Improving uptimes for coker valves

Mechanical availability of valves is a key issue for coker units, acknowledged to be one of the most demanding of applications for valves. This column considers design and selection features for key components in coker valves.

By Gobind Khiani

4-drum delayed coking unit in a petroleum refinery

Current industry practices mainly use one of two types of coking process: delayed coking and fluid coking. Both processes occur at pressures higher than atmospheric and temperatures greater than 900F (485C) that thermally breaks the petroleum feedstock into products such as naphtha and distillate, leaving behind coke.

In delayed coking, two or more large reactors or coke drums are used to hold, or delay, the heated feedstock while the breaking/cracking takes place. While the lighter products are pumped back into the fractionator through the overhead vapor lines, coke is deposited in the coke drum as a solid. This solid coke builds up in the coke drum and is removed by hydraulically cutting the coke, using water. To facilitate the removal of the coke, the hot feed is diverted from one coke drum to another, alternating the drums between coke removal and the cracking part of the process. In fluid coking, the feedstock is charged to a heated reactor. The cracking takes place and the formed coke is transferred to a heater as a fluidized solid where some of it is burned to provide the heat necessary for the cracking process.

Spring selection

One of the first things to consider in coker valves is spring selection and design. This is because spring is one of the internal component in a coking valve that provides isolation requirements, i.e. enough force to wipe away coke adhesion on the ball and prevent migration of coke fines in the seating areas. Some manufacturers utilize Belleville® springs and claim that the valve has 100% reliability with no process failures, stating reasons such as the following: "it is a solid one piece metal component and not a coiled/helical spring," and "it has a very thin profile so any residue cannot affect spring rate or loading," According to spring engineers, the use of bellows/wave type springs has a lower spring force or rate compared to Belleville® shaped springs. They also recommend a Belleville® type spring design for high thermal cycling applications. Keeping the above points in mind several industry experts who are highly knowledgeable about springs were asked the following question: "for valve applications in high temperature cyclic service (960-650 delta), which spring characteristics would be best for high compression loading with ability to seat and maintain constant spring rate and service life; a bellow or a Belleville® type?" The first answered: "the Belleville® will produce the most consistent linear rate with the proper selection of an h/t ratio. Keep in mind both will exhibit some hysteresis on rate. You can control it with certain design options. Belleville® springs with the right ratio are more linear through total deflection than compression springs."

About the author

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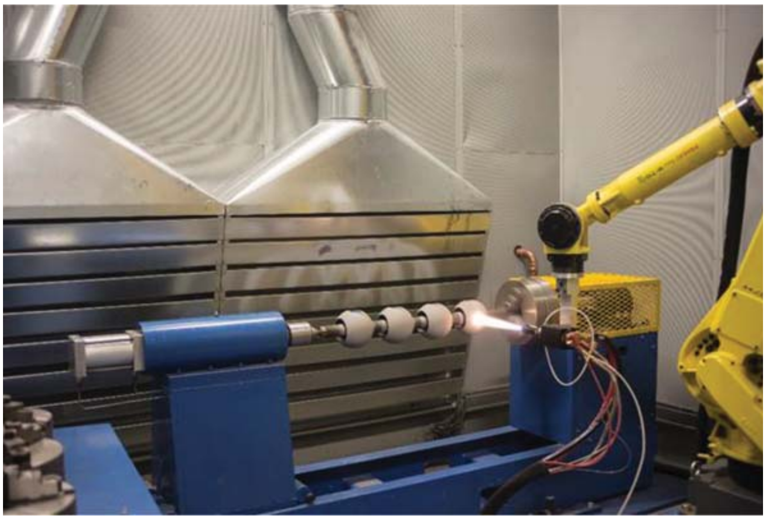
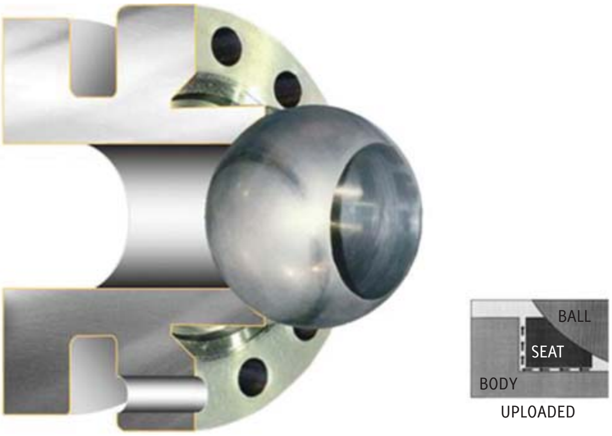


Body 'End Cap' and Integral Seat



An additional reply ran as follows: "the best choice for high thermal applications is Belleville® washers. The spring rate which is dependent on the h/t ratio may see some changes over time because on relaxation that occurs as a result of exposure to stress and temperature. You should consult your Spring Manufacturers Institute (SMI) manufacturer as to how much to expect based on time, temperature and stress exposure."

Ball to seat sealing

Another highly interesting feature of component design by various manufacturers is the ball to seat sealing in the coker process. The majority of ball valves utilize an inserted seat ring. Thus you have to control process leakage at ball/seat interface and behind the inserted seat. Many coker valves experience extreme thermal cycles. Thus different material of construction and mass move relative to each other on quick thermal shock. Customers have experienced coke ingress into seat pockets which can affect shutoff and torque requirements. An integral seat machined into the body half combines two sealing points into one and the probability of residue ingress into the seat pocket is eliminated.
Further, attention should be paid to the possibility of severe water hammer in piping systems due to condensate that can freeze and or flash in the vicinity of the convoluted springs. This can be the case, for example, in northern climates (the USA, Canada) and in hot climates such as the Middle East. A lot of ball valve manufacturers provide seals and seats which have gaps (tolerances). This design allows flexing or movement during operation so this design should certainly be avoided in high temperature coker applications.
Moreover, an inserted seat can in fact have an additional leak path. This means that a replaceable seat, which is often considered to be a beneficial feature, is actually a disadvantage and the ability to isolate in high temperature coker applications may be compromised.
It is a known fact that the seat ring carries coke particles behind the seat. Thus valve reliability is compromised due to misalignment and the torque requirement goes up. These issues therefore need to be carefully considered when designing a coker valve.

Hard coating

A hard coating can protect critical, expensive equipment, thus reducing repair or maintenance costs and improving uptimes. However, not all coatings are the same and due care and attention should be paid throughout the application process.

Content and Pictures Courtesy of ValvTechnologies Inc, USA.

This column is the first part, in part 2 I will discuss purging requirements and elaborate on the importance of purging.