Valve Selection Strategies for the Biofuel Gold Rush

Industry ramps up quickly to manufacture and deliver ethanol and other biofuels without sacrificing long-term profitability

By Eric Fillion, Brian Bombard, and Bob Mulcahy

Gold is glittering in the fields of Iowa, Nebraska, Minnesota, North and South Dakota, and many other states, but it's not precious metal. It's corn destined to be processed into ethanol fuel. This boom, which began in the Midwest, is now spreading to many other sections of the country.

With record-breaking high prices at the pump and the U.S. officially on record that it must reduce its dependency of foreign oil, the rush is on to increase capacity for the production of biofuels &#151 particularly corn-based ethanol. From 2000 to 2005, industrial spending for alternative fuel projects grew by 209 percent in North America. This is the highest growth rate among 11 industrial sectors and the third highest incremental growth. Engine design modifications that allow for combusting higher levels of biofuel along with government programs, including requiring higher percentages of ethanol in gasoline, will spur that growth to even higher levels. Currently, there are more than 50 new ethanol plants under construction. This will result in a nearly 50 percent increase in the number of ethanol manufacturing plants in the next few years. In addition, eight major plant expansions are underway. This level of activity threatens to strain the industry's ability to provide both standard and critical service valves for biofuel manufacturing plants in a timely fashion.

In this frenzied, high-stakes atmosphere, the all-important emphasis on getting production capacity on-stream as quickly as possible, may make it tempting to take shortcuts in the valve selection process. Hasty, less-than-optimal decisions, however, could have unfortunate consequences, resulting in unacceptably high plant operations and product transportation costs. Developing strategies that identify and avoid pitfalls in the selection of valves for biofuel production and its transportation is now of the utmost importance.

Technology Issues

Jamesbury valves use proprietary seat and sealing technologies that make them uniquely suited for ethanol production processes.

As industrial processes go, the dry grind corn-to-ethanol process, which is used in the majority of biofuel plants now under construction or in the planning stages, is straightforward and represents only a moderate challenge to valves and accessories in terms of process severity. Even so, there are many services in these plants where the selection of best-in-class technologies can make an important contribution to valve package performance while maintaining or even improving life-cycle costs for the investment. Some situations to look for include the following:

&#149 Spiking Temperatures: For the most part, top operating temperatures throughout the ethanol plant are moderate. However, in some stages of the process, temperatures can spike severely during startup. Also, in the second stage, valves associated with the molecular sieve can see normal process temperatures in the 350&#176F to 360&#176F range along with severe spikes in temperature. Although normal operating temperatures in these plants are considered moderate, these short duration spikes, which at times can approach the upper limits of most polymer seat materials, are not.

The danger this condition imposes to valves is potential deformation of the valve

seat when the valve is in the closed position. Most standard seats will not recover quickly, if at all, to their normal ideal shape or size under extremes of heat and temperature; this can quickly lead to leaking. One solution to this problem is to order special seats out of an engineered plastic material. While the engineered plastic material seats provide excellent recovery in high temperature situations and are very durable, there are drawbacks. Engineered plastic material seats can be used in ball valve designs but are not suitable for use in a high-performance butterfly valve. For most high-performance butterfly valve manufacturers, the use of more costly metal seats is the only option.

At least one manufacturer offers a wide range of valves with standard seats made of an engineered-filled fluorocarbon polymer (the Jamesbury Xtreme seat) that provides durability comparable to an engineered plastic material along with low torque characteristics. This option has performed well in ethanol processing applications where temperature spikes are prevalent. It allows the ethanol processor to enjoy leak-free valve performance for extended periods of time. The ability to stock valves with one seat material for a number of applications also reduces the processor's inventory levels and increases safety by reducing the potential for misapplication of replacement seats.

&#149 Safety and Environment: A great deal of work has been done in recent years to reduce environmental and safety risks at fuel processing plants. The two broadest areas of concern are minimizing the release of hazardous emissions during normal operations and emergency situations, and ensuring the effective operation of ESD/ESV (emergency shutdown and venting valves) to prevent or minimize the damage of fire and explosions. Automated safety valve monitoring and testing solutions have been developed to ensure that ESD/ESV valves will be available when they are needed.

Valve specifiers and plant management should be aware of their availability if the highest degree of risk management is sought. In most instances, specialized valves are available with features such as live-loaded stem seals to prevent transient emissions and polymeric seats with metal carriers that can provide effective shut-off even if the polymer has been destroyed by fire.

&#149 Molecular Sieve: A critical valve application area for ethanol processing is the molecular sieve where second stage product, already 180 proof, is brought up to 200 proof. This is where the most volatile stage of the product is created, so tight shutoff, stem emissions control, and safety are important concerns. In addition, valves leading in and out of this process have high cycles that could result in premature valve failure, seat leakage, and a significant reduction of process uptime. Also, valve leakage in this critical area can make it difficult or impossible to meet 200 proof requirements. In spite of a large number of concerns, a single carefully selected product can answer all of them.

The control valve used in the molecular sieve application must also provide high-cycle longevity as well as tight shutoff to prevent process disturbances. A frequently employed solution for these requirements is to use two valves, a modulating valve, and a blocking valve for tight shutoff. Another option is to use a special soft-seated control valve designed specifically to provide a tight shutoff. Once again, a single valve can deliver an optimal solution for multiple problems.

&#149 High Cycle Applications: Another concern for valves used in conjunction with the molecular sieve application is the effects of high cycle frequencies. Shutoff valves that cycle frequently from fully closed to some degree of openness will

require replacement far sooner than valves with lower cycling requirements. There are a number of these valves in the ethanol manufacturing process. The question this situation raises is how long an interval can be reasonably sustained before the plant must be shut down for maintenance of critical valves.

In this case, research conducted within the air separation industry is instructive. OEM air separation equipment manufacturers were faced with customers who wanted their unattended, sometimes remotely located, equipment to be guaranteed for up to two years of operation without maintenance. The valve manufacturer involved in this initiative (Metso Automation's Jamesbury brand) redesigned the butterfly valves for this service by substituting a number of advanced wear part components that dramatically reduced torque requirements while improving wear resistance. The manufacturer was able to guarantee its valves for this clean media service for up to 3 million cycles. The company then re-engineered its standard butterfly valve product line to incorporate comparable innovations and increase standard warranty for clean media service to 1 million cycles. Where extending intervals between maintenance is deemed to be important to profitable ethanol operation, 1 million cycles is now a reasonable benchmark for evaluating valve longevity.

&#149 Steam Valve Noise Attenuation: When there is a sharp drop in pressure across a steam valve, high decibel noise is generated. This frequently happens in ethanol processing tank valves where an 80 to 90 pound drop can occur between the 150 psi streamline and the tank. In these cases, a primary concern is meeting OSHA sound exposure criteria for people working around the tanks. Some solutions for attenuating noise in steam applications include installing expensive baffles in the line to make the pressure drop more gradually or using a globe valve with a diffuser. To date, the most cost-effective solution for noise attenuation is the use of a rotary segment valve equipped with specialized trim that causes steam to flow through a series of channels to attenuate pressure drop and noise. This solution is smaller, lighter, and less expensive than other alternatives and reduces noise by up to 18 percent. The specialized trim option also works well in eliminating cavitation in liquid applications.

&#149 Bus Networking: Bus networks are used in major processing plants for the operation, monitoring, and diagnostics of valves in control loops. The most advanced positioners for control valves have built-in intelligence that seamlessly integrates with such field communications protocols as Fieldbus and Profibus. With bus networks, ethanol processors can take advantage of software that offers extensive remote valve management capabilities for optimizing process performance and reducing control valve maintenance costs.

Bus networks are also used with increasing frequency to network automated on/off valves. The principal advantage of doing this is to reduce the installation costs of point-to-point hardwiring using 4-20 mA, two-wire connections. By networking the valves, these costs (wiring and labor) can be reduced by as much as 40 percent in standard applications and by as much as 65 percent for valves in hazardous areas. Automated on/off valves on bus networks can also take advantage of emerging communications technologies for valve condition monitoring and remote diagnostics. Some manufacturers have integrated their product lines with advanced communications options that make it easy to install valve packages on bus networks without having to buy and install additional hardware.

&#149 Actuation Issues: A major cost consideration in selecting actuators for

automated on/off valves is choosing an actuator that is big enough to do the job, but not so big that the cost is out of proportion with the valve package's worth. Vendors that offer a wide range of sizes and types make it much easier to hone in to the proper actuator for the service.
On the other hand, there can be unforeseen process dynamics that could call for more torque than was originally specified. This can cause a properly sized actuator to stall at the critical point of control. There are specialized tools available (such as Metso Automation's Nelprof system) that can analyze process variables supplied by the system designer and detect any unsuspected dynamic torque situations, so the processor can be sure the right-sized valve is being used for the critical ethanol application.

With specialized seat designs and sealing technology, Jamesbury high-performance ball and butterfly valves are popular for the loading and unloading of tank cars.

&#149 Transportation Valves: An important and sometimes overlooked category of valves associated with ethanol processing regulates the loading and unloading of product into railcars and other forms of product transportation. Safety is a vital consideration for ethanol transportation valves, so tight shutoff and preventing escaping from valve stems are key issues. Another important consideration for ethanol transportation is coefficient of flow (CV), which determines how quickly product can be loaded on and off of carriers, primarily railroad tank cars. A new Jamesbury bottom-loading transportation valve to be introduced in the third quarter will substantially increase CV of its existing product. This full-port valve will be able to replace the existing standard port valve with no adapting hardware required. The substantially higher CV will allow tank cars to load and unload dramatically faster so that the cars can make several more runs during the course of a year.

Commercial Issues

In addition to technology issues, there are commercial issues that can have an impact on both the short- and long-term profitability of ethanol plants currently scheduled for production. These include the following:

An important consideration for ethanol transportation is coefficient of flow, which determines how quickly product can be loaded on and off of carriers, primarily railroad tank cars.

&#149 Emphasis on Lowest Cost of Ownership: Do the vendor's offerings tend to minimize maintenance costs and maximize uptime to extend intervals between scheduled maintenance?

&#149 Depth of Channel: Does the vendor have extensive manufacturing resources and strong representatives and distributors who will help offset the delivery and service crunch in today's fast-paced ethanol processing plant construction environment?

&#149 Depth of Experience: Ethanol manufacturing does not represent a brand new manufacturing process. Does the vendor have extensive ethanol processing experience either within the food processing markets and/or with manufacturers who were first into the biofuel marketplace?

&#149 Single Source: Does the vendor offer a broad range of products making it possible for you to reduce your cost of product acquisition?

&#149 Extensibility: Does the vendor offer a broad range of technologies that will be required in the future to implement process improvements or build plants supporting new biofuel processes that use feedstocks other than corn?

If you involve yourself in identifying and resolving valve technology issues and choose a primary vendor who has strong answers for the commercial issues, then you will be well on your way to having a solid valve strategy and a profitable ethanol processing plant.

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