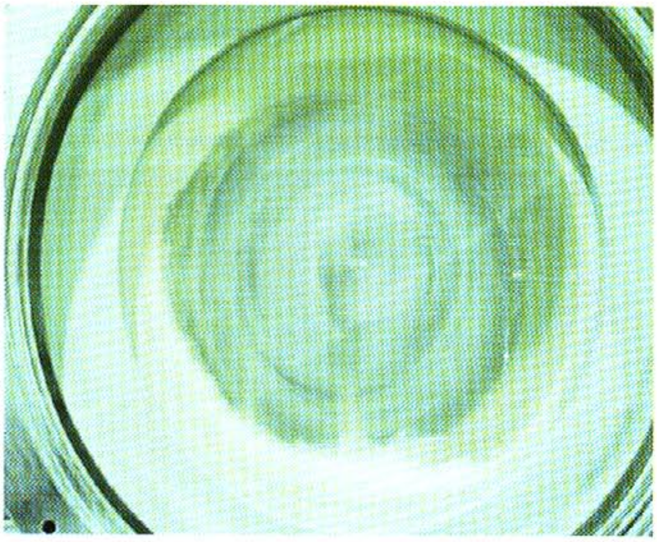
New Process in the Solid Liquid Separation: Safe Production even with a Wide Grain Size Spectrum

It is common practice to use centrifuge dryers for solid-liquid separation. Conventional centrifuge systems will fail with certain product properties, such as a wide grain size spectrum with a large fraction of fine grains. Thanks to a new production method, it is now possible to get around these difficulties in a safe and reliable way.

The known production sequence in a centrifuge dryer is as follows (Fig. 1): The suspension is filled into the filter drum through the drive shaft. In the centrifugal field, the solid material is retained by the multi-layer filter and the mother liquor passes through the product cake. In the following step, the filter cake is washed. After the washing process, centrifugation starts for mechanical dehumidification. The residual capillary rise can be reduced by applying an overpressure. In the next step, an extremely efficient and gentle thermal drying process with fixed bed drying and / or fluid bed drying starts: After dislodging the product cake - the solid particles are accumulated in a heap in the process chamber - either a stop-and-go process or a continuous process is typically used for the fluid bed drying.

In a stop-and-go process, the drum is positioned, a drying nozzle is moved towards the stationary drum and the drying gas is injected through the drum bottom openings into the segmented process chamber. (Fig. 2) The shot nozzles return to their initial position and the drum is rotated by a defined angle to the next opening. While the drum is successively rotated, the product is mixed thoroughly and uniformly dried.

Fig. 1: Filling a centrifuge dryer



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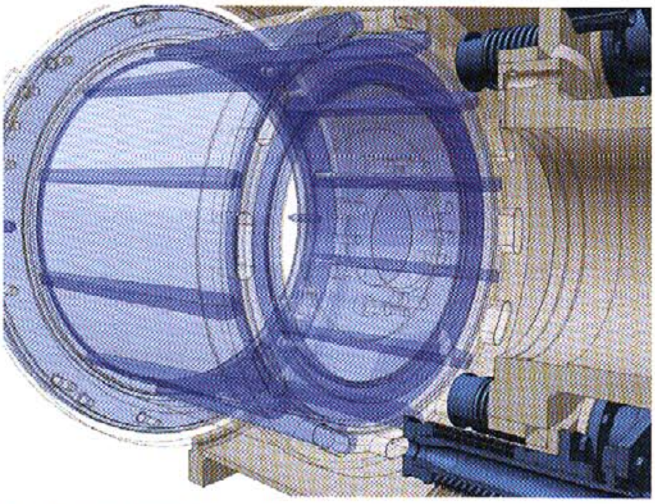

Fig. 2: Shot nozzles inject drying gas into the segmented basket

During continuous drying, the shot nozzles remain at a minimum distance from the drum bottom. The drum rotates continuously at low speed. Each time an opening of the drum bottom arrives in front of a shot nozzle, drying gas will be injected. Thanks to the continuous rotation of the drum, the solids are constantly whirled up, thus being dried in a very homogeneous, efficient and gentle manner.

For the fixed bed drying process, the product cake is not dislodged at the beginning. The drying gas is injected into the process chamber and dehumidifies the cake while flowing through it from the inside to the outside. During this process, the ring-shaped product is dried and then detached from the filter drum. This method allows a safe drying of the material without lumping.

Products with a wide particle size distribution (Fig. 3) and a high fines content, or with bimodal distribution (Fig. 4) can only hardly be dried with this process.

Centrifuging and drying of products with a wide grain size spectrum (Fig. 3) and a large fraction of fine grain (Fig. 4), i.e. with a bimodal distribution is not possible by using common processes, or only

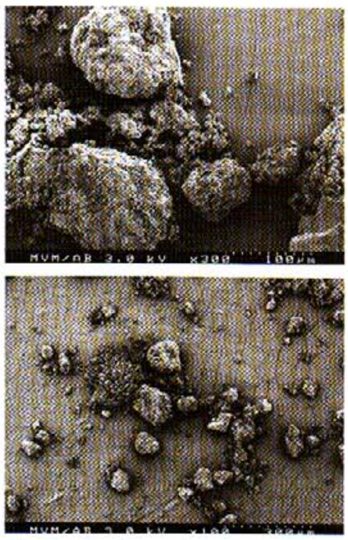

Fig. 3: Product with a very wide grain size spectrum under REM

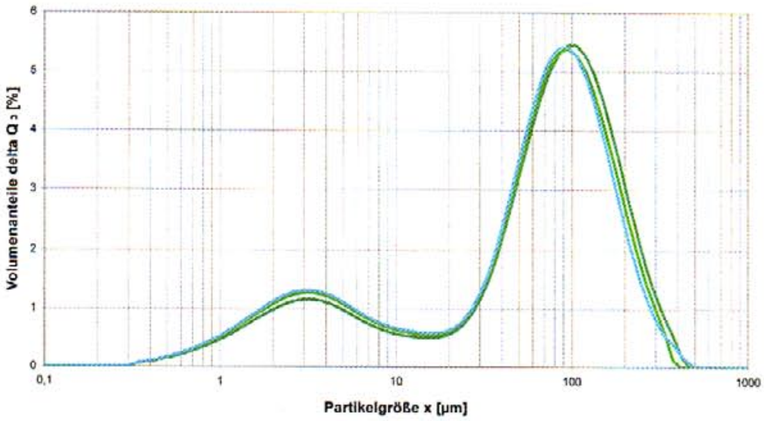

Fig. 4: Bimodal distribution with a large fraction of fine grains

with considerable effort. During filter cake forming, the interstitial spaces of coarser particles are filled with fine-grained material, thus preventing the liquid phase from draining off during filling. Consequently, the filtrate passes through the product cake only very slowly, the ring of liquid gets higher and is reduced extremely slowly. Additionally, as the ring of liquid remains in the process chamber for a rather long time, an undesired sedimentation is caused (Fig. 5).

Due to the different surface-to-mass ratio, larger particles sediment faster than finer particles in the centrifugal field outward on the filter cake. The smallest fraction floats longer in the ring of liquid and, at the end, the particles deposit on the cake, leaving an impermeable greasy film.

During washing and centrifuging, too, the filtrate speed is very low, which considerably increases process time. Better results cannot be achieved by increasing the rotation speed, i.e. by an increased C-value or overpressure, since the product cake is being highly compressed and even becomes less permeable to the drying gas during further fixed bed drying.

This is where the new filtering and drying variant comes in: Thanks to the counter pulse method, the product cake can be loosened in every process step. During filling and washing, the C-value is kept to a minimum, a ring of liquid is not produced, the risk of sedimentation and forming of a greasy film is excluded. With the counter pulse method, the product cake is not dislodged either during dehumidifying. With each rotation of the drum, each nozzle shoots in a different opening in the bottom of the drum.

The gas flows through the moist product ring, in the opposite direction to the centrifugal forces, from the outside to the inside. As this process is performed at a rather high speed, the product ring is constantly kept upright by the centrifugal forces in the filter drum. This guarantees that the product is loosened on the whole circumference of the drum, thus increasing its porosity and enabling its processing.

Additionally, in contrast with previous methods, the drying gas flows twice through the product cake: at first, when it is shot in, from the outside to the inside. As the gas must escape through the filter drum, it passes a second time through the filter cake, using the moisture transfer to the drying gas in a more efficient way.

In order to reduce the drying time, drying gas may additionally be blown through the filling shaft into the filter drum. Contrary to the conventional fixed bed drying, the gas flows more uniformly through the filter cake thanks to the increased porosity. In addition, as the product cake is constantly loosened, no drying cracks will be formed, thus preventing the additional gas from escaping through the filter drum without being used. The filter cake remains stationary and will not roll in the filter drum as it is the case with the stop-and-go or the continuous drying; materials with a tendency to agglomerate (Fig. 7) remain homogeneous and powdery.

After this process, the dried product (Fig. 8) will be discharged: For this purpose, the filter basket inside the still closed system is opened on the face and the powder is conveyed just by the rotation of the conical filter drum. A unit for gravimetric discharge, pneumatic or vacuum conveying is connected to this system.

Fig. 5: Sedimentation in the ring of liquid

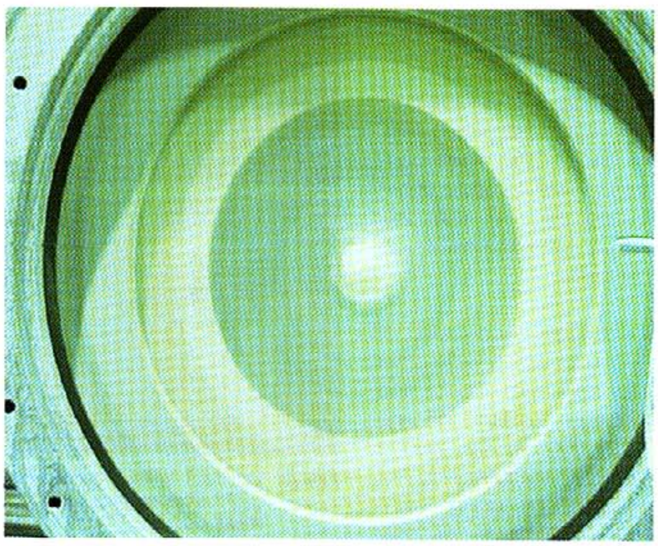

Fig. 6: Counter pulse method with moist product and low porosity

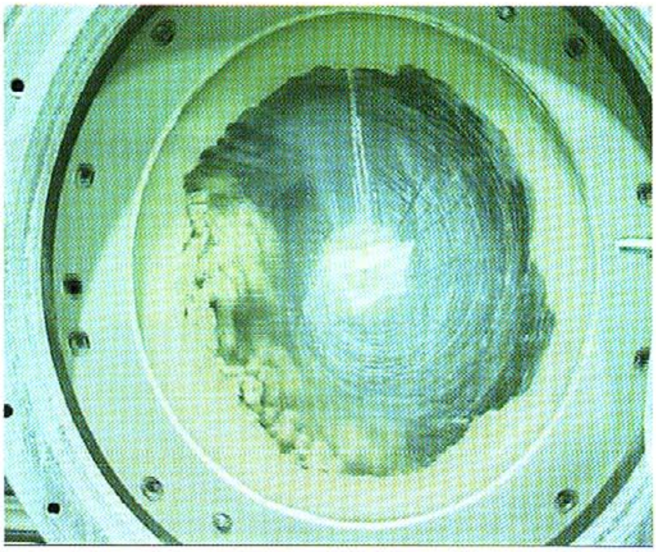

Fig. 7: Product with tendency to agglomerate in case of conventional drying

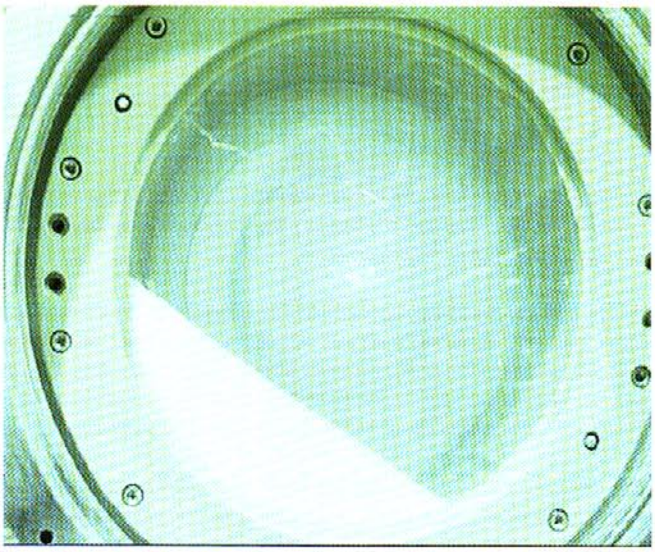

Fig. 8: Dry powder, ready to be discharged with no residual heel cake

The residual product in the filter is blown out through the shot nozzles. As the inner chamber of the centrifuge is free of any built-in parts, the system enables 100% product discharge without caking - it can immediately be used for the next batch (Fig. 9).

This counter pulse method has been developed by FIMA Maschinenbau (Obersontheim), with the option of upgrading existing systems. TZT centrifuge dryers can additionally be provided with CIP, SIP, PAT modules and an online sampling option (Fig. 10). This makes the centrifuge dryer especially suitable for toxic products in high containment systems. The hygienic design of the TZT is in accordance with GMP guidelines and prevents cross-contamination. FDA requirements are satisfied for all sealing systems.

Until now, TZT centrifuge dryers by FIMA (Fig. 11) have mainly been used in the pharmaceutical and chemical industry for the production of API's. Recently, however, we have seen

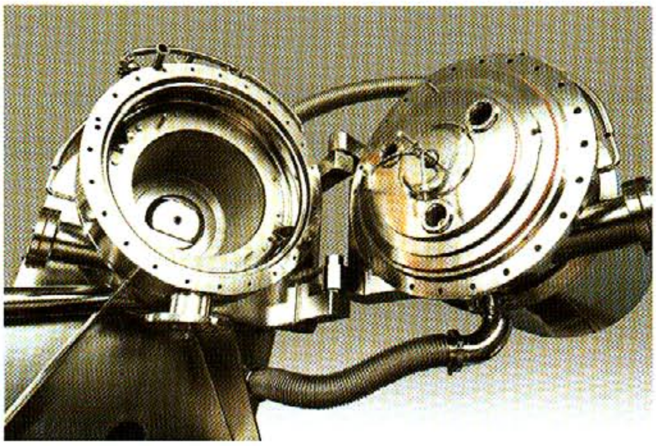

Fig. 9: Opened centrifuge dryer, filter drum and sealing plate

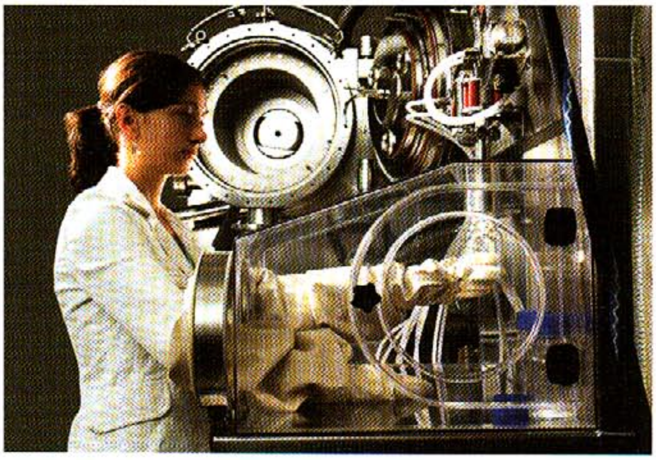

Fig. 10: Centrifuge dryer sampling for high containment

increased interest from other industries such as the fine chemistry, mineral or colour pigment industry. Depending on the application, systems are available for testing and production - the filling volumes range from 37 to 800 litres of suspension, corresponding to a cake volume of 20 to 400 litres.

The FIMA project and process engineers give advice to customers on the planning of their system, on its integration into the existing production process, on the selection of control system and software as well as on the periphery configuration.

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Fig. 11: Centrifuge dryer TZT 400SD