[Author]

Dr.-Ing. Hans-Joachim Jacob

Senior Expert Process and Applications

ystral gmbh maschinenbau + processtechnik

[About ystral]

The German machine and plant manufacturer ystral designs and manufactures highly efficient mixing, dispersing and powder wetting machines as well as process systems. Technologies from ystral are used worldwide in the chemical, pharmaceutical, coatings & inks, foodstuffs, home and personal care as well as battery production industries.

More information about ystral at www.ystral.com

[Headline]

New food: Processing of protein powders with the vacuum expansion method

Dr.-Ing. Hans-Joachim Jacob

[Intro Copy]

Whether it is a plant-based lactose-free alternative to milk, vegan ice cream or a meatless steak: The offer of non-animal food is continuously growing. The most important ingredients of these "new food" products are proteins, which have so far usually been plant-based. However, processing of these protein powders poses a challenge: In order to ensure optimum product quality, the proteins must be fully unlocked, starches must be degraded to the required degree, and agglomerates and foam must be avoided during production. All of this is achieved when processing protein powders in the vacuum expansion process.

[Main text with subheadings]

A glance onto the shelves of an ordinary supermarket or discounter shows: Vegan food increasingly takes up space here next to animal-based products such as meat or sausage or milk products. For example, as an alternative to animal milk, and in addition to oat, soy, rice, coconut or almond drinks, the range offered by food retailers increasingly also includes products based on plants such as peas, lentils, adzuki or fava beans, cashews or peanuts. Adding to this is a large number of further vegan products, from whipping cream and yoghurt to spreads.

While so far, vegetable proteins have been the most important ingredients of the “new food” products, in future, additional protein types are expected to increasingly gain in importance. This applies in particular to **fermented proteins**: Such proteins gained from bacteria or yeasts have a neutral taste, are inexpensive and resource-saving in their production, easily digestible, and contain – a crucial advantage compared to plant-based proteins – all essential amino acids as well as vitamin B12, which is indispensable for the human organism.

These novel foods require new technologies

What the alternative proteins used in the new food segment have in common is that they are difficult to process, and they also have very different characteristics: Wheat protein for example is extremely cohesive, while soy protein is extremely adhesive. If protein powders of seeds, grains, nuts and pulses are mixed into water, they are prone to clogging, agglutinating and foaming. The proteins are shear-sensitive on the one hand, but at the same time, they require high shearing while being dispersed into the liquid. Therefore, shearing under controlled conditions is required, in a very short period of time.

To achieve optimum product quality, what is crucial is that **agglomerates** that are contained in powders are instantly broken up fully when mixed into the liquid, and the formation of new agglomerates is prevented from the outset. Otherwise, these agglomerates must be broken down subsequently through long stirring and time-consuming redispersion - with negative consequences for the product quality: Dispersing the agglomerates damages the quaternary and tertiary structure of the already hydrated protein and impairs the viscosity and texture in an uncontrolled way.

Equally, with regard to the **starch** contained in the powder, the prevention of agglomerates is also very important. The degradation of starch usually occurs through enzymes, occasionally also through acids. If powder particles are already separated before the infeed of liquid, and highly dispersed during powder induction, the enzymatic degradation of the starch is supported and thus accelerated.

In case of **conventional agitators, injectors or in-line blenders**, however, the particles always come into contact with the liquid as compact discharge. This leads to sturdy, partially wetted agglomerates, which are difficult to break down. Redispersion then not only costs considerable amounts of time and energy - but the air, which is contained in the protein powder, is also dispersed to form undesired micro foam by this means. When protein powder is inducted into the liquid during conventional processing methods, it either fully flocculates, or sticks to the machine parts. This results in local overheating, discolouration or even burns on rotating parts and a slightly burnt taste of the end products. A large part of the proteins that were not fully unlocked is filtered out unused at the end.

Separation of powder particles through vacuum expansion

These problems of conventional process engineering solutions are avoided when using the vacuum expansion method of the mixing and dispersion technology specialist ystral: Here, the air contained in the powder is expanded by a multiple, which significantly enlarges the distance between the particles. The primary protein particles are separated before they enter the liquid, they are completely wetted on first contact with the liquid, they are dispersed in situ under vacuum, and are subsequently hydrated without agglomerates under pressure. The whole process takes 2 to 3 hundredths of a second, with minimal heat input. The powder is immediately completely disintegrated. No agglomerates are formed. The texture is not damaged or destroyed. The process time compared to conventional technologies is significantly reduced here.

Through this intensive dispersion, significantly less **enzymes** are needed for the degradation of starch compared to conventional procedures. The air, which was previously contained in the powder, is separated from the significantly heavier dispersion through the centrifugal effect of the fast-running rotor and coalesces to large air bubbles, which can easily escape in the process vessel. Foam, which is usually generated through protein processing, is almost completely prevented this way.

Versatile process options

The machine and system design from ystral can be precisely tailored to the requirements of the respective powder type. While for the processing of oatmeal for example - same as for soy and rice - dispersing in the vacuum expansion process with an inline operated powder wetting and dispersing machine YSTRAL Conti-TDS is sufficient, other powders containing protein (such as coconut or some pea flour) require additional dispersing under high shearing, to fully break down the product. In these cases, in addition to the Conti-TDS, ystral uses a Z-Inline Disperser, which redisperses the

protein powder, while the entire powder is inducted at the same time via the Conti-TDS. The Z-Inline Disperser can be operated here either in parallel in a separate circuit, or in series with the Conti-TDS.

With a special version of the YSTRAL Conti-TDS, **strongly adhesive and agglomerating powders** can also be processed. Compared to other Conti-TDS designs, no dispersing takes place at the time of wetting with this version. The powder is neither in contact with the rotor nor the stator, but is directly inducted into the liquid flow at high speed. This method is called direct injection. The fluid stream is checked in proportion to the liquid stream and the proteins already contained in this, to rule out concentrations that are too high by induction that is too fast. This occurs by means of control valves for protein concentrates or combinations. Nozzles are used for isolates and pure proteins.

In addition, **allergenic and non-allergenic powders** can for example be absorbed completely separately and processed in separate liquid circuits. A Conti-TDS can also be easily integrated into existing process systems and be piped with several process vessels or storage tanks. The disperser can either be operated inline or in the circuit on large process vessels, or generate a highly concentrated premix in a small batch, which is subsequently diluted in the main process vessels.

The quality of the end product is determined to a significant extent by the technology used

The mechanical processing technology has a tremendous influence on the taste, consistency, mouthfeel, and lastly also the visual impression of food – this also and particularly applies to the “new food” segment. To further improve acceptance of vegan products on the market, it is important that they do not exhibit any deficits compared to traditional products with regard to these factors. These demands are met by technologies from ystral and the dispersing of protein powders in the vacuum expansion process.

Figures and captions:

- **[Figure 1: Lead subject -** We recommend a non-technical subject as lead picture, e.g., different bags with seeds, grains, nuts and pulses]

[Caption]

The most important ingredients of “new food” products are proteins, which have so far usually been plant-based. For example, as an alternative to animal milk, and in addition to oat, soy, rice, coconut or almond drinks, the range offered by food retailers increasingly also includes products based on plants such as peas, lentils, adzuki or fava beans, cashews or peanuts.

(photo credit: Moving Moment - stock.adobe.com)

- **[Figure 2: YSTRAL Conti-TDS]**

[Caption]

With the YSTRAL Conti-TDS powder wetting and dispersing machine, even protein powders which are difficult to wet, which raise dust or are adhesive can be dispersed agglomerate-free. The particle unlocking can occur in cold or warm liquid.

(photo credit: ystral)

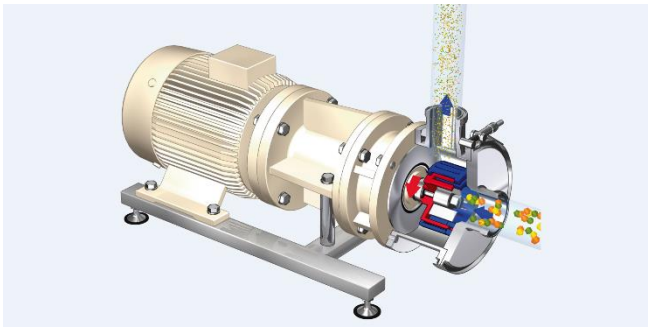
- **[Figure 3: Process System]**

[Caption]

Example of a process system with two bag infeeds, one big bag station, one YSTRAL Conti-TDS Inline dispersing machine and one process vessel with YSTRAL Jetstream Mixer.

(photo credit: ystral)

- **[Figure 4: YSTRAL Z-Inline disperser]**



[Caption]

The YSTRAL Z-Inline dispersing machine is used when proteins require a more intense dispersion.

(photo credit: ystral)