

BEST PRACTICES FOR MOLECULAR SIEVE SWITCHING VALVES
 IMPROVING DEHYDRATION UNIT RELIABILITY AND PERFORMANCE

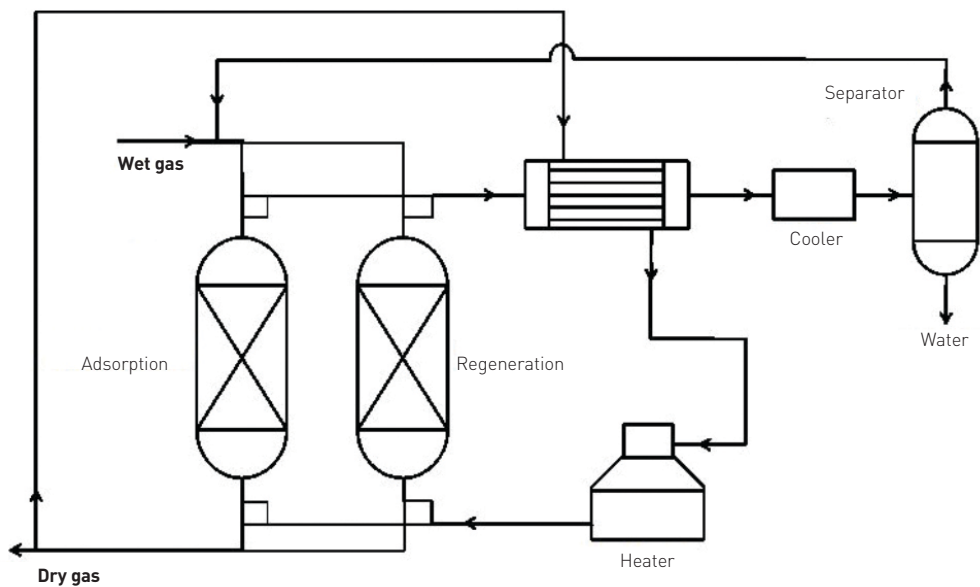


Introduction

Dehydrating hydrocarbons is a key step before further processing such as fractionation and liquefaction. The industry standard method to achieve this is with molecular sieve dryers

utilizing the adsorption principle. The typical dryer has at least one tower in an adsorption state and one tower in a regeneration state at temperatures as high as 315°C. These towers are alternated to provide continuous drying.

FIGURE 1
 Typical molecular sieve dryer layout



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Switching Valves

The valves that control the switching of the towers are known as switching valves. The combination of criticality, high cycle, thermal cycle, high temperature and the potential for erosive/abrasive dust makes this one of the most severe applications for metal seated valves.

Key requirements:

- Reliability
- Tight bidirectional shutoff
- Mechanical seal independent of springs and process pressure
- Low emission
- Proven performance

Reliability of the dryer and the even the plant itself depend on the choice of switching valves. The decision of which valve to use is one of the most critical choices for overall plant reliability. Therefore it is advised to review best practices for molecular sieve switching valves.

Reliability

Key attributes of reliable valves are simple and robust construction, low wear non-rubbing trim and materials ideally chosen for the severe environment. Historically reliability problems have occurred in molecular sieve dryers using valves that wipe the trim back and forth as the fine abrasive dust degrades the trim on every cycle of the valve.

To avoid that phenomenon, switching valves typically use a cam motion whether in the stem of a "tilt and turn" rising stem ball valve or in the eccentric rotation of a more modern rotary switching ball valve. See Figure 3.

In addition to abrasive wear from dust, valves utilizing springs, Belleville washers and seats that can move and be contaminated by dust particles must be avoided. Experience shows the most reliable valves for this service have a fixed single seat that cannot be contaminated by dust. See Figure 4.

Materials of construction are key to long term reliability. High levels of quality for castings is mandatory with certification to standards such as EN 10204-3.1 or 3.2 with mandatory radiographic testing of critical areas and appropriate NDE.

Hard facing must be applied to the ball that can withstand the many years of thermal cycling, heat and abrasive/erosive dust. Chromium carbide is an excellent choice with high resistance to thermal cycling, temperature limit of 815°C and resistance to abrasive particles. See Figure 5.

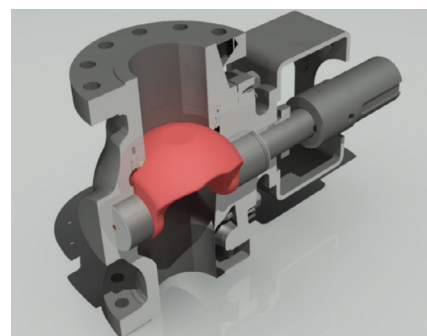
FIGURE 2
Typical switching valve installation in Texas, USA



FIGURE 3
Conventional ball valve on abrasive dust service



FIGURE 4
Switching valve with single fixed seat



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Tight Bidirectional Shutoff

Unlike most isolation valves, molecular sieve switching valves operate as a divider between two streams, the process stream being dried and the hot gas regenerating the beds. Therefore to avoid intermingling these flows and negatively impacting dryer efficiency, the switching valve must have tight bidirectional shutoff. Tight shutoff should be to a TSO standard such as API 598, ISO 5208 Rate A or Class VI. However this standard alone is not enough.

The molecular sieve switching valve shutoff requirement is especially challenging due to the process design that typically has minimal differential pressure between the regen gas on one side of the valve and the process on the other. In fact, most valves use process pressure and/or springs to energize the sealing members. With pressure in balance between upstream and downstream, a floating ball valve for example will not have any sealing energy. It must be recognized that leakage standards, while reassuring, may not be relevant at low differential pressures. Therefore it is critical that the switching valve seal independent of process pressure.

Mechanically Assured Shutoff

Experience shows reliable valves for molecular sieve switching such as rising stem ball valves utilize a mechanical seal. This assures tight bidirectional shutoff even when pressures are in balance around the valve. Modern switching valves also use this principle except utilizing modern manufacturing methods to achieve mechanical sealing with a true rotary design. See Figure 6.

Meeting Regulatory Emission Limits

One of today's most demanding aspects for the operator is meeting the ever more stringent ppm emission regulations in place for gas processing plants. Just a few years ago 10,000 ppm was allowable, today it is 500 ppm and enhanced LDAR requirements of 100 ppm are being discussed. Meeting these requirements without undue amounts of ongoing maintenance on thermal cycling hydrocarbon service requires intelligent planning according to best practices for low emissions.

Polished stainless steel stems are mandatory for long-lasting low emissions. While steel stems may have been tolerable in years past, today they are a path to constant violations of emission limits and frequent maintenance. Live loaded packing is critical as is certification to standards such as ISO 15848-1 and Shell SPE 77-300 demonstrating 3rd party verification of the Type Acceptance Testing of the manufacturer to stringent code requirements. See Figure 7.

Perhaps the most important advancement in modern molecular sieve switching valves is the ability to deliver all of the reliability and performance features of the rising stem ball valve without the rising stem. OREDA (Offshore Reliability Data Project) confirms that as a general rule, 99% of potential emissions can be eliminated simply by using quarter turn valves instead of a rising stem.

FIGURE 5
Chromium carbide coated ball



FIGURE 6
Modern rotary switching valves



FIGURE 7
Switching valve with low emission packing undergoes testing



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Modern quarter turn switching valves featuring a highly polished stainless steel stem protected from side load and live loaded packing operators can go years without a single packing adjustment. No rising stem solution can be considered comparable unless equipped with an expensive and fragile bellows seal. See Figure 8.

Conclusion

For reliable molecular sieve switching valves, use proven suppliers and follow best practices. Key attributes of the switching valve should be a simple and reliable design with low wear, non-rubbing trim, robust materials well suited for the harsh environment, tight bidirectional shutoff independent of process pressure without springs and seats that can be contaminated by dust. Care should be taken to meet today's regulatory requirements with stainless steel stems, live loaded packing and if possible, quarter turn valves.

Emerson is a leading manufacturer of critical service valves for the Oil and Gas, Petrochemical, Polymer, Refining and Aerospace Industries. Specializing in severe service zero leakage switching valves, cryogenics, high temperatures, high pressures, ESD and HIPPS valves, Emerson's AEV™ valves can be found anywhere there are extreme conditions.

Designed to

API 6D • ASME B16.34 • EN ISO 10497 • Shell SPE 77/300 • API 608 • BS 6364 • ISO 15848-1 • API 607 • ASME B16.10 • ISO 28921-1

FIGURE 8
Switching valves leave Emerson's AEV manufacturing facility



FIGURE 9
Emerson's AEV facility in Belgium



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