Keywords: Energy • Petrochemicals • Shale Gas • Sealing

Butterfly valves offer solutions to the chemical and energy sectors

The past few years have experienced dramatic changes within the petrochemical industry. While the recent shale gas boom has brought renewed focus to the standardization and development of valves for use in natural gas extraction, petrochemical and oil& gas sectors, governments in North America and Europe are passing increasingly-stringent fugitive emissions regulations. To keep pace with these trends, manufacturers must deliver solutions that are versatile, cost-efficient and able to provide the next generation of sealing performance. Lightweight, compact and effective in a variety of applications, butterfly valves could become the epicenter of development as a low-cost alternative to other valve types. This article explores the implications of the rise in shale gas production and intensification of fugitive emissions regulations, and suggests that butterfly valves could provide an efficient, low-cost solution for demanding applications.

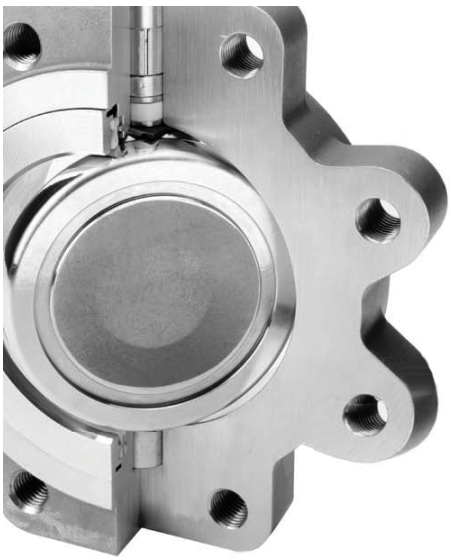
By Mike Brausch & Vijay Malik, Crane ChemPharma & Energy Engineering

The Shale Gas Boom

First extracted as a resource in 1821, shale gas has experienced a rapid expansion in use throughout the past decade, and continues to grow as a significant source of natural gas in the United States and around the world. Accounting for only 1% of U.S. natural gas production in 2000, shale gas increased its presence to more than 20% in 2010, and is projected to compose 46% of the U.S. natural gas supply by 2035, according to a 2013 report released by the U.S. Energy Information Administration.[1]

Modern technological advancements have catalyzed the shale gas boom. Hydraulic fracturing (fracking) has facilitated the permeation of shale reservoirs and increased exploration activity around the world.

The impact of this activity resonates throughout the chemical and energy sectors. The abundance of an alternative natural gas supply has reduced its cost, driving the development of natural gas extraction systems and bringing about the resurgence of a highly-profitable U.S. petrochemical industry.



For valve and other equipment manufacturers, shale gas utilization generates rewards throughout the value chain. Valve manufacturers can capitalize on the momentum created by the sudden surge in pipeline production and the ensuing demand for gas pipeline valves. Major increases in production are threatened by a potential shortage of proper equipment, and suppliers must be poised to offer a solution.

Additionally, as U.S. petrochemical producers experience reduced input costs and increased global competitiveness, a renewed focus on plant construction and pipeline infrastructure has emerged, offering another opportunity for valve manufacturers to benefit from the shale gas boom.

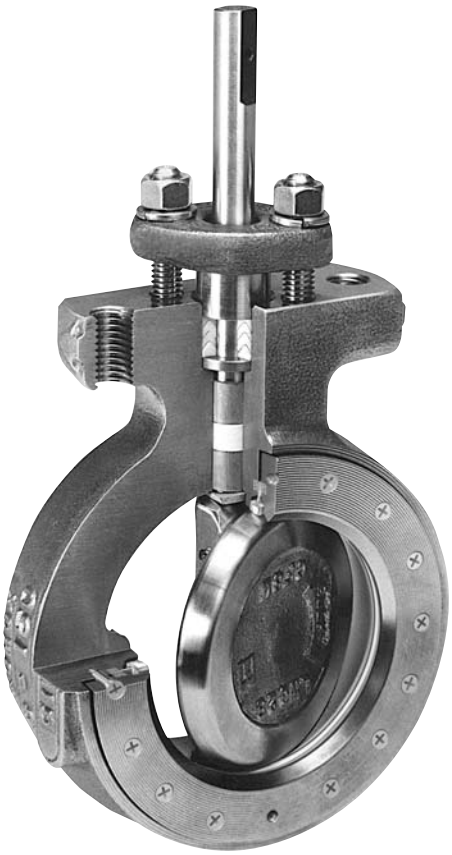
While the U.S. is a global leader in shale gas production, The U.S. Energy Information Administration estimates that China has over 1,110 trillion cubic feet of technically-recoverable shale gas reserves—almost twice the projected capacity of the U.S.1 Thus, although the Chinese shale gas industry is still in its infancy and there remain many unknowns, valve and equipment manufacturers should look to this emerging market as an opportunity for significant future growth.

Butterfly Valves in Shale Gas and Petrochemical Applications

Volatile, diverse and susceptible to environmental influences, shale gas and petrochemical applications present a variety of flow control challenges. Valves and other equipment designated for use in shale gas pipelines and petrochemical plants require operational efficiency, resistance to abrasive media and chemicals, and versatility within a wide range of operating conditions. High-temperature and high-pressure situations are also characteristic of severe service applications and require a valve that can withstand extreme conditions.

Triple-offset butterfly valves, are commonly recommended for use in chemical, power and refining applications, including shale gas. Specially-designed to shut off in high temperature service where other, resilient-seated valves are not well suited, these butterfly valves offer a compact, low-cost alternative to other valve types.

As the name implies, three separate offsets are designed into the valve. Two of the offsets apply to the location of the shaft with respect to the center line of the bore and the center line of the disc/seat sealing surfaces. The third offset in the design is the axis of the seat cone



angle that is inclined from the center line of the valve bore to minimize rubbing of the seat/seal contact surfaces during operation, and to preserve sealing integrity over the cycle life of the valve. This unique design can accommodate the temperature extremes present in gas applications, from cryogenic to extremely high temperatures.

The benefits offered by triple-offset butterfly valves make them ideal for inclusion in shale gas and petrochemical applications. The triple offset design provides bi-directional zero leakage shutoff while a self-centering disc prevents binding due to thermal shaft expansion, both of which are critical components in high-pressure, high-temperature applications. To prevent fugitive emissions, a clamped seal ring with flat gasket provides even compression and consistent sealing performance while the supported shaft prevents shaft deflection and seal leakage. Finally, an inherently fire-safe design ensures valve functionality under hazardous conditions.

The quarter-turn design offered by a triple-offset butterfly valve is easy to install, automate and operate, while providing a reliable and cost-effective means of flow control and isolation that performs well in shale operations with minimal torque.

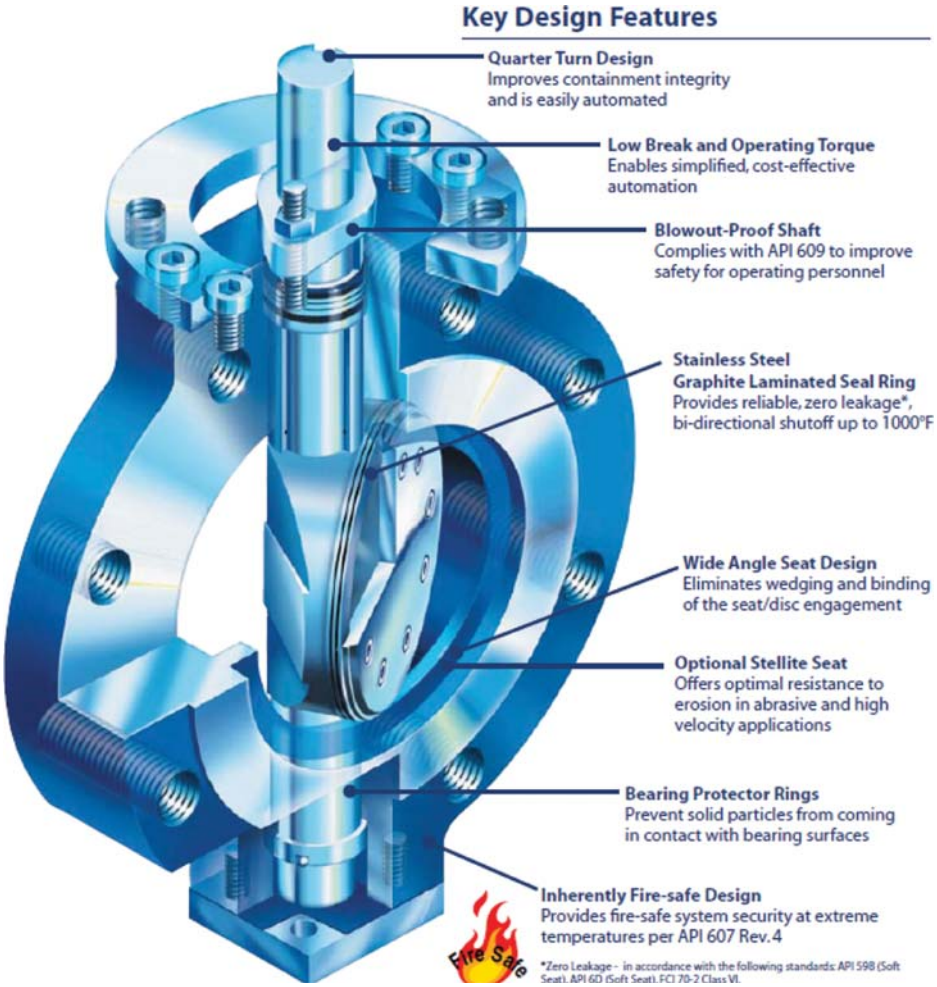
Fugitive emissions

With the recent boom in shale gas extraction and an increased focus on the environmental impact of the power, gas and chemical industries, fugitive emissions regulations have become increasingly rigorous in North America and Europe. Regulatory agencies and industry authorities in these countries have imposed strict limits on acceptable rates of valve leakage, and valve manufacturers have made great advancements in sealing and control to comply with the standards. Although the natural gas industry has received much attention for fugitive emissions concerns—natural gas systems were the listed by the EPA as the largest anthropogenic source of methane emissions in the U.S. in 2011—the problem is certainly not limited to one sector, and is of vital consequence to the valve industry in particular.[2]

Fugitive emissions account for a considerable number and extent of all emissions at large industrial processing facilities. This is so due to the difficulties in detecting leaks as the number of potential leak sources is substantial, and there are various difficulties frequently encountered in repairing (preventing) certain kinds of emissions. In recognition of this, strict standards have been developed and adopted by industry aimed at prevention of atmospheric leakage via paths inadvertently enabled by dynamic sealing action (rising and rotating of stem seal) of valves. The most important process valve packing standard, the API 622, is a pre-requisite in order to meet the API 624 valve fugitive emission standard. API 622 establishes requirements and testing parameters for fugitive emissions, while also taking into consideration corrosion, oxidation, and packing material composition and its properties. This Standard further specifies High temperature packings that are considered adequate at service temperatures from –29°C to 538°C, and temperature limited packings suitable for manufacturer-specified temperature range.

Fugitive emissions combat

Although many valve types are effective in controlling fugitive emissions, the low-cost, compact design of high-performance butterfly valves make this valve type a lucrative alternative to traditionally-higher-cost valve selections. Significant advancements in valve design and packing materials, as well as effective flow control in high-temperature and high-pressure conditions, make high-performance butterfly valves a worthwhile option for applications that require superior sealing and fugitive emissions management. For example, the XOMOX® Tufline® and Flowseal® brands offer an extensive range of trusted high-performance butterfly valves that feature double-offset (double-eccentric) disc mounting. These features extend seat life while reducing maintenance costs and downtime. Seats last longer and maintenance is reduced because the eccentrically mounted disc minimizes seat deformation and wear. The packing material preference has evolved toward all-braided packing rings and the use of flexible graphite or PTFE to fill any voids, thus maintaining sealing and resistance to dimensional distortion.



This sealing arrangement can be further enhanced with highly oxidation-resistant end rings for very severe process conditions. In chemical applications where the medium is very corrosive but requires lower temperature tolerance, other appropriate sealing materials (PTFE) and arrangements (Chevron® V rings) are commonly used while still meeting FE limits set under this Standard. The packing material selection process also takes into account friction, durability and process compatibility. A number of packing formats have been produced to limit the risk of fugitive emissions. Based upon process requirements, packing materials such as Elastomer rings, lip seals, PTFE / TFM rings and Graphite plus alloy materials can be utilized. Thermal cycling, mechanical cycling, or pressure and relaxation of packing over time can affect the loading of packing on the stem or shaft. This requires manual adjustment during routine maintenance or the use of live-loading, which provides a degree of cushioning to the packing system and maintains the required sealing load. Multiple sealing arrangements (i.e. with built-in redundancy) are designed to maintain low leakage over longer periods of time, and additional fugitive emission control can be gained with monitoring systems or early detection systems utilizing an additional leak port.

For enhanced emissions control, the XOMOX® Tufline® high-performance butterfly valve contains a patented, captive, snap-in retainer ring. When the valve is installed in the pipeline, the flange gasket overlaps the captive retainer and enhances the seal by preventing external leakage at the flange. With no screws through the standard butterfly valve retainer ring or a bottom plug, the valve's sealing capabilities are further enhanced by the elimination of leak paths.

The Flowseal Fire-Flow™ high-performance butterfly valve is a fire-safe, soft-seat quarter-turn valve. Incorporating two patented seats that function together to seal off pipeline flow, the soft seat provides a bi-directional "bubble tight" shutoff (zero leakage) in normal operation while the metal-seat provides bi-directional shutoff in the event of a fire.

With little or no pressure, the Fire-Flow seat creates a self- energized seal against the disc. Higher line pressures act on the geometry of both seats to dynamically load them against the disc, creating higher sealing forces in either direction. The Fire-Flow metal seat is made of Inconel® material that is shaped by a proprietary hydroforming process into its unique, patented design. Stainless steel outer bearings are included for post-fire disc and shaft alignment and fireproof packing is used to prevent external shaft leakage. Providing a secure seal, long life and a cost-effective alternative to other valve types, high-performance butterfly valves are an excellent option for inclusion in applications where fugitive emissions are a concern.

Conclusion

As the chemical and energy sectors continue to evolve and producers seek cost-effective ways to maximize efficiency without sacrificing innovation, butterfly valves offer a practical and effectual solution. Emergent trends like the shale gas boom and intensifying fugitive emissions regulations require valves that are able to perform under severe conditions while maintaining strict control of unwanted emissions. Evaluating alternative valve options like triple-offset and high-performance butterfly valves could offer the industry the solutions that the changing landscape requires.

Sources:

1. U.S. Energy Information Administration, *Technically Recoverable Shale Oil & Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States*, June 2013, Washington, DC. http://www.eia.gov/analysis/studies/worldshalegas

2. U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and sinks: 1990-2011*, April 15, 2012, Washington, DC. www.epa.gov/climatechange/emissions/usinventoryreport

About the authors

Mr. Mike Brausch is a Senior Product Engineer, CRANE® ChemPharma & Energy. As senior project engineer at CRANE® ChemPharma & Energy, Mr. Brausch has more than 35 years of experience with valves and actuation. He has worked for the XOMOX® brand for the past 28 years, and previously worked in the Automax division of Flowserve as an actuation project coordinator/manager. At Crane ChemPharma & Energy, he has been a product engineer for Tufline® high performance butterfly valves since the brand's inception in 1977, and for the Flowseal® line from 2002-2007. He has been named a subject matter expert by CRANE in the fields of technical standards and materials.

Vijay Mallik P.E. is Director of Global Engineering, XOMOX-WTA. Mr. Mallik is the Director of Global Engineering at CRANE® ChemPharma & Energy, representing the XOMOX® and WTA® brands. He has been in the valve industry for more than 25 years, with more than five years working for CRANE. Previously, he worked with ITT Corporation. He has been recognized as a tool champion for transactional processes, 3P and valve stream mapping, and is an ASME and SPE board member.