Show centrifuge selection some consideration

Nigel Day, process development manager at Thomas Broadbent, explains the best way of selecting the right centrifuge for solids/liquids separation applications

When compared with alternative methods of solids/liquids separation, centrifugal processing provides a number of benefits but it is imperative that the most appropriate machine is selected for a specific duty. Doing this requires a thorough understanding of the various options.

Centrifuges can be installed in a relatively small footprint; have a high washing capability; produce low cake moisture; achieve a high capacity throughput and can provide the user with a totally enclosed and contained vapour-tight processing facility. Centrifugal filtration is also considered to be one of the most effective methods of removing impurities.

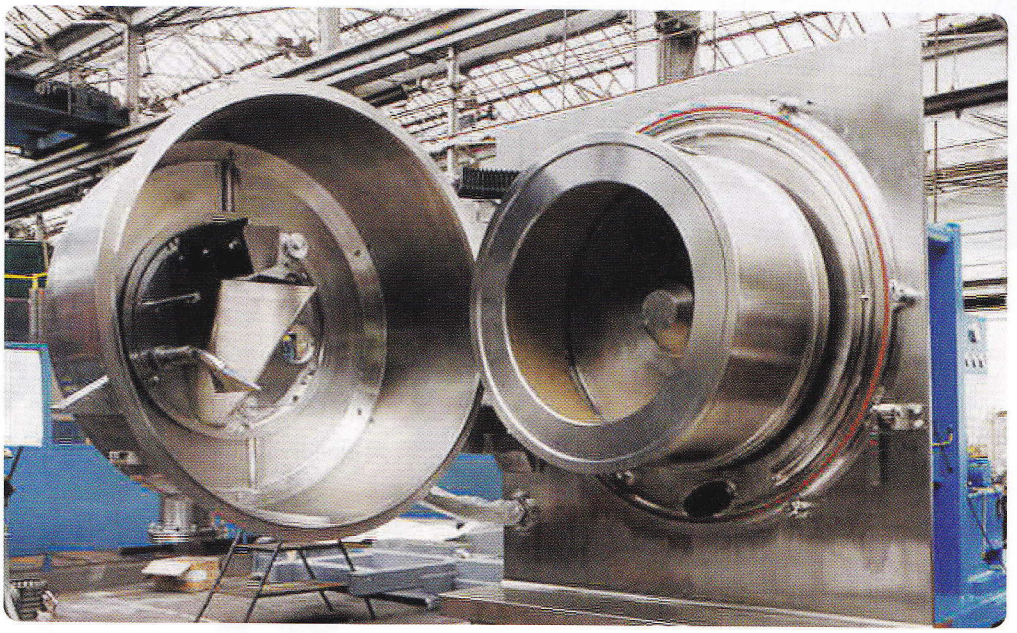
Correct selection of a centrifuge is based on two key concerns: economic expectations and technical requirements.

Before considering the various options, it is essential to clearly define the process, and pass this information to the centrifuge supplier at initial briefings. This means the supplier can then base screening tests and feasibility studies on relevant data.

Once the process is clearly defined, it is easier to identify variables such as the percentage of suspended solids, volumetric slurry throughput, solids throughput and the required product consistency at discharge. Materials usually exit the centrifuge in a powdered or granular form, but there are some instances in which it can also be discharged as a paste. Product consistency will to some extent dictate the method of materials handling and transportation.

The prospective user should also clearly define exactly what the centrifugal process is required to achieve. Does the material require clarification, classification, degritting, thickening, dewatering, washing or separating and repulping, and is the process a solid-liquid, liquid-liquid or a three phase liquid-liquid-solid duty?

Other considerations include the expected 'G' force; allowable cake dryness; allowable solids in the discharge liquors; product temperature; viscosity; specific gravity; pH and whether the process should be batch or continuous. If the centrifuge is to be used within the pharmaceutical or fine chemical industry, it may have to be manufactured to a GMP design with an integral CIP system.



Selecting the most appropriate centrifuge for the job requires a detailed understanding of the various options available as well as an accurate definition of the process

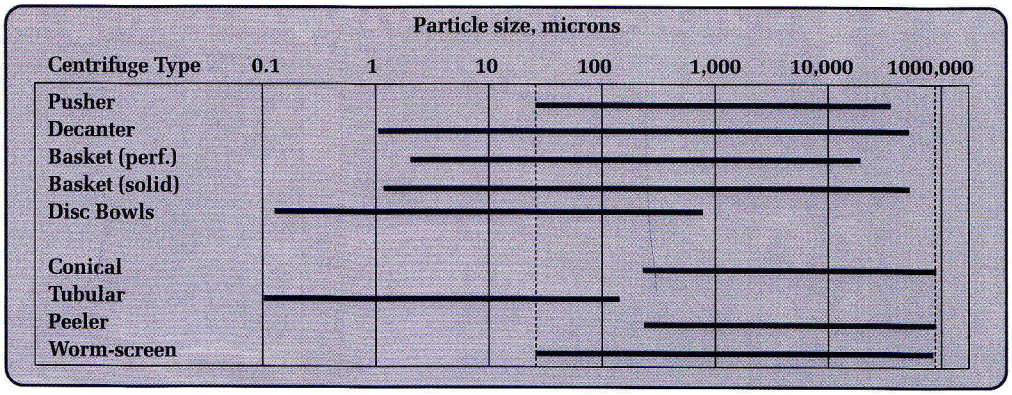
The decision to use a batch or continuous machine can depend on many factors. Batch centrifuges have few limitations on the wash function, whilst continuous machines are mostly limited to a wash-solids ratio of approximately 10%, with no more than a few seconds allocated to the wash zone before completing the operation. If, for example, the materials to be processed have low residual impurities and a high washing requirement, the greater flexibility of the batch processing will allow the necessary adjustment to satisfy individual needs such as extended washes and longer residence times.

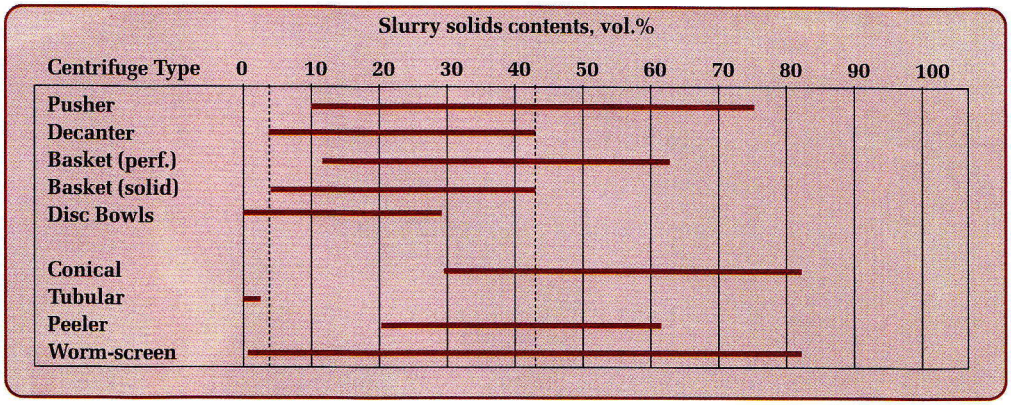
Particle size, distribution and shape are also important factors when determining separation capabilities and whether or not a batch or continuous centrifuge is the best option. Generally, materials which are predominantly 45 microns and above and relatively incompactable are suitable for separation by filtration equipment, whereas finer or compactable materials lend themselves more to separation by sedimentation. Experience has shown that in some instances, material compositions can be suitable for both batch and continuous processing, irrespective of size or shape.

In circumstances where it is necessary to ensure that there is no cross-contamination between batches, machines can be installed with pre-programmable, validated clean-in-place (CIP) washing systems, which also eliminate the need to open the casing between cycles for cleaning and maintenance. These machines suit pharmaceutical and fine chemical applications

Stringent codes of practice, influenced by recommendations of authorities such as the FDA - have created a need for validatable centrifuge designs, and have provided the initiative for the development of machines which combine good manufacturing practice (GMP) and PLC controls. These centrifuges are GAMP compliant with the ability to satisfy the requirements of process and environmental integrity. In situations where centrifuges are required to handle potentially explosive or flammable products, they can be installed with inert gas purging systems. Machines can also be supplied with pressure tight systems.

Having defined the process objective and required variables, specifiers can then select a specific type of centrifuge to meet their criteria.





If the requirement is for filtration (including drainage, cake washing or classification), a vertical basket, conical basket, peeler, pusher, screen scroll, screen bowl, inverting bag or vibratory centrifuge is suitable. Where the requirement is sedimentation - (including separation, clarification, classification, degritting or thickening) - decanter, solid bowl basket, disk bowl and tubular centrifuges are appropriate. Preliminary screening tests will quickly indicate the best option.

Centrifuge Types (Sedimenting)

Horizontal solid bowl decanter centrifuges consist of two horizontal concentric rotating elements, the outer one of which is tapered so that solids discharge from a smaller radius than the liquor. Feed slurry is introduced into the conveyor hub by pump or gravity feed and delivered by centrifugal force into the rotating bowl via discharge ports, where solids settle through the liquor pool formed on the wall of the bowl. There is a slight differential speed between the rotation of the bowl and that of the conveyor which takes the solids to discharge ports. The clarified liquor discharges continuously in the opposite direction from adjustable overflow ports. Employed as a classifier, the solid bowl decanter centrifuge effects sharp cuts of solids in liquor suspension, with materials as course as 50 micron, or as fine as one micron.

Solid bowl decanters are now favoured over batch perforated basket centrifuges mainly due to advances in conveyor design. There are exceptions to this where relatively small volume materials have to be processed, and cycle times are not a significant factor.

The disc bowl type centrifuge operates at high speeds of 3000 to 20,000 times gravity, providing a continuous clarification system which is suitable for use where materials have a solids content of less than 1 - 2 %. These centrifuges are designed to separate either a solid-liquid or two liquid phases on a continuous basis. The disc stack increases the effective settling/clarification area, and the liquid and solid phases travel up or down the disc surfaces. The liquid discharges through one or more paring discs.

Designed as a solid tube which is capped at both ends, the tubular centrifuge is usually fed through a bottom inlet with two liquids of different specific gravities. Of the two liquids, the heavier phase is concentrated against the wall of the cylinder, whilst the lighter phase floats against it. The two phases are separated by means of a baffle, which discharges them into two distinct flows.

Centrifuge Types (Filtering)

Due to a wide selection of feed, wash, spin and plough speeds available, modern basket filtering centrifuges can be used to process slurries and chemical compositions. Producing a very dry cake, these batch machines have two main advantages, a capability to give cake solids an efficient wash using minimum wash fluids, and an ability to discharge the separated solids at low basket speed which ensures negligible breakage of delicate crystals.

Given correct feed conditions, feed speed and filter cloth, basket centrifuges are able to dewater solids from 1 to 10,000 microns.

Two types of peeler centrifuge are available - a heavy duty chemical design and a GMP design. The peeler centrifuge offers both a filtering and decanting capability, and is suited to processing a wide range of materials in ultra clean environmental conditions. Machines have perforated baskets and screened membranes for filtering processes or solid bowls for decanting. The Peeler centrifuge has an automatic peeler knife mechanism for cake discharge and the added benefit of an effective 'heel' removal system - a feature which provides complete batch-to-batch containment and reduces the operating cycle by removing separated solids at high speed.

The scroll/screen consists of a horizontally driven scroll conveyor, which revolves at an optimum differential speed within a rotating conical basket.

Scroll/screen machines have good washing capabilities and can be used for solids/liquids separation where feed materials have high particle sizes - typically 50 microns and above. It separates both floating and sedimenting solids.

Horizontal screen bowl decanters are operationally similar to solid bowl decanters, but provide additional washing efficiency and moisture removal for applications involving crystalline materials. The decanter combines the clarification and sedimentation advantages of the solid bowl centrifuge with the dewatering benefits of an additional screen section.

Pusher centrifuges offer long residence times, operate on a continuous basis, retaining solids as a cake on a wedge wire basket, from which it is transported by an oscillating pusher mechanism in the direction of the solids discharge. Feed solids can be granular, crystalline or fibrous, but should be relatively incompressible.

High throughputs of up to 350 tonnes/h can be attained with vibratory centrifuges whereby solids are retained by a sieve and transported by axial vibrations greater than the rotational speed of the centrifuge. These centrifuges are suitable for processing high throughput products which can be easily dewatered to the required moisture content.

The inverting filter centrifuge is a horizontal machine, incorporating an automatic unloading bag. The front and rear basket walls stroke forward by hydraulic piston to discharge solids. As the piston strokes forward,the filter cloth is turned inside out and the solids discharged in clumps into the collection housing.

The tables above indicate just how a prospective user might make an initial selection for a specific duty. This is little more than a basic guide, however, and it is strongly advised that, in the interests of cost-effectiveness for all concerned, the prospective user should consult the centrifuge manufacturer at the earliest stages of process design

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