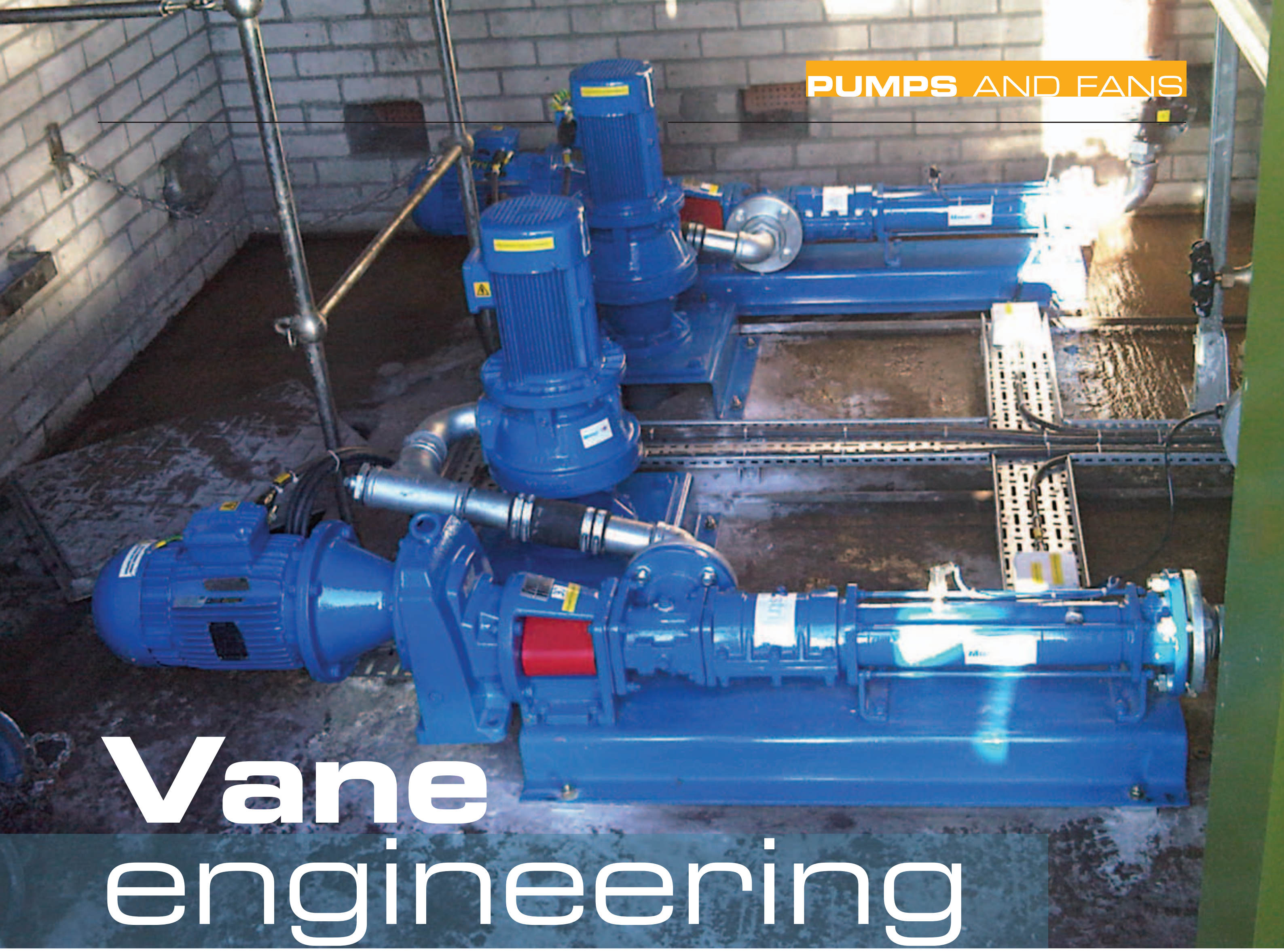


Vane engineering

With plant engineers' focus strictly on costs, uptime and efficiency, it's worth reviewing your pumps and fans – and what's on offer from variable speed drives and associated equipment. Brian Tinham reports

Such has been the success, albeit slow, of variable speed drives' sales people that plant engineers increasingly believe all they need do is install some inverters and start reaping the benefits of significant energy savings on pumps and fans. And that may well be the case – particularly where existing rotating plant is relatively large and runs for long periods at full speed, with flow throttled by gate valves or baffles (for pumps and fans respectively).

Remember, even a small reduction in speed yields very significant savings, in line with the affinity laws: a centrifugal pump or fan running at 80% consumes only half the energy of the same unit running at full speed. And there are financial benefits, in terms of reduced maintenance, to boot (see panel over page).

But the truth is that such very desirable outcomes are not always on offer; neither is the installation necessarily as simple as it sounds. So how can you tell? The first essential is to conduct a plant and process audit to establish the detailed potential for savings, as well as engineering viability. As Mark Chrimes, business development manager for motion control with Siemens, says, that entails plant engineers examining several key aspects of their existing plant setup, including the electric motor itself.

Motor versus drive

"For instance, a pump motor may have been under DOL (direct online control) for more than 20 years," explains Chrimes. "Putting a variable speed drive in to control its speed may well save energy initially, but then the new drive's high switching frequency could cause the motor to fail within a couple of months. In that instance, installing a new high efficiency electric motor, as well as the drive, would be a better way to get real, sustained savings."

Many modern drive manufacturers have now dealt with the technical problems associated with motor resonances, sparking across bearings etc, hitherto caused by inverters on older motors. But it's good to be aware – and to be prepared to ask the question. That said, buying a new motor and installing an inverter is a very different capex

Above: United Utilities' newly installed pumps at Acton Bridge

Below: The Exopack pollution abatement plant in Wrexham is equipped with Siemens drive technology

Choosing the right pump for the job in hand

Although pumps and fans are not renowned for new technology, evolution is ongoing, and the range of types and manufacturers is wide. So choosing the right equipment can still be confusing – as can checking existing installations for good practice.

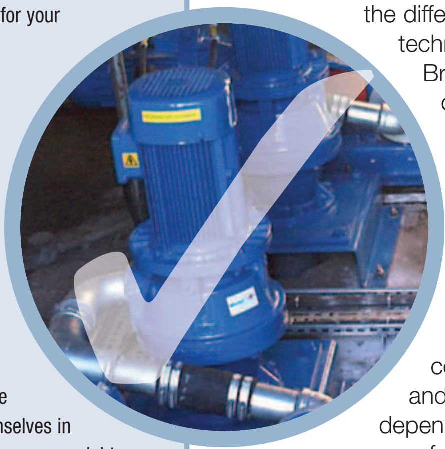
On water pumping duty, for example, centrifugal types include double shrouded and closed impellers, while process pumps can be similar, but with semi-open impellers to pass solids, and waste water pumps favour two or single vane impellers capable of giving free passage to larger solids, with the expected compromise on efficiency.

Andy Cruse, head of Eriks' pumps division (which majors on positive displacement pumps, both rotary and reciprocating), warns that pump manufacturers necessarily focus on a subset of available designs, but that many will tell you theirs is the best for your application. "The fact is, there's massive crossover. So someone's [rotary] progressing cavity pump may be just as effective as someone else's air-operated [reciprocating] diaphragm pump."

In this case, the biggest difference is the latter's requirement for a compressed air supply, although there is the advantage of self priming, and air operated pumps will happily dead head and run dry without damage. Then again, if you need to run in an ATEX zone, the lack of electric motor and control gear is clearly a big plus. It's also possible to adjust the flow by altering the regulation of compressed air ,so it's very versatile – but massively inefficient.

As Cruse says, you have to weigh the benefits versus the costs for your particular application – and take a similar approach when auditing existing installations. For example, citing water pumps again, he makes the very valid point that most are designed to pump water, yet many find themselves in waste water applications, where abrasives are a common problem. "A water pump might run from 75 to 91% efficiency, but abrasive media can easily lose 12 points of efficiency as clearances open up, which is quite big. So plant engineers need to look at materials of construction, but also suitability of the pump types for their application."

Beyond that, he suggests considering ceramic coatings on water pump internal pump surfaces (suction and volute casings) and potentially also the impeller for anything above a 37kW on single stage pumps. "A lot of cast iron pumps will suffer from corrosion and scale build-up, which impact frictional losses, but these coatings can preserve the surface condition. Efficiency gains for a large pump can be 4%, so you very quickly get payback." Incidentally, these are not recommended for multi-stage pumps with diffusers, because of the risk that they might restrict flow and change the pump characteristic.



Drives can usually be accommodated in the plant room, in this case with a 180kW exhaust fan motor

proposition to simply installing a new variable speed drive – even with the promise of additional savings. It means an entirely reworked calculation for ROI (return on investment) and a new project justification.

However, there may be other good reasons to consider changing motors, too – such as original over-sizing. Andy Parker-Bates, marketing manager with Parker Electromechanical, makes the point that motors on pumps and fans have often been sized for the worst case scenario, with an additional safety margin built in to accommodate potential plant changes.

"That often means they specified the next frame size up," he states. "In fact, we often see electric motors as much as 20% over-sized."

Clearly, that alone results in expensive, wasted energy. And, in this context, it's not just about motors either: it may well be worth reviewing mechanical losses caused by the existing power transmission arrangements. Experience shows that, while belts and pulleys vary enormously, in terms of efficiency (and modern technologies can approach synchronous behaviour), moving to direct coupling, wherever possible, substantially improves efficiency – so providing another route to cutting pump and fan operating costs. Just one caveat:

Incidentally, even when variable speed and/or direct coupling are overkill, simply changing the belts and/or adding a soft start can make all the difference. As Terry Davis, UK technical manager for MRO firm Brammer, puts it: "We've seen cases where reducing fan speed using new belt arrangements was the best approach, because the application didn't need to run at varying speeds. Adding a soft start can also make sense for motors of 22kW and above [inverters are more cost effective at lower power and include greater functionality], depending on the loading on the pump or fan, how it's being started, numbers of stop-starts etc.

Either way, Parker-Bates says that his firm's audits of real plant regularly reveal significant opportunities for savings with motors and coupling arrangements. "Quite apart from the efficiencies of the original equipment, processes may have changed over time, or plant been modified, and maintenance work may have resulted in different pumps or fans being installed, with different characteristics."

Plant issues

But there is another critical point: what about the pump or fan itself and its duty? Energy surveys on the drive side are one thing; practicalities of the driven equipment are just as important, particularly where pumps are concerned.

"There is a dynamic, as well as a static, aspect to the pressure generated by centrifugal pumps," explains Andy Cruse, who heads up Eriks' pumps division in Reading.

"On the dynamic side, it's about frictional losses, which increase exponentially with speed. On the static side, it's the pressure head. If you're considering installing a variable speed drive, you need to make sure the static pressure is no more than 60%, otherwise you risk dead heading the pump as it slows down."

Checking is about looking at the system resistance curve and testing it by running a simple data logging exercise, with a power meter and a pressure transducer, to give you hard facts. Incidentally, if your survey proves that investment in drive technology does make sense, Cruse also urges plant engineers to think about the parameter they intend to use to effect control.

"A lot of pumps exhibit flat performance curves so, if you try to control these on pressure, you will have problems, because there is very little change in head for a given large variation in flow," he explains. "You might want to use a flow meter for control to solve that problem." Temperature, level, air quality (for example, in stairwell air conditioning plant) etc are other potential control parameters.

Fit for purpose

One final point, though: if your survey reveals that the pump or fan itself is reaching the end of its useful life, this is the time to ask if the equipment in place is still best for the current duty. Cruse suggests that 70–80% of pump retrofit sales are like-for-like, and says: "Plant engineers should use the pressure gauge tappings on the suction and discharge sides, and take head readings against motor current, as part of planned maintenance. Looking at the efficiency curve, if it's running 20% either side of the design duty, there's a 10% loss in efficiency."

This is worth some time: several water companies are currently funding pump repairs from the energy savings that their engineering surveys reveal. It's a straightforward matter of looking at the energy tariff and attributing the cost in pounds per mega litres pumped for the 'as found' and 'as new' performance, in order to estimate payback. Funding can then come from projected energy savings, instead of from the maintenance budget.

Above: Weg's fan and pump online energy payback calculator
Below: Mark Chrimes, business development manager for motion control at Siemens

Nov Mono pumps improve capacity and head at United Utilities' Acton Bridge plant

A high performance packaged pumping system from Nov Mono has been specified by United Utilities to improve process efficiency at its pumping station in Acton Bridge, following an increase in capacity.

Ian Warburton, field service engineer at Acton Bridge, explains that the pumping station began experiencing problems shortly after the addition of raw sewage from a local bar and restaurant. It could no longer cope with the full pressure of the discharge head in the rising main, which runs at just over a mile, he says.

United Utilities needed new plant that could handle the rise in capacity and pressure, but also allow the pumps to be dismantled and maintained in a restricted space. "Having unsuccessfully trialled a number of alternative technologies, we decided to call upon Nov Mono. We have used [their] products for over 15 years at a number of sites and we know they are extremely reliable," says Warburton.

"By combining two of its EZstrip progressing cavity pumps with two high performance macerators, Nov Mono provided us with the ideal solution," he continues. "The installation process as a whole was extremely smooth and we are very happy with the service. I have worked with many subcontractors over the years and have never come across a team more willing to go the extra mile."

With a capacity range of up to 500m3/h raw sewage, Nov Mono packaged pumping systems typically combine a progressing cavity pump with a solids grinder, which enables the use of a small bore rising main. This involves significantly lower installation costs compared to a traditional 100mm rising main sewer – up to 75% savings, according to Nov Mono.

In action, the positive displacement action of the pump lifts the raw sewage from the sump into the cutting chamber of the macerator/grinder. By using a larger bore elutriation pipe for the pump suction, hard and heavy objects are left behind in the bottom of the sump and so cannot cause any damage to the pumping equipment. Meanwhile, the sewage and any textile and fibrous matter is macerated and then pumped away into the main gravity sewer.

Above: Parker's AC890PX high power, large scale, modular systems drives
Right: Siemens' motor drive technology

At the end of the day, it's down to you to get your pump or fan calculations right – and, if the drive route looks solid, then install it, also remembering the importance of proper commissioning. As Siemens' Chrimes says, too many fitters seem to believe wrongly that 'fit and forget' includes the installation phase.

"Our drives are designed to measure motor flux and deliver the correct current for an application," he explains. "Setting them up is not an expert job; it's just a matter of best practice engineering – for example, using shielded cable to comply with ESD and harmonics requirements, and following the menu process. But we routinely send in application engineers to get the set-up correct and often find another 10% energy savings."

Everyone agrees: do it this way, and go for the new variable speed drive, high efficiency motor and direct (or comparably improved) coupling recommendations, and you can realistically expect many years of faithful service, as well as a payback in as little as three to six months. And it's not just about size, either. Clearly, the greater the pump or fan duty, the greater the potential for savings, assuming that the equipment is currently running unnecessarily. But Chrimes insists that drives on electric motors even below the 30kW mark can result in similar payback periods – and for much more modest investments.

Justifying variable speed control on pumps and fans

The justification for installing variable speed drives on centrifugal pump and fan equipment comes down to the fact that running at half speed consumes only one-eighth of the energy, compared to one running at full speed. This is because the torque needed to run a pump or fan is the square of the volume (following the affinity laws).

For instance, reducing a pump's speed to 80% only requires 64% of the torque (0.8 x 0.8). Further, to produce 64% of the torque only requires 51% of the power (0.64 x 0.8), as the power requirement is reduced in the same way.

ABB's energy spokesperson Steve Ruddell explains that it's all about the pressure difference across the impeller. When less pressure is produced, less acceleration of air or fluid across the impeller is required, and the simultaneous reduction of acceleration and pressure multiplies the savings, he says.

And even better energy efficiency can be achieved by implementing techniques such as motor flux optimisation. This is particularly beneficial in pump and fan applications, and under light loading conditions. Ruddell says that overall efficiency of an ABB low voltage ac drive and its motor, equipped with the technology, is typically 1–10% higher than conventional kit.

Energy consumption figures for mechanical and electrical airflow controls on typical centrifugal fans is just as compelling as for pumps. At 80% airflow, energy consumption is 97% of maximum with damper control, 76% of maximum using guide vanes, but only 51% using low voltage ac drives. That difference represents wasted energy.

And then there are the maintenance benefits from soft starting. As Eriks' pumps division lead Andy Cruse puts it: "As the motor is ramped up and down, under variable speed drive control, mechanical shocks on the belts, bearings, pipe or ductwork etc are all significantly reduced. Additionally, the fact of running slower reduces the speed at which filters clog – all of which helps to improve reliability, and reduce the cost and frequency of maintenance."

Pump and fan payback calculator goes online

Weg has put its payback calculator for electric motors online – enabling pump and fan users to work out energy savings and CO_2 emission reductions when evaluating new projects and replacements.

The web-based tool is ideal for comparing the effects of a wide range of variables, based on usage and component specifications, to find the best solution for any application, including multiple motor installations.

Also, it's not limited to Weg electric motors: it can compare efficiencies with any product on the market. However, Marek Lukaszczyk, European marketing manager for Weg, says that, since it offers permanent magnet hybrid motors and motors with IE3 efficiencies off-the-shelf, it believes that any other manufacturer is going to be hard pushed to match it.

Incidentally, there is also a downloadable Blackberry App for pump and fan engineers on the move. That is downloadable at: http://www.weg.net/green/uk/blackberry-apps.html

It is less comprehensive, but you get payback times for premium versus standard efficiency motors and you can assess running costs of existing motors, to determine repayment time for replacements. It also shows payback time for new motors against the cost of rewinding, following a motor failure, taking into account the fact that rewound motors may experience a drop of up to two points in efficiency.