Prolonging choke valve life

The life of choke valves has typically been unacceptably short. Multistage valve technology has been shown to prolong their life by as much as 10 times.

Wellhead choke valves, usually in sizes of up to 6in and in the API pressure range 5000 to 15,000, have long been considered an almost expendable item of equipment. Typically, the life of choke valves can be very short. A matter of hours is not unheard of, although months is more common, but this is still unsatisfactory.

The reason for this history of rapid choke valve failure is complex, and only recently has it become comprehensively understood. Essentially, it is a system problem — the interaction of many factors which constantly change and produce a number of failure is complex, and only recently has it become predictable. Another reason lies in the area of a different and longer-term unpredictability, design operating conditions that are appropriate today can change over time and may, in a few years, extend beyond the capabilities of the original valve design. These controlling factors largely exclude operating pressure and differential pressure as problem areas in choke valve design. Today, even at the high end of choke valve operating pressures, the industry has a vast store of high-pressure application experience that is equally applicable to choke valve service.

Fluid composition. The fluid handled is a mixture of crude oil, gas, water, sand, and often other solid components. Since the proportion of each component in the fluid mixture can change constantly, it is difficult, if not impossible, to accurately determine the actual effective fluid velocity because each of the components travels at a different velocity in the build stream. Therefore, velocity in the pure sense cannot be a useful and reliable choke valve design criterion. However, it is obvious that the sand, and perhaps other solids, is the bottom-line culprit in short choke valve life. But this is far from the whole story.

Changing operating conditions. While in time, choke valve flows are relatively constant, wellhead pressures change as the wells age. Usually, high operating pressures are associated with relatively stable down-well geological formations where less sand is released. But as wellhead pressures start to fall, and these geological formations start to collapse, the percentage of the sand in the fluid flow can increase. In some cases, this decreasing pressure/increased sand relationship can be inverted, further complicating the choke valve design process. In addition, decreasing operating pressures with relatively constant flow can increase the required valve coefficient (Cv) by as much as a factor of 10, usually well beyond the original valve's design capability.

While common single-stage choke valves have attempted to achieve acceptable performance life through improved materials, this has not been enough. As more and more large older wells are changing from oil to gas production, choke valve internal velocities are increasing, exacerbating the erosive damage effect of the entrained sand. And, as valve trim erodes as a result, control is compromised and the flow needed requires closer plug/seat operation. This, in turn, accelerates plug/seat erosion, regardless of materials. Another contributing factor is increased vibration (and related high noise levels) which the eroded valve trim and other related operating circumstances can create.

So, it is this vicious circle that plagues operations with extremely high maintenance costs and grossly unacceptable short choke valve life.

Multistage choke valve design

To limit fluid velocity throughout the valve trim and to drastically reduce the erosive effects of the sand, a multistage valve design uses a stack of disks, each of which incorporates a tortuous path flow pattern by means of a series of right-angle turns in each disk. The velocity of all fluid components is thereby cut by at least 75 per cent compared to single-stage plug/seat and drilled hole-cage designs. By using tungsten carbide trim throughout, the erosive effects of the sand are minimised. In addition, long valve stem stroke increases rangeability and enhances controllability, so that flow set points can be maintained and changes in operating conditions can be accommodated over time.

These valves are also 'characterised'. This means that the tortuous paths in discrete groups of individual disks in the disk stack are differently designed; that is, flow per disk in one group is higher or lower than in a disk in another group. The benefit in choke valve characterisation lies in the ability to maintain a
larger distance between the plug and the seat at low flows; pressure reduction is therefore the same as that achieved within the tortuous path, multistage disks rather than by a throttling process through a small plug/disk annular clearance.

The use of this multistage valve technology and modern materials of construction has borne fruit. Valve life has been demonstrated to be up to 10 times greater than was experienced previously, especially where sand content was high. This gain in choke valve life has been shown to be true for new valves, replacement valves, and old valves that have been retrofitted with multistage, characterised, long-stroke, all tungsten-carbide trim. ■