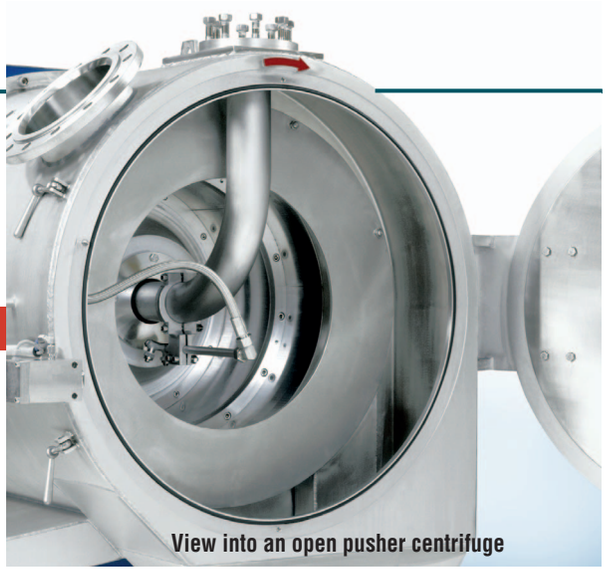
Hunting solids

Filter centrifuges for continuous or batch-type operation



View into an open pusher centrifuge

Most separating processes in chemical engineering are based on the classic separation methods such as distillation, solvent extraction, sedimentation and filtration. This article gives an overview on the separation of solids from liquid media using modern filter centrifuges.

For the separation of solids from liquids – an important stage in most chemical processes – there are primarily three methods to choose from, wherein the user either applies a difference in pressure or a difference in density to separate the liquid phase from the solid phase: sedimentation in the centrifugal field, filtration using a vacuum or overpressure and filtration using centrifugal forces.

Equipment is available for all of these methods, which either operate in continuous mode or in batch-type operation. The selection of the most suitable equipment type can be made using just a few process parameters which already allow an approximate selection, without necessitating suitability tests. This is where the particle size, solids concentration of the slurry and differences in density between solid and liquid phase play a decisive role.

In the event of very fine-grain slurries, with particle sizes of substantially less than 10 µm and low solids content, the filtration behaviour to be expected is relatively poor; in this case sedimentation equipment is preferably used. These include decanting centrifuges, plate separators or solid bowl centrifuges (vertical or horizontal). In the event of particle sizes of over 10 µm, a range of filter centrifuges of varied design are used in addition to vacuum filters. Filter centrifuges are roughly distinguished between types with continuous operation and types with batch-type operation.

Batch-type operation

Discontinuous or batch-type separation equipment is used when the greater part of the particles is less than 100 µm in size. The vertical centrifuge was the very first filter centrifuge, also known as "pendulum type hydro-extractor" or "three column centrifuge". It is still the most widely used centrifuge throughout the world today. Originally designed for manual feed and discharge only, today's modern variants operate fully automatically. But the relatively low speed of rotation achieved and the centrifugal forces being perpendicular to the natural gravitational force restrict the field of application considerably. Nevertheless, technical progress has reached this centrifuge design as well, and it is still popular on the market:

- perfect feed opposing the force of gravity is achieved with a rotating feed distributor;
- complete emptying using pneumatic residual heel removal;
- contact free feed level control.

In the horizontal centrifuge (peeler centrifuge; with or without rotary siphon) the basket rotates about the horizontal axis, like a modern washing machine. This centrifuge can also discharge the solids at high speed using a hydraulically operated peeler and is therefore of an extremely sturdy design. As a result of this it is able to reach high spin speeds and is therefore suitable for a wider spectrum of applications than the vertical centrifuge. Because the centrifuge forces run parallel to the natural gravitational force, the product distribution is more uniform. Horizontal centrifuges are today fitted with intelligent feed control systems, an automatic residual heel removal and automatic cleaning systems up to the pneumatic product discharge into a dryer.

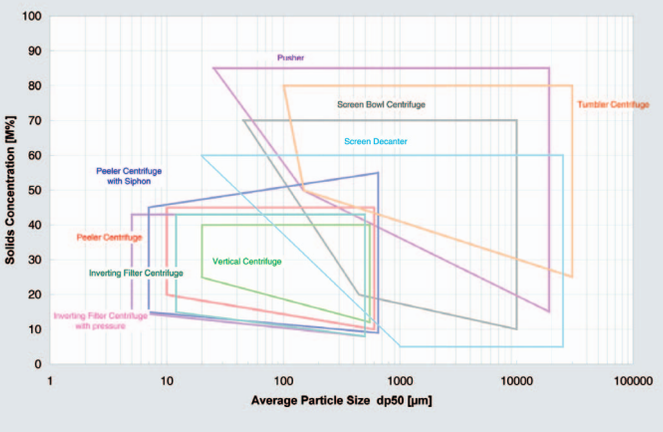
The horizontal centrifuge with rotary siphon adds differential pressure to the centrifugal force by lowering the pressure beneath the filter cloth to the vapor pressure of the mother liquor, caused by the geometry of the basket. This increased driving force accelerates the filtration and lowers the capillary lift in the filter cake. This not only increases the output of the siphon centrifuge but also broadens the application spectrum.

Also the inverting filter centrifuge processes the product in a basket which rotates about the horizontal axis. Only the form of emptying differs to that of the peeler centrifuge: the filter cake is pushed out of the basket using a pusher bottom. At the same time the filter cloth is inverted and the solids fall in lumps into the solids housing. This equipment is particularly suitable for all filter cakes that cannot undergo peeling. This complex and expensive design, however, only permits relatively low speeds. The inverting filter centrifuge is also available with a closed and sealed basket so that a pressure of up to 6 bar can be applied to the inner area of the basket, once the feed has been completed.

Continuous operation

In the event of the greater part of the crystals being larger than 100 µm, dewatering can be carried out using the continuous mode. Such centrifuges achieve throughputs which are many times that of centrifuges with batch-type operation.

The pusher centrifuge comprises one or several concentric baskets with slotted screens arranged parallel to the axis. A mechanically or hydraulically operated pu-



Fields of application for filter centrifuges

sher bottom pushes the filter cake built up on the rear wall of the basket towards the end of the basket in cycles of a second, step by step until the dewatered cake falls out of the basket. The slurry feed is continuous. The restricted residence time of the cake does limit the possibility of washing the cake. In addition to this the slurry should be pre-thickened. Modern pusher centrifuges boast feed systems which pre-accelerate the crystals and also an easy-maintenance modular design which minimizes down times in the event of wearing products. Products with a higher coefficient of friction are easier to process on multi-stage (up to 4 stages) pusher centrifuges. The operating mode of the worm screen centrifuge corresponds approximately to that of the pusher centrifuge. The cake, however, is conveyed using a worm screw which, in comparison with the conical basket, runs at a lower differential speed. Screen and worm screw are exposed to a high degree of wear. The crystals are very much reduced in size (grinding effect). Fields of application of pusher and worm screen centrifuge overlap to a certain extent.

A special design for niche applications is the tumbler centrifuge. For slurries with very coarse particles these centrifuges achieve throughputs of over 200 t/h. Without support from any conveying tool the solids cake travels along the length of the conical basket to the discharge chute, purely on the basis of the tumbler action. Cake washing is only possible in a restricted form. Typical applications are the treatment of coal and ore as well as the production of mass products such as Carnalit. The screen decanter supplements the sedimentation part of a standard decanter with a screen zone. The screen zone is connected to the conical part. In this way, cake washing and dewatering are to be improved. Similar to the action in the worm screen centrifuge, the cake is pushed along the screen zone by a conveyor screw. The screen decanter can process slurries with low solids concentration because the pre-thickening basically takes place in the sedimentation part; it is, however, prone to wear and particle breakage. The screen decanter has established a market for specific applications, e.g. in the soda industry. *jab*

„ An increase in machine safety and measures for boosting performance are the most frequent topics relating to modernization.“

Bernhard Prummer, Head of the Service Consulting, Krauss-Maffei Process Technology, Munich