Avoiding Agglomeration in the Mixing of Sensitive Ingredients

Using the vacuum expansion method to disperse without shear

Ystral
110% MIXING SOLUTIONS

PTI Powder Technologies Incorporated

The inherent issues with thickeners and stabilizers in food processing

The thickeners and stabilizers used by the food industry are shear sensitive. If they are mixed into liquids, agglomerates are initially formed, and these subsequently have to be broken down by dispersing. The solution to this problem is a technology where the primary particles of the polymer powder are separated by vacuum expansion before being inserted into the liquid, are then completely wetted upon their initial contact with the liquid, dispersed in situ under vacuum conditions and hydrated under overpressure – all free from agglomerates.

When used in food production, thickeners and stabilizers provide optimum rheology and texture to the final product, as well as a pleasant mouth feel for the consumer. Because they prevent the product from separating during mixing, and the dispersed ingredients from sedimenting or floating up, they are a common ingredient in many food products such as dressings, desserts, baby food and dairy products, to name a few.

However, there are a number of production issues that arise when using these ingredients. The first is their requirement for a colloidal dispersion in the liquid phase, even though used in low concentrations as a result of their strong thickening effect. This requirement is further complicated by the proteins resident in the food product, which are even more sensitive to shear than the thickening or stabilizing agents.

The specific properties of these thickening and stabilizing agents as powders also contribute to the difficulties in their processing. They form dust, they stick to surfaces, and traditionally form lumps and agglomerates. They are difficult to stir into a liquid and they float to the surface. If one tries to avoid this surface flotation by pulling them down from the surface with increased agitation, a vortex is created and air is always introduced into the product as well. This air is undesirable because it is difficult to remove. But even external addition of thickeners or stabilizers via injectors or in-line blenders is problematic, because likewise, these kinds of conventional systems are known for producing agglomerates by their very nature.

When lumps and agglomerates are formed, they must be broken down again. They then have to be further dispersed until all lumps are destroyed. In most of these thickening and stabilizing powders however, hydration begins immediately upon their first contact with water. They develop shear-sensitive polymer structures and form gels. From this point on, any further shear destroys the gel structure partially and reduces the thickening effect.

In order to compensate for the loss of this thickening effect, higher concentrations of thickeners, proteins and stabilizers are applied. This increases the costs of production. The quality is not improved. Flavors are masked. In the case of excessive thickener use, the flow and appearance of the product are unnatural. Ultimately, the look and image of the product suffers.

There are two basic issues causing the problems resulting from use of these agents. One is the formation of powder agglomerates every time the thickening or stabilizing powders are initially added to the liquid. The second is the damage caused to the already hydrated gel in the subsequent dispersion of these powders. To overcome this, one needs to employ a different method for the addition of thickening and stabilizing powders. This needs to be a method where no agglomerates are formed and where there is no need for a subsequent dispersion.

Dispersing by means of vacuum expansion

A highly effective way to avoid agglomeration when adding thickeners or stabilizers to the food item is to disperse under vacuum. Powders consist of individual particles that touch each other but have air between these particles. Air can be expanded under a vacuum so that the air between the particles increases its volume when this vacuum in applied. This effect can be used in a high-speed moving powder stream in order to separate the particles. As long as powder flows under vacuum, the air expands between the particles. The distances between the particles increase, separating the particles. As the thickening or stabilizing powder is dispersed from its container into the mixer, the vacuum increases. The higher the vacuum produced, the wider is the resulting particle distance. No additional air is added - only the air already present in the powder expands.

The YSTRAL Conti-TDS mixer uses this exact process in producing powder dispersion by means of vacuum expansion. The machine inducts and disperses powder directly into liquids. In order to do this, it builds up an extremely powerful vacuum in its dispersion zone. The powder is inducted into this dispersing zone. The closer the powder comes to the dispersing zone, the higher the vacuum becomes, the faster the powder flows and the further the distances are between the individual particles. In the dispersing zone, the powder particles come into contact with the liquid under maximum turbulence and they are completely wetted on an individual basis and colloidally dispersed. Agglomerates do not occur. Further subsequent dispersion is typically not required.

Fig. 1 - Separation of powder particles in the dispersing zone under vacuum pressure

At the moment it is wetted, the powder is not yet hydrated, and therefore, it is not yet sensitive to shear. Maximum dispersion is desired and required at this moment of initial wetting – not afterwards, not in a subsequent dispersion stage, and not in a downstream dispersing machine. The Conti-TDS wets and disperses in situ under vacuum within a small mixing chamber, while passing the thickener or stabilizer powder through the dispersing and wetting zone. The stress takes only fractions of seconds, better protecting the product and improving production outcomes, as well as producing significant energy savings. This is in direct contrast to traditional mixing methods of adding the powder to the top of a liquid and then spending hours to wet it within the entire tank.

Even hard agglomerated or porous powders with capillary structures in their interior are fully wetted in this way. This is due to the fact that these inner structures and capillaries are also filled with air in the initial state. The air in the interior also expands under vacuum as it approaches the dispersing zone. The complete wetting from the outside takes place under maximum vacuum. Subsequently, the agglomerate or porous particle is completely surrounded by liquid. When it is further conveyed together with the liquid, it goes from the maximum vacuum and dispersion zone into the surrounding zone of maximum overpressure and strong centrifugal action.

At this point in the process, the air in the inner capillary volume contracts like an implosion as a result of the overpressure drawing the surrounding liquid into the interior. Agglomerates immediately disintegrate due to the simultaneous dispersion. Porous particles with internal structures are wetted from the interior. The air which was previously contained in the powder and is now released, coagulates under the centrifugal effect of the rotor to form large air bubbles and is transported together with the liquid to the process tank, where it escapes through the surface of the liquid.

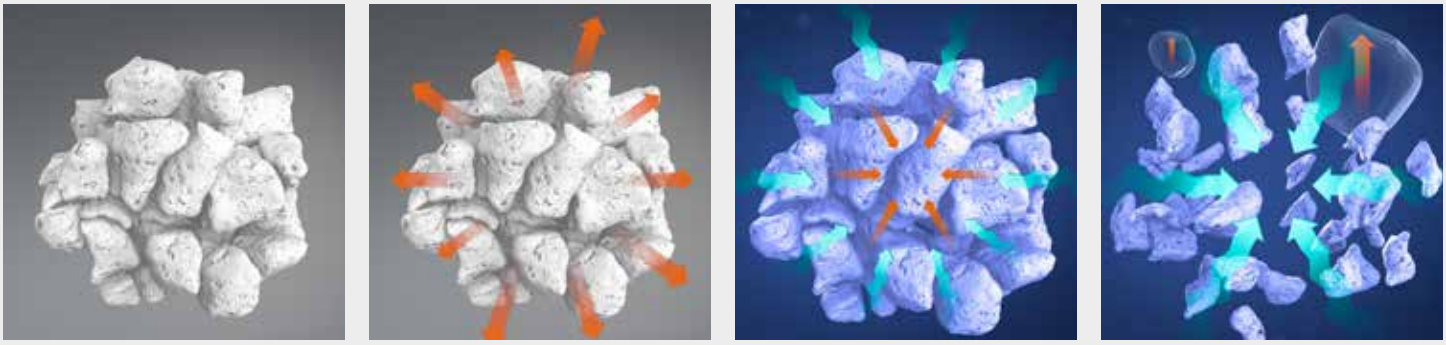

Fig. 2 - Wetting under vacuum pressure and deagglomeration under shearing and pressure

On the one hand, the method is characterized by particularly gentle dispersion, and on the other hand, by particularly fast dispersion and maximum utilization of the powdered ingredients resulting in faster production, less raw material, less energy, and higher quality product on a repeatable basis. It is used with great success in the manufacture of dressings, dairy products and desserts, as well as in the production of dough, ice cream premix, beverage concentrates, baby food and many other products in the food production sector. There are also many similar applications in the manufacturing of pharmaceutical products, cosmetics and the production of chemicals.

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Dr. Jacob is a senior process engineer and customer application specialist with ystral gmbh maschinenbau + processtechnik. Degreed in mechanical engineering and design at the Dresden University of Technology, he specializes in powder incorporation into liquids, dispersion and mixing.

About ystral – 110% MIXING SOLUTIONS

ystral is a fast-growing, owner-managed company active in mechanical and industrial engineering. Its focus is on designing and building custom mixing, dispersing and powder wetting machines and specialized mixing, dispersing and powder wetting systems for fluid mechanical engineering. In addition to mixing, dispersing and powder wetting, ystral also offers technologies for emulsification, homogenization and mixed dispersion processes. ystral is ISO 9001 certified and if required, machines and systems can be made in compliance with hygiene standards or explosion-protection standards.

The ystral head office is located in Ballrechten-Dottingen in the Baden region of Germany, near the borders of France and Switzerland.

YSTRAL Conti-TDS

PTI Powder Technologies Incorporated

PTI is the exclusive distributor of ystral products in North America. PTI prides itself on its ability to improve production processes and profitability with ystral high quality equipment and feasibility and engineering studies, process and plant design, installation, start-up, training, and maintenance and parts inventory. PTI has a fully equipped and staffed test facility, as well as rental equipment for on-site evaluation.

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