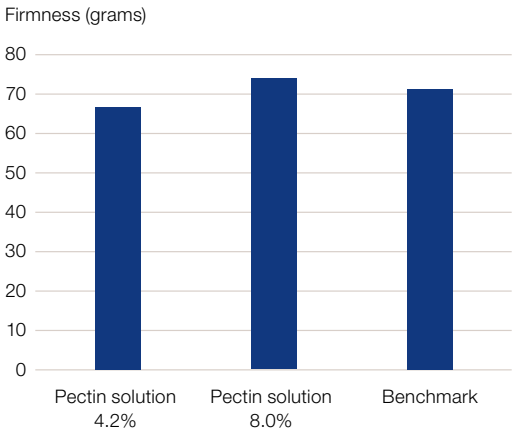
Highly efficient preparation of concentrated pectin solution

To demonstrate its efficiency in preparing concentrated pectin solutions, the Alfa Laval Hybrid Powder Mixer has been tested in a series of dispersion tests, using GRINDSTED® Pectin SF 530 by DuPont™ Danisco®. This medium calcium-reactive pectin is specially designed for jams and other types of fruit preparations.

Testing took place at the Alfa Laval Test & Training Centre in Denmark. The Alfa Laval Hybrid Powder Mixer was installed on the recirculation loop of a holding tank filled with water at 80°C, without an additional circulation pump. The target pectin concentration was set at 8%. To measure the impact of pectin concentration, solution samples were taken at various intervals immediately at the outlet of the Alfa Laval Hybrid Powder Mixer during dispersion. The samples were filtered over a one-millimetre mesh sieve. No lump of undissolved powder was observed; the pectin was fully dispersed and immediately hydrated.

The solution viscosity and powder dispersion capacity of the Alfa Laval Hybrid Powder Mixer were monitored against the pectin concentration (Figure 5). As the pectin concentration in the solution increased from 2% to 8%, the dispersion capacity decreased by approximately 50%, while the pectin viscosity increased to above 200 cP under shear. Although this range of viscosity does not seem especially high, it corresponds to very strong water binding and limited hydration speed of the last added fraction of pectin.

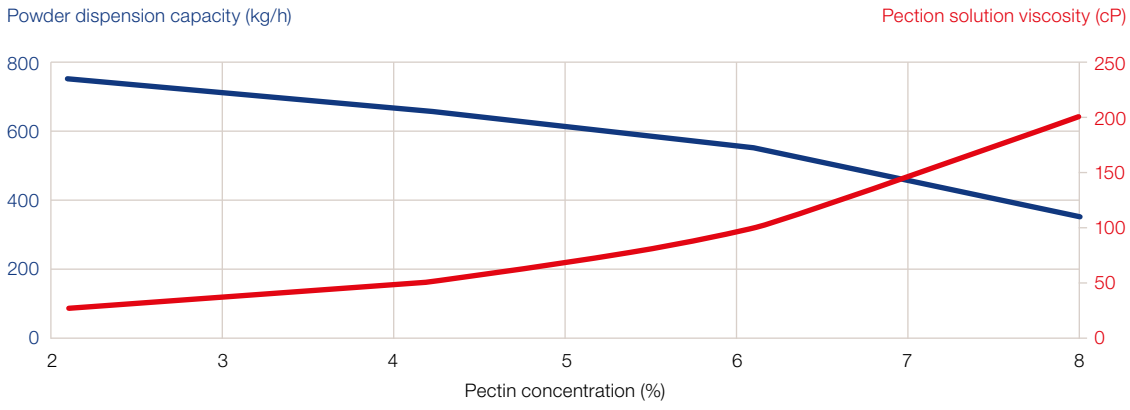
Figure 5. Evaluation of pectin solutions in model fruit preparation.



The performance of 4.2% and 8% pectin solutions used in the Alfa Laval Hybrid Powder Mixer provide the same texturing effect as that of the dry-blend pectin used as a benchmark.

The pectin solution produced by the Alfa Laval Hybrid Powder Mixer was tested at concentrations of 4.2% and 8% in a fruit preparation against a benchmark based on pectin powder. The dispersion efficiency was evaluated by measuring the final texture in the fruit (Figure 5). Results showed that functionality of the 8% solution was as good as the benchmark and the 4.2% solution; in other words, pectin dispersion and hydration had been fully achieved at this high concentration.

Figure 6. Effect of pectin concentration.



Alfa Laval Hybrid Powder Mixer: The effect of pectin concentration on dispersion capacity and pectin solution viscosity.

Real-life performance under actual working conditions

The dispersion capacity of a powder mixer under actual working conditions differs significantly from the overly optimistic values seen in commercial brochures, which are measured immediately upon starting powder dispersion. The dispersion capacity must take into consideration both the target concentration as well as the exact viscosity profile of the products tested. This is especially important for pectin and other hydrocolloids, for which the viscosity increases exponentially with the concentration. Furthermore, high viscosity results in a pressure drop in the circuit of a powder dispersion unit, which makes the outlet pressure a critical parameter for maintaining flow without requiring an additional booster pump.

The Alfa Laval Hybrid Powder Mixer has the capacity to prepare an 8% pectin solution at the rate of 380 kilograms per hour of pectin powder, corresponding to 4,750 kilograms per hour of pectin solution. In other words, a single Hybrid Powder Mixer is sufficient to supply at least 47 metric tons per hour of fruit preparation, when taking into consideration a typical pectin dosage of up to 0.8%. This exceeds the current requirements of most fruit processing plants now in operation around the world. Practically speaking, the Alfa Laval Hybrid Powder Mixer can produce sufficient volumes of concentrated pectin solution in just 60 minutes to support several hours of fruit preparation production, thereby reducing the manual labour costs associated with powder dispersion.

Increasing pectin concentration even higher is another possibility. A pectin concentration of up to 9.5% has been tested with the Hybrid Powder Mixer. At this concentration, adjustments in design are required to overcome the pressure drop in the inlet line resulting from viscosity that is too high and to ensure sufficient feed flow to the dispersion unit.

Flexible, cost-saving design

A unique inline powder mixer, the Alfa Laval Hybrid Powder Mixer is able to disperse pectin uniformly into fruit preparation process tanks while simultaneously pumping out the preparation mixture at pressures of up to 4 bars. It features an optimized pump with a single motor drive, which is based on the high-efficiency Alfa Laval LKH centrifugal pump. Compared to other powder mixers that incorporate liquid-ring pumps, the Alfa Laval Hybrid Powder Mixer provides greater energy savings, lower maintenance costs and a quieter working environment.

With its self-cleaning design, the Alfa Laval Hybrid Powder Mixer can be used either as a stand-alone mixer or can be integrated in a dispersion skid. After the mixing is completed, this versatile powder mixer can also be used as a discharge pump or, when used with the Alfa Laval Rotary Jet Mixer, as a CIP pump to clean the tank interior.

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Interested in learning more?

The Alfa Laval Hybrid Powder Mixer can be tested at Alfa Laval facilities in Denmark. Mobile units are also available for on-site factory trials. For more information or to set up a trial using a mobile Alfa Laval mixing unit at your factory, contact michael.stenderup@alfalaval.com or frederic.liot@alfalaval.com.

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 2017, posted annual sales of about SEK 35.3 billion (approx. 3.6 billion Euros). The company has about 16,400 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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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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