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BACK TO BASICS

# Triple Offset Butterfly Valves

BY PHILIP TAYLOR

Since their introduction to the market more than 50 years ago, triple offset valves (TOVs), which are also known as triple eccentric valves, have continued to evolve, while uses for this type of valve have expanded across multiple industries. Originally designed for water shut-off applications, design enhancements through the years placed this versatile valve among other industry staples for performance in the harshest conditions of critical process environments. At the same time, these valves have always had certain parameters within which they can operate effectively.

Today, TOVs offer countless benefits to the industry, and most recently they've received attention because of the role they can play in controlling fugitive emissions. The industry has started to look for more unique and innovative ways of combating this global emissions challenge, and TOVs are an area where valve manufacturers have recently focused. By incorporating new and improved features, TOVs are used in ways never before seen while they are also being used more cost effectively. To understand how far these valves have come, we first must inspect the standard features and benefits that made the TOV valuable in the first place.


**Executive Summary**

**SUBJECT:** Because of the attention on fugitive emissions and new features that give superior sealing, triple offset high-performance butterfly valves are gaining in popularity.

**KEY ISSUES:**

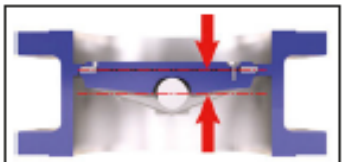
- How they work
- New features available
- What those features mean

**TAKE AWAY:** The next generation means enhanced valve safety and performance. When added to cost savings, that should lead to even more use.

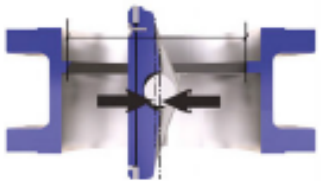

## DECONSTRUCTING THE TOV

A TOV can be the right solution when a tight seal is required. As the name implies, three separate offsets are designed into the valve (Figure 1). They are: 1) the center line of the disc/seat sealing surfaces, 2) the location of the shaft with respect to the center line of the bore, and 3) the axis of the seat cone angle that is offset from the center line of the valve bore.

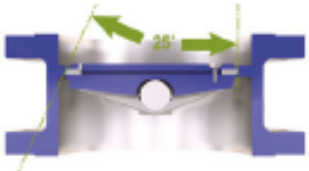
The combination of these three offsets provides an uninterrupted sealing surface, minimizes wear between the seat and seal, and preserves sealing integrity over the lifecycle of the valve.



First Offset: This offset applies to the center line of the disc/seat sealing surfaces, which provides an uninterrupted sealing surface.



Second Offset: This offset refers to the location of the shaft with respect to the center line of the bore, which enables a camming action of the disc to minimize rubbing and wear between the seat and seal.



Third Offset: This offset is the axis of the seat cone angle that is offset from the center line of the valve bore to eliminate rubbing of the seat/seal contact surfaces during operation and to preserve sealing integrity over the cycle life of the valve.

Figure 1 The three offsets of a TOV

Additionally, the optimized seat angle minimizes sticking or binding of the disc and lowers valve operating torque.

Generally, TOVs are selected for specific applications because of their sealing features as well as cost savings over other metal-seated valve types. Because of the compact, quarter-turn design and lightweight structure, TOVs can be installed and operated easily, and they require less pipe bracing. A replaceable seal ring that allows quick and easy repair and the low torque of TOVs (which permits smaller actuators) mean even more cost savings.

In addition to the financial benefits, TOVs offer a bi-directional zero leakage closure with a metal seat once only available with soft-seated valves. This expands application possibilities tremendously. Innovative self-centering, flexible seal rings and optimal torque transmissions mean these valves can offer fire-safe design and sealing performance that can be greater than the largest temperature range of general butterfly valve designs (Figure 2).

Figure 2. TOV (left) compared to gate (middle) and globe (right) valves

## TRADITIONAL TOV AND UPDATED TRENDS

Traditionally, TOVs could be found in numerous industries spanning oil and gas processing, refining, chemical and petrochemical plants, power generation, offshore platforms, district heating, pulp and paper, steel mills, sugar mills, desalination, and water treatment and distribution.

Their use in all industries has increased as strict governmental regulations and greater production demands have compelled users to seek solutions that are as efficient as they are effective. Usage is also climbing because the features of the TOV that have been around for decades offer many benefits to all applications, including those with greater challenges. Some of those benefits include operational efficiency, resistance to abrasive media and chemicals up to a certain temperature or pressure, and versatility within numerous operating conditions.

Capitalizing on previous TOV design features, the next generation offers features that further enhance valve safety and performance, including:

Figure 3. One of the benefits of using a wide gasket TOV is that it assures an even compression over the entire sealing surface of the lubricated seal, resulting in a long seal life and tight shutoff.

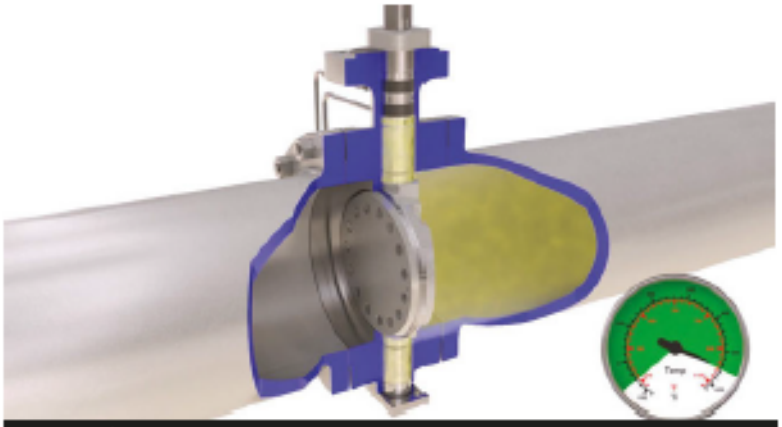


Figure 4. TOV high-temperature operation

## WHY USE A TRIPLE OFFSET VALVE?

Triple-offset butterfly valves offer the best sealing and longest life of all butterfly valve designs. Here are some of the reasons they are chosen:

- For the harsh conditions of critical process applications, steam isolation and temperature extremes, TOVs provide performance reliability and quality.
- The bi-directional zero leakage closure with a metal seat, even after extensive cycling, provides sealing integrity formerly associated only with soft-seated valves.
- Low torque from quarter-turn action permits smaller actuators and lower cost.
- Fire-tested designs per API 607, 5th Edition/ISO 10497-5 are available.
- Compact design means easier installation since valves are lighter and require less pipe bracing.

1. ***Metal-to-Metal Sealing.*** By offering a precision-machined metal seat and seal ring, the TOV can deliver reliable and bi-directional shutoff approaching zero in high-temperature, high-pressure and severe service applications as well as others. Additionally, a metal-to-metal seat can better handle thermal fluctuations, and the standard right-angle conical design of the TOV facilitates low-friction, in-line sealing, an important feature in high-temperature/high-pressure applications. In hydrocarbon service, the metal-to-metal seat allows a valve to meet the requirement for fire-safe applications, which is further supported by the TOV's quarter-turn characteristic.

2. ***Optimized Seat Angle.*** The seat angle design combined with using Stellite in the valve body seat, results in a longer seal life, as well as improved abrasion resistance, even after extensive cycling. This optimized seat angle can minimize wedging or binding of the disc, and lower the operating torque.

3. ***Torque seating.*** Torque-seating in TOVs allows the valve to self-adjust to evenly distribute seal compression. A "floating" seal ring and a wide seal ring-supporting gasket yield a superior seal and a tight shutoff (Figure 3). A slight increase in torque yields a better seal because of more evenly distributed compression of the seal ring along the entire sealing area. The applied torque also ensures a bi-directional seal.

4. ***Shaft Design.*** Positioning the pin connector in the lower portion of the disk allows good performance in thermal expansion and minimizes shaft deflection, thus permitting a longer valve life.

Today, manufacturers are tweaking the classic design and are blending standard features with new ones that are enhancing TOV capabilities, allowing these valves to cater to more challenging applications and environments. TOVs are also offered in expanded size and pressure ranges. A key differentiator from previous designs is a tighter ISO Class A emissions level that typically was associated with bellow-sealed valves. By incorporating new stem seals, TOVs can also provide fugitive emissions control under thermal cycling. This tighter seal is possible because of updated stem seal designs and packing assembly methods, which allow the valve to face higher temperatures (Figure 4).

By offering different packing solutions, including standard process industry (ISO 15848, Class BH), a Low-E option (ISO 15848, Class AH), and TA-Luft (VDI 2440), TOVs can be customized by application.

With the incorporation of these new types of features, TOVs can accommodate high-temperature steam applications, emergency shutdown service and fire-safe applications.

## CONCLUSION

Although many valve types are effective in controlling fugitive emissions, the compact design of TOVs makes them a viable alternative to higher-cost valve selections. ■

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