Cage or maze?

Choosing the right control valve isn't as simple as some would have you believe. Brian Tinham talks to ex-BP specialist Lyn Thomas about pitfalls and possibilities

It's a sad fact that plant owners and operators have long since shed most of their engineering departments, leaving behind only skeleton staffs stretched to carry out essential inspection and maintenance tasks. So, with the process, instrumentation and equipment gurus generally gone, how do they manage when it comes to engineering change and upgrade projects?

The answer, more often than not, is that purchasing relies on third party advice and – in the absence of in-house specialists with the time or knowledge to offer additional insight – takes a gamble. At best, that means money may be being wasted; at worst, it means a risk of sub-optimal, potentially dangerous, installations. Why? Because making the right equipment choice is often much more complicated than it seems.

Process control valves – and the actuators, positioners and accessories that make up the automated package – are a case in point. Typical problems include cavitation – where fluid flowing through a valve turns progressively to gas, due to pressure drop, and then returns to the liquid state – and flashing, where it turns permanently, partially or wholly, to gas. Each, if not properly controlled, can cause valve and pipework damage, leading to premature failure – as well as sub-optimal control.

It's not a black art, but there are trade-offs. Just as important, there may be serious mechanical, hydraulic, pneumatic and electrical engineering considerations. And there are very significant price

What type of control valve do you need?

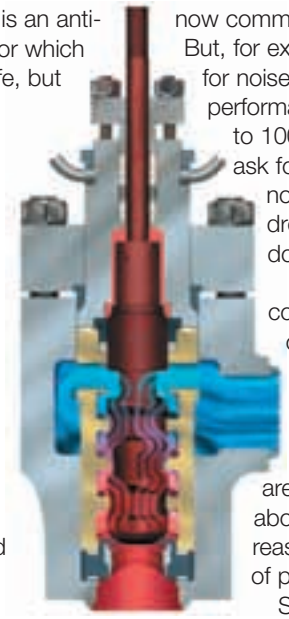
As a simple rule of thumb, the first choice for rotary control valves is the butterfly type, if only because they're lowest cost. If they can't do the job – and they're not fit for all applications – it's time to consider ball type valves. If they also can't cope, then look at standard control valves with multiple stages: although two and four are common, Dresser and others have produced 60-stage valves for particularly demanding applications.

Beyond that, there are eccentric disc and eccentric plug control valves, cage-guided types and then you're into bespoke engineered valves. There is also the entire globe valve portfolio – the list goes on.

Then there are the valve accessories – everything from the range of valve actuator types to positioner types, valve end connections, valve body bonnet types, control valve packings and seals, restricted capacity control valve trims… All suggesting control valve selection is not something that can be undertaken lightly.

differences in the required valve, even with apparently similar process conditions – all of which makes it essential to think about the precise requirement very carefully. Is this a conventional modulating duty or, at the other extreme, is an anti-surge valve needed, the design criterion for which might be tight shut-off for 99.99% of its life, but sub-second opening on-demand?

Lyn Thomas, regional manager for engineered projects at control valve manufacturer Dresser Masoneilan – an ex-BP specialist with more than 20 years of project and operations experience – warns users to be vigilant and to contact specialist suppliers as early as possible. "People don't understand what happens in control valves: they don't realise that a four-inch valve can cost anything from $2,000 to $100,000, depending on its construction and materials – which are determined by the application, the nature of the fluids, the process conditions, the upstream and downstream pipework, and what you actually want the valve to do."



Flashing and cavitation

Looking at flashing, for example, he makes the point that the proportion of liquid turning to gas could be anything between 1% and 100%. "The more the gas, the greater the increase in volume, which usually, but not always, necessitates expanding the valve body and trim [the clever bit inside the valve body, manipulated by the actuator] to cope with increased fluid velocity and prevent erosion of the valve," explains Thomas. And he adds: "Remember, flashing can also be caused by problems with the upstream pipework. Maybe there are too many bends or there's a reduced bore isolation valve causing a pressure drop. Either way, the valve might see gas in and gas out, so can't work. That's why we like to get involved at the P&ID [piping and instrumentation diagram] stage."

Meanwhile, with cavitation, the issue is more one of managing energy and noise problems – but, if you focus only on eliminating the symptoms, he warns, you might pay dearly for a valve that fails to perform as well as something more modest. "Many anti-cavitation valves rely on labyrinth design or drilled hole cages in the trim. So think about what happens if the fluid is dirty," he suggests. On the other hand, simply allowing cavitation to go unchecked can render any valve useless.

The bottom line: when specifying a cavitation-reducing valve, think of the fluid involved and the options. Then, when considering flashing, indicate how much is likely and talk to specialists about what can be tolerated. With flashing, typically increasing the volume of the valve outlet area, say by one or two sizes, may well do the trick.

Then again, there's valve noise, where well-intentioned but sometimes misguided preferences can cause massive price hikes. "Acceptable noise levels are coming down, to the point where 80dB is now common and we've had requests for 70dB. But, for example, we have 10 different valve types for noise control, four of which offer similar performance, but range in price uplift from 40% to 100%," explains Thomas. "Many users ask for labyrinth-type valves, which are normally reserved for very high pressure drops, and pay the price, when they just don't need it."

And there are other techniques and considerations: "You could put a silencer on the back end, but it makes the upstream valve expensive, if there's virtually no back-pressure." Which is why flare valves – sometimes necessarily with zero back-pressure – aren't cheap. "We can make a valve about 40% cheaper by providing a reasonable pressure drop – even a couple of psi can make a difference."

So what about some of the more difficult applications? Thomas cites fast-acting anti-surge valves, for example, that might be expected to protect a $20 million compressor on a gas plant. "People think that anti-surge valves must open within one second and that's pretty well all you need to specify. But some valve packages will open smoothly from zero, while others stay closed for half a second before flying open – and the hysteresis from that can play havoc with the control system."

Some of the problem is down to the choice of positioner – the device that responds to the control system's 4—20mA (or digital HART or fieldbus) demand signal, driving the booster relays or hydraulics for the valve actuator, he explains. "Today, most users want 'smart' digital positioners, because of their diagnostics benefits, but that can lead to this dead time issue – unless they specifically select fast-acting smart devices, such as Masoneilan's SV1 IIAP positioner."

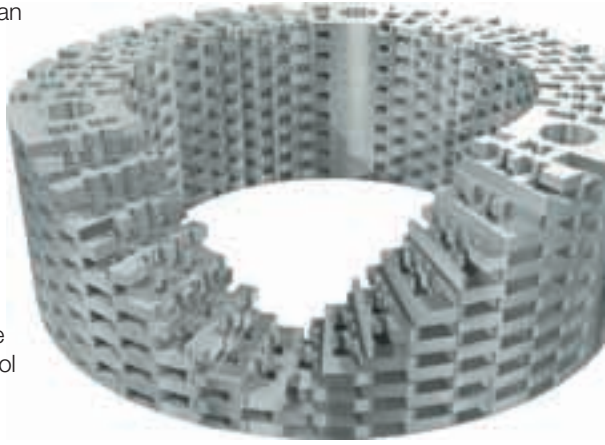
The issue is being aware that analogue positioners often exhibit less than half the dead time – maybe less than 100msec – of their conventional digital counterparts.

Much the same goes for fast-acting vent valves, which might be required to open very fast, but then stick at around 50% to provide some flow modulation. "Getting this right is about looking at the whole package – the control

Pointers

- Process control valve selection is far from simple
- Key considerations include the nature of the fluids, the process conditions, the upstream and downstream pipework, and exactly what you want the valve to do
- Beware of cavitation and flashing – and 'conventional' solutions. You can spend a lot and be rewarded with poorer control
- A four-inch control valve can cost anything from $2,000 to $100,000
- Anti-surge valves vary hugely in the detail – and signalling is part of that

Far left: control valves come in all sizes
Left: part of a valve's function is to manage energy dissipation
Below: the classic labyrinth, drilled-hole trim cage



The rise and rise of plastic control valves

ABS, PVCU, CPVC, PVDF and polypropylene plastic valves are becoming an increasingly popular choice for everything from water (commercial and industrial) to chemical process applications – for both modulating control and isolation purposes.

Durapipe, for example, manufactures plastic ball, diaphragm, butterfly and solenoid valves – the latter typically for dosing in water treatment. What's more, whereas once we were talking about low-flow, low-pressure applications, some units are now available with up to 12in bores and handling up to 16bar. They can also be equipped for pneumatic actuation, with options ranging from double-acting to fail safe open or closed, with or without positioners.

Geoff Rogers, valve manager at Durapipe, says: "A lot of plant engineers are now replacing steel valves and pipework, and that's not just on low-pressure systems. Typical applications include refrigeration for cold stores, where companies are moving away from copper, and using ABS and electrically actuated ABS ball valves. It's much quicker to install and very flexible. It's the same with heating and ventilating applications – for the chilled water on the air conditioning side."

Other applications include temperature and flow control in analytical equipment, and managing cooling through heat exchangers on, for example, temperature-controlled cabinets.

valve type and construction, the actuator, its quick dump valve and booster relay arrangements, the positioner, even the supply pipework and its ability to cope with the required speed and quantity of actuating air inrush or exhaust," says Thomas. Not easy – which is why control valve specialists like Dresser offer software to predict valve package combination behaviour.

Moving on, consider pump recirculation valves, which also need to be closed most of the time. "In this application, it's no good saying we'll use an eight-stage valve, if it spends most of the time sitting on its seat, slightly leaking. That will destroy the seat in no time. Shut-off has to be tight and the valve needs to be configured in flow-to-open mode, so that any failure on the pneumatic side leaves the plant protected."

On the other hand, gas or fluid injection valves, that typically have to handle high pressure drops, do require several energy-reducing stages – sometimes in excess of 20 – in order to avoid heavy erosion, noise and vibration problems. "Multi-stage valves, built with slightly larger bodies to accommodate the trim stages, are much more expensive, but essential for this kind of duty," he explains.

The glaringly obvious point: every application has to be considered on its merits. Thomas gives a recent example involving pressurised underground storage of natural gas, which has to be depressurised as it's brought on stream. "Below a certain temperature, hydrates form as a powder and cause valve blocking, if unchecked. You can solve the problem by heating the gas or by injecting methanol or glycol, but neither method is cheap. We retrofitted the correct eight-stage valves, instead of the original two-stage units, and changed the temperature profile across the valves – keeping it above the hydrate curve and solving the problem that way. As a result, the heating system and 75% of the already purchased control valves were eliminated, saving massive operational costs." PE