Pumped up and potent

Choosing the right pump can be hit-and-miss, as plant engineers seek to escape issues such as over-sizing and over-engineering. Steed Webzell investigates

Did you know that, after electric motors, pumps represent the most populous of machine type in the world? Despite this, many plant engineers are still not fully acquainted with how different kinds work, or their limitations and ideal applications. That's hardly surprising, given the huge range of designs – which makes it equally unsurprising that pump selection is a chore for many engineers that sometimes results in the wrong pump being specified for the wrong task.

Choosing a pump is invariably about balancing several factors – the volumes and contents to be pumped, the efficiency required and how frequently the pump is to run, for example. That may sound straightforward, but it isn't. Half the problem is that sheer choice, with pump types ranging from positive displacement to hydraulic ram, velocity, diaphragm, progressing cavity, peristaltic and gravity pumps.

Then there is the desired application: chemical movements, sewage and sludge transfer, water supply, gas supply, air conditioning, refrigeration, flood control and marine services (to name just a few) all have their own distinct operating requirements – and the devil is in the detail. Pump specialists will want to check the duty against the pump design and materials of construction, noting any possible effects of the medium on the equipment (especially with abrasive or corrosive media) and vice versa (where food products are concerned). Other factors include delivery volume, pressure, temperature, viscosity, specific gravity, solids content, as well as toxicity, hygienic requirements and issues around hazardous areas.

Get all that right and there is still scope for inefficiency. Among the most common problems is pump sizing. So often, engineers use the 'just in case' approach to specification and the result is usually oversized pumps. And another cause of inefficiency is ignorance: engineering design moves on, particularly where high-value applications drive advances, so some (but not all) pump styles and makes are now more energy-efficient than they were, say, five years ago.

So let's look at some examples, starting with positive displacement (PD) pumps, if for no other reason than the wide range of technologies in this category, with different horses for different courses. In general, PD pumps are defined as having an expanding cavity on the suction side and a decreasing cavity on the discharge side. Liquid flows into the pumps, as the cavity on the suction side expands, and then out of the discharge, as its cavity collapses. But while that means there are two main classes of PD pump (reciprocating and rotary), the range includes rotary lobe, progressing cavity, rotary gear, piston, diaphragm, screw, gear, vane, regenerative (peripheral) and peristaltic pumps.

Take peristaltic pumps: here, fluid is drawn into the pump, trapped between two rollers compressing a hose and then expelled. The complete closure of the tube gives the pump its positive displacement action, preventing backflow and eliminating the need for check valves when the pump is not running. Equally, since nothing but the hose or tube touches the fluid, there is no risk of the

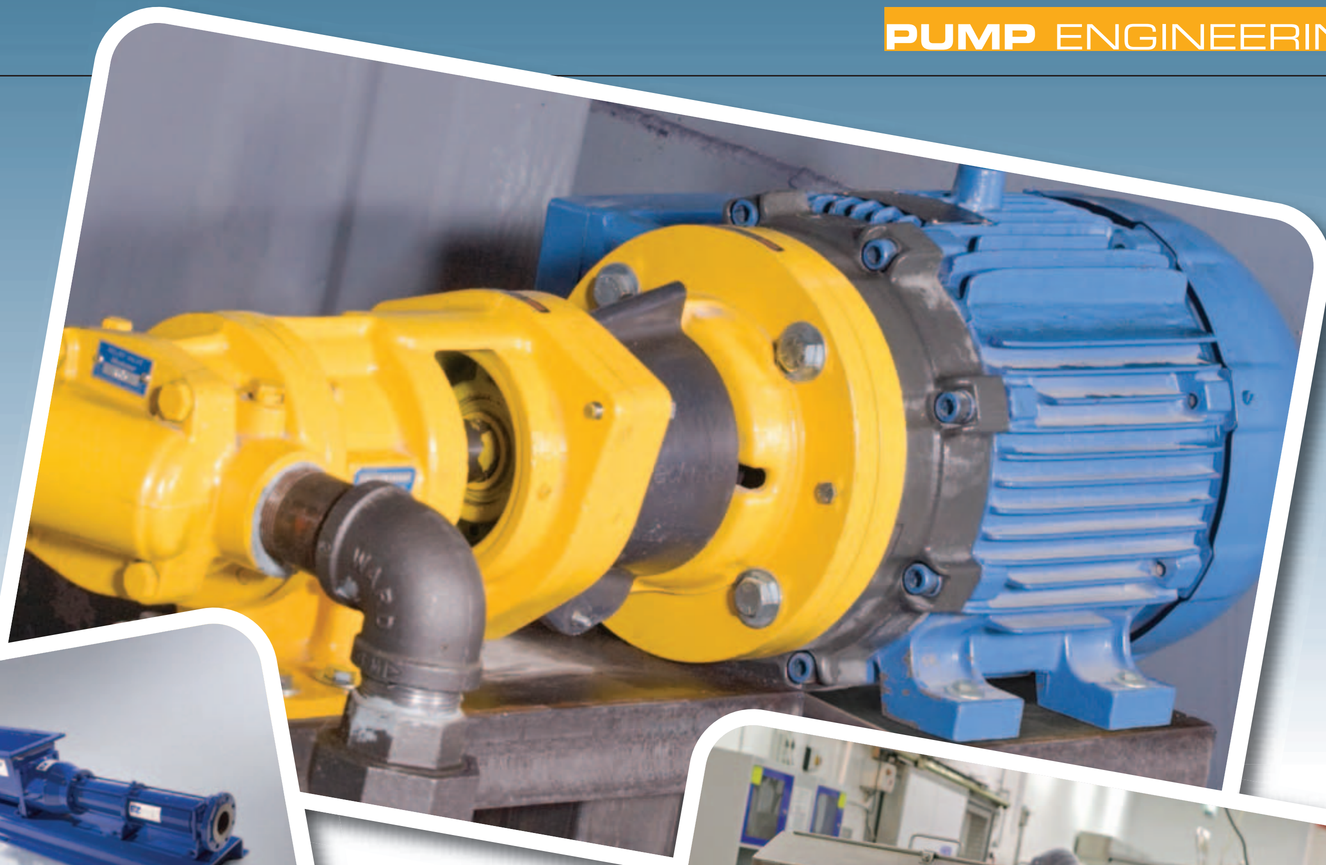
Pump refurbishment: sweet success

During a recent process improvement project at British Sugar's Bury St Edmunds plant, engineers identified that one of its production bottlenecks was the throughput of pumps moving sugar juice between large storage tanks and a syrup conditioning section.

The original plant had six Girdlestone pumps located between the two stations. At any time, each station had two pumps running in parallel and one on standby. Engineers determined that, by changing the two running pumps in each station to a single larger duty pump, they could control flow rates more accurately and increase throughput, while also reducing running costs.

British Sugar had recently decommissioned two Girdlestone pumps from its factory in York and these looked suitable for the project. So, to reduce capital outlay, pump specialist Amarinth proposed using these two bare shaft pumps for the upgrade.

Amarinth refurbished the decommissioned pumps and mounted them on heavy-duty base plates, with couplings and motors to British Sugar specifications. Two new Amarinth C Series pumps were then selected that were dimensionally and hydraulically interchangeable with the refurbished pumps. British Sugar says that refurbishing the redundant pumps delivered a cost saving of more than £10,000.



pump contaminating the fluid, or vice versa, so peristaltic pumps are seeing considerable uptake in food applications.

Of course, it would be easy if the whole world pumped fluid as inert and inviscid (near zero viscosity) as water, but life as a plant engineer is rarely that easy. Again, that's where peristaltic pumps score – being ideally suited to viscous, shear-sensitive and even aggressive fluids. For example, in terms of viscosity, chocolate and egg white are enough to give nightmares to pump speicfiers. However, Watson-Marlow's peristaltic pumps have taken on both applications like the proverbial duck to water.

Chocolate eggs

In the case of the former, Watson-Marlow Masosine MR and SPS pumps were installed at the Fakenham, Norfolk plant of confectionery firm Kinnerton. "We had an inclusion mixer on one line that was supported by an ageing gear pump," explains engineering supervisor Phil Barwick. "The line was set up to produce a new white chocolate Easter egg, with dried raspberry mixed in. However, when the fruit went through the mixer, it was squashed by the gear pump – producing pink Easter eggs." An MR125 peristaltic pump came to the rescue and not only was the raspberry unharmed but even subsequently introduced biscuit pieces were also processed without damage.

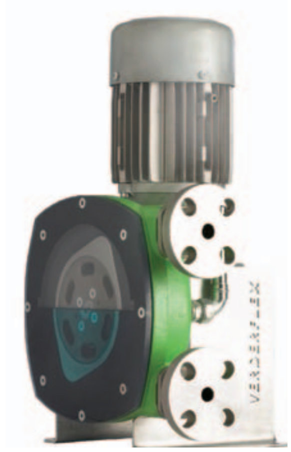
A similar tale of success took place recently at Cornish food manufacturer Rowe's, which had suffered repeated pumping failures using impeller pumps for the transfer of egg white in pasty glazing. "The problem with an impeller pump is that it lacks a non-return valve, so, if the process stops, then the pump needs to be re-primed," explains plant engineer Phil Thomson. "Furthermore, because egg congeals, cleaning of both the pump and its connections is required... Escalating downtime meant we had to find an alternative."

The solution arrived in the form of a 520 series peristaltic pump. Importantly for Rowe's, Watson-Marlow pumps enable users to clean in-line at full velocity, without a bypass (required by many other positive displacement pumps). The pump also self-drains, has low-shear and straight-through flow. And the tube is swept for hygienic performance.

At rival peristaltic pump supplier Verder, though, the emphasis is on bigger and better. "Every once in a while, something comes along that shocks the world and shakes up the way we do things," says sales manager Duncan Brown. Until the launch of the firm's Dura 35, it wasn't possible to get a Dura model that could pump more than 1,700 litres per hour. However, the new unit delivers maximum continuous flow of 3,180 l/hr at pressures to 16 bar.

Brown also says that Dura offers greater reliability over other pumps, due to its rigid drive connection. In fact, the rotor is mounted directly over the bearings, so there is no overhung load. Further, the

Pumps come in a very wide range of types and sizes, aimed at the equally wide range of applications



rotor requires no shims, simplifying installation and reducing overall power consumption.

Another popular form of positive displacement device is the vane pump. These have no internal metal-to-metal contact and self-compensate for wear, enabling them to maintain peak performance for a long time. Noted for their dry priming, ease of maintenance and good suction characteristics, they are available in a number of configurations, including sliding, flexible, swinging, rolling and even external vane types.

A new sliding vane model currently attracting attention is the Blackmer ProVane, available from AxFlow. This pump employs a hydrodynamic journal that eliminates contact between the shaft and the bearing in the pump by hydroplaning above the bearing surface on a cushion of liquid. In this condition, wear is eliminated, so bearing life becomes almost indefinite.

Get the choice of pump right and you can relax

Progressive cavity

Progressive cavity pumps are also found throughout industry as yet another example of positive displacement units at work. This type transfers fluid by means of the progress, through the pump, of a sequence of small, fixed-shape, discrete cavities as the rotor turns. This leads to volumetric flow rate being proportional to rotation (bi-directionally). It also results in relatively low levels of shearing being applied to the pumped fluid and modern units are increasingly easy to maintain in place.

One case in point is the EZstrip sludge cake pump, from Nov Mono, which, according to its makers, can be stripped down and rebuilt in just 15 minutes, without the need to disconnect or remove any pipework. The pump features a feed chamber that can be disconnected by removing a few screws, which allows access to the pin joint area for removal of blockages. Southern Water recently installed six EZstrip pumps at its treatment centre in Millbrook, Southampton, where they are transferring sludge at various stages in the process, including centrifuge feed, digester feed and cake dilution.

Hydraulic ram pumps are also commonly used for sludge transfer applications. This type of pump functions as a hydraulic 'transformer'. It takes in fluid at one hydraulic head (pressure) and flow rate, and outputs at a higher hydraulic head and lower flow rate. Exemplifying their application is a recent project at Severn Trent Water, which initiated a de-sludging trial at its Stoke Bardolph sewage treatment works in Nottinghamshire, with the objective of reducing costs and energy consumption.

Monitoring and control instrumentation was provided by Hach Lange and a hydraulically operated ram pump, with an adaptive control system, was provided by EMS Industries. All data was handled by an SC 1000 plug-and-play controller, which interfaced with the EMS control system to vary the speed of the pump stroking action to suit changing sludge conditions. The EMS system is now pumping sludge with solids at more than twice the concentration of the previous progressive cavity pump – and runs for just three hours each day, as opposed to the 8–16 hours required with the previous arrangement.

Go with the flow

Moving on to velocity pumps, the goal here is adding kinetic energy to a fluid, in order to increase flow. This increase in energy is converted to a gain in potential energy (pressure) when the velocity is reduced prior to the flow exiting the pump into the discharge pipe. One practical difference between velocity pumps and positive displacement pumps is their ability to operate under closed valve conditions for short periods of time.

Centrifugal pumps are the most common type of velocity pump. Here, the fluid enters the pump along or near to the rotating axis and is accelerated by an impeller, flowing radially outward or axially into a diffuser or volute chamber, from which it is discharged. One recent user of this technology is Wright McGill, which manufactures the Eagle Claw fishing tackle brand. This company's plant chose the Finish Thompson DB Series centrifugal pumps (available in the UK from Michael Smith Engineers) to handle concentrated nitric acid, used as a stripping agent for built-up plating materials on barrels employed in the process.

Nitric is an aggressive, oxidising acid, capable of dissolving most metals, so it becomes saturated with plating products and needs to be recycled. The DB pump in question, which was first trialled in the plant's filtration system, was manufactured from corrosion-resistant materials, including precision moulded carbon fibre filled PVDF, with PTFE bushing, and high purity ceramic and neodymium drive magnets encapsulated in pure PVDF.

Clearly, there's a lot more to pump technology than meets the untrained eye. PE

Pointers

- Most plant engineers might be surprised at the sheer range of pump types
- Selecting the right pump is about balancing factors such as volume, media, materials, efficiency, head and usage
- Other key parameters include delivery volume, pressure, temperature, viscosity, specific gravity, solids content, toxicity and hygienic requirements
- Oversizing pumps routinely causes plant inefficiency
- Even engineers who do know pumps can't keep abreast of developments