

Taking a spin through CENTRIFUGES

As an intensified separation technique, centrifugation has many advantages. But selecting the right centrifuge for a specific duty requires some basic knowledge of the machines themselves. **Nigel Day** spins through the options, while overleaf we look at some of the machines in action

Compared with alternative methods of solids/liquids separation, centrifugal processing — depending on the type of system selected — provides a number of specific benefits. Centrifuges can be installed in a relatively small space; have a high washing capability; produce low cake moisture; achieve a high capacity throughput and can provide the user with a totally enclosed and vapour-tight processing facility.

The correct selection of a centrifuge for a specific application, however, is based on two key concerns — economic expectations and technical requirements.

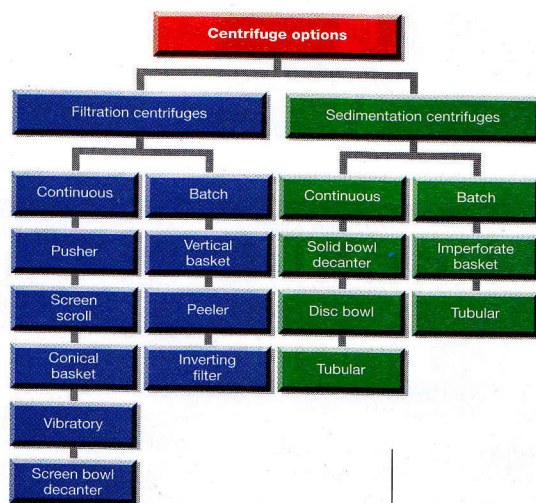
Before considering the various options, it is imperative to define the process clearly — a first step that prospective centrifuge users often overlook due to uncertainty as to what exactly a centrifuge is capable of achieving. An accurate process definition is also of vital importance at initial briefings with the centrifuge supplier, who needs to base screening tests and feasibility studies on relevant data — and not waste time and effort on vague and often misleading assumptions.

Once the process is clearly defined, it is much easier to identify variables which affect the choice of process package. Such variables can include 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.

The user needs to clearly define exactly what the centrifugal process is 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 of equal importance include: the expected G force; allowable cake dryness; allowable solids in the discharge liquors; product temperature; viscosity; specific gravity; pH and whether the process is batch or continuous. Also, if the duty is in the pharmaceutical or fine chemical industry, the centrifuge may have to be manufactured to a GMP design with an integral CIP system.



Though many and varied, centrifuge types can be broadly broken down into two distinct categories — filtering and sedimenting machines

The decision to use a batch or continuous machine can depend on many factors. Batch centrifuges have very little limitations on the wash function, while continuous machines are mostly limited to a wash-solids ratio of approximately 10 per cent, with no more than a few seconds allocated to the wash zone before completing the operation.

Particle size, distribution and shape are also important factors when determining separation capabilities and whether or not batch or continuous is the best option. Generally speaking, materials that are predominantly 45 microns and above, and relatively incompactable, are highly suitable for separation by filtration equipment, whereas finer or compactable materials lend themselves more to separation by sedimentation.

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. These can also eliminate the need to open the casing between cycles for cleaning and maintenance. Such machines are particularly suitable for use on applications within the pharmaceutical and fine chemical industries.

Over the years, stringent codes of practice, rigidly enforced across the international process industries — greatly influenced by the recommendations of authorities like



Preliminary site tests, as with this Thomas Broadbent 350mm peeler centrifuge, can be an important step in the selection process

the FDA, have created a need for validatable centrifuge designs. These codes have provided the basic initiative for the development of machines, which combine the very best of good manufacturing practice (GMP) and state-of-the-art PLC controls. These centrifuges are GAMP compliant with the ability to more than satisfy the requirements of process and environmental integrity. In situations where centrifuges have to handle potentially explosive or flammable products, they can be installed with inert purging gas systems to ensure complete operational integrity. Machines can also be supplied with pressure-tight systems.

Having clearly defined the process, it is now possible to proceed with selecting a specific centrifuge to meet the criteria, combining optimum performance with maximum cost-effectiveness.

Table 1 opposite shows the basic

split between sedimenting and filtering machines, with more specific application areas shown below in terms of particle size and slurry solids content. Preliminary screening tests will quickly indicate the best option.

Some of the salient features of each type now follow, starting with:

Sedimenting Centrifuges

● Horizontal solid bowl decanters

Decanter centrifuges consist of two horizontal concentric rotating elements contained in a stationary casing. The outer rotating bowl is tapered so that solids discharge from a smaller radius than the liquor. Solids are moved to the tapered end of the bowl by the inner element — a hollow hub screw conveyor that rotates at a slightly different speed to that of the outer bowl. Clarified liquor discharges continuously in the opposite direction from adjustable overflow ports. Used as a classifier, the solid bowl decanter centrifuge gives sharp cuts of solids in liquor suspension with materials as coarse as 50 micron, or as fine as one micron.

● Solid bowl basket centrifuges

Batch perforated basket centrifuges have, in recent times, been generally looked upon as obsolete technology. Other machines, especially solid bowl decanters, are more in favour for difficult-to-convey solids. But where relatively small volumes have to be processed, and cycle times are not a significant factor, then solid bowl baskets could be considered.

● Disc bowl centrifuges

Operating at high forces of 3000 to 20 000G, the disc bowl centrifuge provides a continuous clarification system suitable for materials with a solids content of less than 1-2 per cent. Either solid-liquid or liquid-

liquid phases can be separated — solids settling on the wall of the bowl and liquid discharging through one or more paring discs. The disc stack greatly increases the effective settling/clarification area, with the liquid and solid phases travelling up or down the disc surfaces.

● Tubular centrifuges

A solid tube capped at both ends, the tubular centrifuge is usually fed through a bottom inlet with two liquids of different specific gravities. The heavier phase concentrates against the cylinder wall, with the lighter phase floating against it. The two phases are separated by means of a baffle that discharges them into two distinct flows. Where solid feeds are processed, regular cleaning is necessary, but if there are no suspended solids the process can be continuous.

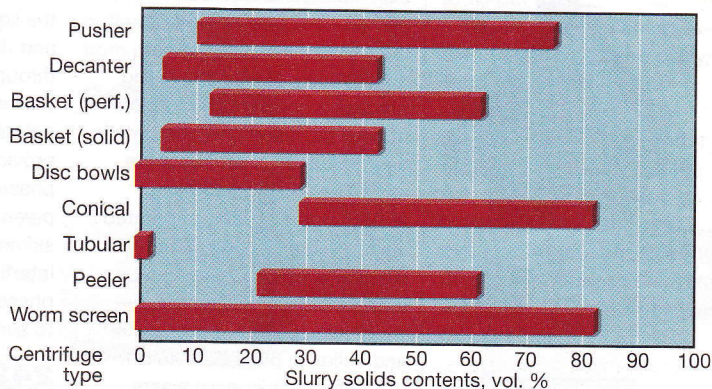
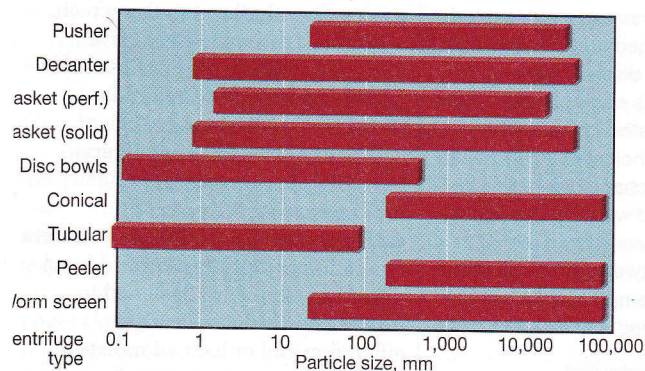
Filtering Centrifuges

● Vertical basket centrifuges

Modern basket filtering centrifuges are very adaptable machines, thanks to the wide selection of feed, wash, spin and plough speeds available, through either electrical inverter or hydraulic drives. Producing an exceptionally dry cake, these batch machines have two major advantages — the capability of efficiently washing cake solids, using minimum wash fluids, and an ability to discharge the separated solids at low basket speed, ensuring negligible breakage of delicate crystals. Given correct feed conditions, feed speed and filter cloth, basket centrifuges can dewater solids from 1 to 10 000 microns. They can also be fully sealed and purged for safe operation, and can operate fully automatically with minimum operator attention.

● Horizontal basket peelers

Two types of peeler centrifuge are

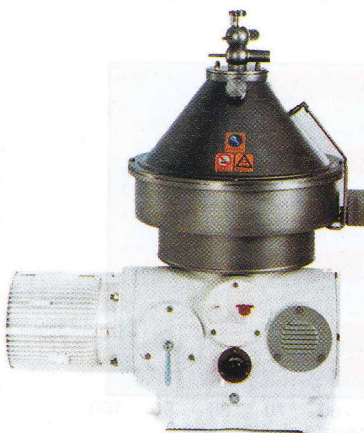


Modular disc design brings benefits

Designed for the clarification of wine, fruit and vegetable juice, beer and other beverages, the SG40 disc bowl centrifuge from Westfalia Separator features a modular design that is said to make the clarifiers less expensive to manufacture and easier and cheaper to maintain. The SG40 is claimed to be the smallest and lightest in its class, with the highest capacity for its bowl size (10 000 l/h). It features clean-in-place for fast turnaround and is easy to install and simple to operate.

With its standardised use of components, the same basic machine can be used in a wide range of applications. Only the bowl inlet, distributor, disc stack and the feed and discharge system need to be changed for different duties. The drive system, bowl, sludge collector, hood, operating water connection, annular piston and tools are all common throughout the range. Even the electric motors are standard components available locally throughout the world.

240 on enquiry card



The cream of the crop?

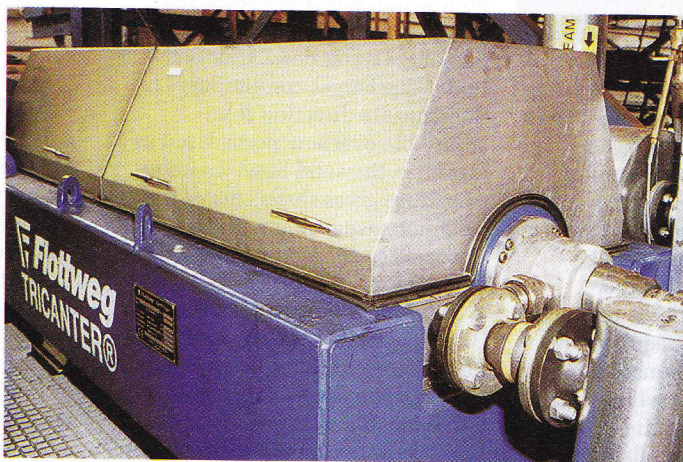
Westfalia Separator has extended its range of MSE skimming separators to include a high capacity machine for use in large dairies. The MSE 400 milk separator uses the Westfalia 'soft-stream' process to reduce shearing forces and skim the product gently. It can be used for the economical separation of milk to produce skimmed milk, skimmed whey and cream.

Milk and whey skimming capacity is up to 45 000 l/h, while that for milk clarification and milk standardisation is up to 50 000



l/h. This is said to make the machine ideal for all skimming applications in the largest dairies.

241 on enquiry card



Three out of one package

Corus Packaging Plus, the former British Steel Tin Plate company, has installed a Flottweg Tricanter system at its Llanelli steel works in south Wales for the reprocessing of biodegradable rolling mill oils.

The Trostre Works cold rolls steel strip produced at nearby Port Talbot and distributes the end product to a variety of industries for packaging applications. During the rolling process a special blend of non-mineral oil, water and additives is used to lubricate and cool the strip. The reject mixture is collected and crudely separated in large skimmer tanks, from where the settled water can be recycled, but the skimmings — which can be 50 per cent water and solids in oil — have to be disposed of as special waste.

The skid-mounted Tricanter now processes this waste to provide clean oil for recycling or resale, returning residual water back to the plant.

With the decanter type machine, two liquids with different specific gravities can be individually separated from solids. The two liquids are separated in the liquid zone and are decanted and discharged from the bowl through two discrete systems to prevent cross contamination. The patented system generally provides a choice as to which phase is discharged under pressure and which by gravity. A skimmer device allows the interface between the two liquid phases to be optimally adjusted to suit the feed material.

242 on enquiry card

available — a heavy duty chemical design and a GMP design. Both offer a filtering and decanting capability, and are suitable for processing a wide range of materials in the ultra-clean environmental conditions of the pharmaceutical and fine chemical industries. The machines have perforated baskets and screened membranes for filtering processes or solid bowls for decanting. The peeler has a fully opening front-end casing and, as the name implies, an automatic peeler knife mechanism for cake discharge. It has the additional benefit of an effective 'heel' removal system, a feature that provides complete batch-to-batch containment and dramatically reduces the operating cycle by removing separated solids at high speed.

Due to high G forces and increased discharge speeds, the peeler has short cycle times that can be adjusted to ensure a range of washing capabilities. The machines can be used for applications where the feed slurry has either a low or fluctuating solids concentration. Peelers can be fitted with CIP systems and also built to a 'through the wall' design that allows the centrifuge to be more easily and speedily serviced in a completely separate area of the factory. This totally eliminates the risk of contamination to the front end process side of the system.

● Scroll/screen centrifuges

The scroll/screen consists of a horizontally driven scroll conveyor, which revolves at an optimum differential speed within a rotating conical basket. Solids discharge takes place by the inclination of the basket and the differential speed of the scroll. At the point of separation, solids are conveyed forwards by the scroll to discharge at the widest open end of the basket, while filtrate passes directly through the screen.

Scroll/screen machines have excellent washing properties and can be used for solids/liquids separation on a diverse range of applications where feed materials have high particle sizes, typically 50 microns and above.

● Horizontal screen bowl decanters

Operationally similar to solid bowl decanters, these are designed to provide additional washing efficiency and enhanced moisture removal for applications where

crystalline materials such as paraxylene and coal fines are involved. The decanter operates in two stages, combining the clarification and sedimentation advantages of the solid bowl centrifuge with the dewatering benefits of an additional screen section.

● **Pusher centrifuges**

This type of filtering centrifuge, which provides particularly long residence times, operates on a continuous basis, retaining solids as a cake on a wedge-wire basket. Solids are discharged by an oscillating pusher mechanism. Feed solids can be granular, crystalline or fibrous — but should be relatively incompressible. They should also be free-draining with a low aspect ratio and an average size of 200microns.

● **Vibratory centrifuges**

High throughputs of up to 350tonnes/h are possible with this machine. Solids are retained by a sieve and transported by axial vibrations greater than the rotational speed of the centrifuge. These machines are highly suitable for processing high throughput products that can be easily dewatered to the required moisture content.

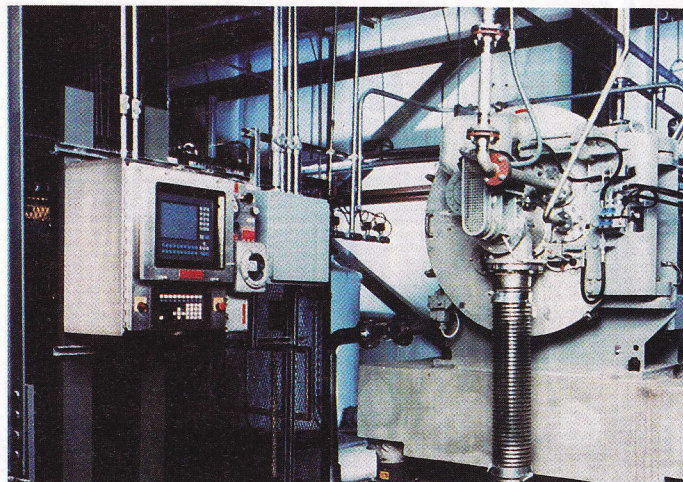
● **Inverting bag centrifuges**

These are horizontal, automatic filtering machines, incorporating an automatic unloading bag. The front and rear basket walls stroke forward by hydraulic piston to discharge solids. The filter cloth is arranged as a cylinder, with the rear edge secured to the rear basket wall and the front edge to the basket shell at the front rim. As the piston strokes forward, the cloth is turned inside out and the solids discharge in clumps into the solids collection housing. Primarily used in the pharmaceutical industry, this type of centrifuge provides heel removal after each cycle, though is limited to smaller sizes and capacities.

While the information given above provides a basic guide to making an initial selection of the best centrifuge for a specific duty, in the interests of cost-effectiveness for all concerned it is strongly recommended that the user should consult the centrifuge manufacturer at the earliest possible stages of process design.

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Nigel Day is process development manager with centrifuge company Thomas Broadbent & Sons Ltd



System engineered for protection

Global crop protection company Zeneca Agrochemicals, part of AstraZeneca, has installed three Krauss-Maffei turnkey centrifuge systems at its Grangemouth site. Each system consists of a peeler centrifuge, a table feeder, a vacuum plate dryer, skids for heating/cooling, and a solvent recovery circuit — the whole separation system leading to a big-bag handling system.

Tim Wrate, senior process engineer at Zeneca, who was responsible for commissioning the systems, says: 'This was a product that was particularly difficult to isolate, so we knew that we were going to need a high

quality centrifuge system. We had previous experience with Krauss-Maffei on similar product, and were confident of the high quality of their equipment. We were also impressed with the fact that they were the only company that could offer a complete system.'

According to Barry Dumble, md of newly created K-M Process Technology (see page 4), 'we form a partnership with our customers so we can engineer and deliver complete component separation process lines to meet their needs, from the handling of slurry to packaging of dried product.'

243 on enquiry card

Pushing the service side

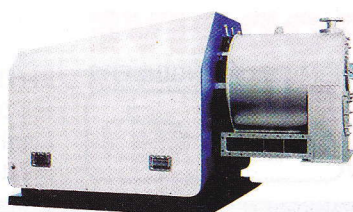
A recent installation by Krauss-Maffei of a pusher centrifuge at East Lancashire Chemical's soda production site in Manchester was sealed because of the company's 'technical back-up and serious expertise in centrifuge technology', according to East Lancashire's project engineer Bruce Maxwell.

The installation was part of a modernisation of the East Lancashire plant, with a modern vacuum crystallisation plant replacing a traditional pan crystallisation plant that had been in place for over 60 years. The Krauss-Maffei SZ400/2 centrifuge continuously separates sodium carbonate decahydrate crystals from a mother liquor as part of the production of multipurpose

soda crystals used for acid neutralisation and degreasing in a wide range of industries.

Krauss-Maffei has also recently launched a maintenance contract service. Service manager Steve Scott believes that this is the best way to provide customers with the optimum level of performance from process machinery.

244 on enquiry card



More milk at Marshfield

The installation and commissioning of a new 5000 l/h Tetra Alex homogeniser at the Unigate Dairy Crest dairy in Marshfield, South Wales, has brought an end to a redevelopment programme that has greatly increased production capacity and flexibility, together with improving CIP throughout the plant.

A 30 000 l/h milk treatment line has replaced the former 20 000 l/h whole milk pasteurisation line, creating increased production flexibility, as well as giving a 50 per cent rise in output.

Tetra Pak was the contractor for the programme, which also included the moving, resiting and recommissioning of process equipment brought from Unigate's closed Bournemouth plant. As well as the homogeniser, the items of equipment involved were Tetra Clip 10 and 6 plate heat exchangers, a Tetra Centri centrifugal separator model HMRPX 618, and a Tetra Alfast 210 standardisation unit.

The Tetra Alex homogeniser has been installed to allow the dairy to carry out partial stream homogenisation. With this system, only the cream and a small amount of the skim milk stream is homogenised, cutting energy costs by up to 75 per cent.

To upgrade the clean-in-place facilities at the dairy, Tetra Pak supplied and commissioned a two-channel raw CIP set and a five-channel finished CIP set. Specially designed to Unigate's requirements, these units replace existing CIP equipment on site. Two BBRPX 618 bactofuges were also installed.

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