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2017

A supplement to

E&P MIDSTREAM Business

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The 2017 Valve Techbook

A supplement to *E&P* and *Midstream Business*

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Hart Energy's Techbook Series

The 2017 Valve Techbook is the 13th in a series of techbooks in which Hart Energy will provide comprehensive coverage of effective and emerging technologies in the oil and gas industry. Each techbook includes a market overview, a sample of key technology providers, case studies of field applications and exclusive analysis of industry trends relative to specific technologies.

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Motor-man Jose Reyna turns the choke manifold of the BOP as he and the crew rig down Patterson UTI Rig 212 after drilling Covey Park Energy LLC's Chaffin Heirs 4-33 HC#1&2 near Grand Cane, La., in July 2016. (Photo by Tom Fox, courtesy of Hart Energy's *Oil and Gas Investor*)

The global industrial valve market is estimated by Grand View Research at $58.3 billion, an amount expected to increase during the next several years as the demand for flow control equipment grows.
(Photo courtesy of Freedomnaruk, Shutterstock.com*)*

Customizing Flow Control

Fit-for-purpose designs and automation are leading the valve market through the next growth phase.

By Brian Walzel
Associate Editor

The global industrial valve market is valued at $58.3 billion, according to Grand View Research, an amount that is only expected to increase during the next several years as a result of rising automation and growing demand for flow control equipment. Hart Energy's Valve Techbook features a variety of the latest trends and technologies expected to lead the flow control market out of the commodities downturn. The oil and gas industry accounts for 21% of the total valve market, according to Grand View Research, and market players are adopting new strategies, particularly with fit-for-purpose designs and automated systems.

The research firm reports that "Growing production and exploration spending in the oil and gas industry spurred the demand owing to technological innovations, enabling access to resources in deep waters or unusual reservoirs such as underpressured and unconventional or depleted reservoirs."

In a brief overview of its recent global valve marketplace study, MarketsandMarkets reports that similar to nearly every sector of the oil and gas industry, the valve market took a substantial hit following the commodity pricing collapse in 2013. But the valve market could experience a recovery from increased energy uses in developing countries and North America, where the shale boom is having a trickle-down effect to the valve industry.

Editorial contributor Scott Weeden addresses how more stringent environmental demands and challenges when drilling and producing from a HP/HT well are leading valve manufacturers to turn to simpler, fit-for-purpose valve designs. Among those that Weeden features are new valve designs by Interventek, NOV and Emerson.

Cameron, a Schlumberger company, offers details of its PULSE LF low-flow ultrasonic chemical injection metering valve. According to Cameron, the PULSE LF addresses the limitation of low-dose inhibitor chemical injection technology by accurately metering chemical inhibitors without the need for filtration.

Paul Hart, editor-in-chief of *Midstream Business*, addresses the challenges the valve industry is facing—and overcoming—in today's economy. He describes the significant number and variety of valves required in a single operation. And while the valve industry—like so many others in 2016—took a substantial hit, 2017 is so far proving to be a rebound, particularly in North America where rig counts have increased, leading to more infrastructure projects moving forward.

Hart Energy also reports on the trend of automation in the valve industry and how technological advancements, particularly in specialty valves, are better meeting customer needs and cutting down on costs.

Finally, PJ Valves (PJV) and Emerson Automation Solutions provide detailed case studies. PJV shares its successes in supporting the Angolan oil and gas industry through its two major projects at an LNG processing facility and the upcoming Kaombo offshore project. PJV has provided engineering and delivered custom valves to an LNG processing facility at the base of the Congo River capable of supplying 5.3 million tonnes of LNG to the worldwide market annually.

Emerson presents three case studies that reflect the versatility of its Vanessa triple offset valve (TOV). The first case study details why one offshore operator opted for the Vanessa TOV after several years of utilizing ball and gate valves for its flow isolation applications. A second case study shows how an operator offshore Brazil chose the Vanessa TOV for isolation and emergency shut-down functions for five FPSO units. The final study shows how the Vanessa valve has evolved with new applications in E&P, specifically on molecular sieve offshore operations in Malaysia.

These case studies and examples of critical valve applications reflect the latest developments and designs in today's valve market. ■

Improving Valves for Reliability, Robustness

Safety, reliability and robustness are key factors in valve re-engineering and redesign for deeper wells, larger wellbores or HP/HT environments.

By Scott Weeden
Contributing Editor

With oil and gas drilling and production having to deal with HP/HT environments, more corrosive fluids and greater water depths offshore, the industry is challenged to design valves to operate safely and reliably.

Many valves were designed years ago when environmental demands were not as stringent. What worked at 2,000 psi or 3,000 psi isn't always as efficient or safe at 10,000 psi or 20,000 psi. Manufacturers know the valve requirements and are asking questions such as how can that piece of equipment be more robust and reliable, is that feature needed, is there a need for that much pressure and how do we make sure this failure doesn't happen again?

John Sangster, technical director and co-founder of Interventek Subsea Engineering, believes that the future of valve technology lies in the creation of simpler, more fit-for-purpose designs that are re-engineered from the ground up to reduce cost and suit the logistical requirements of projects. Adapting existing solutions is simply not viable when addressing the increasing safety challenges faced by deeper, longer, larger bores or HP/HT wells.

"Over the last 20 years or so, in-riser valves have developed into extremely complex designs as bore size, pressure and temperature requirements have increased. Complexity, along with the use of exotic materials, has increased costs but reliability has been reduced and forced some operators to consider if the use of subsea landing-string systems can continue," he explained.

"Interventek's new valve technology not only provides superior shear and seal capability in a single unit, but vastly increases reliability and provides HP/HT capability at a significantly reduced cost leading to major savings for the operator," he continued.

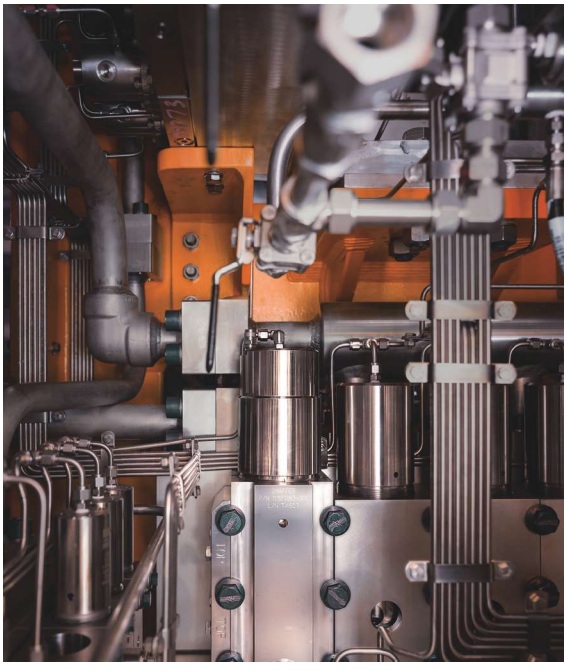
"Open-water intervention valve manufacturers have also taken the 'one-design-fits-all' approach, but this creates a huge burden on the system provider as they are invariably left with an unnecessarily high shearing capacity and operating volume. This approach has a major impact on the system's weight, control volume requirement and ultimately vessel size and type," he added.

"In times of low oil price where low cost, fit-for-purpose solutions are increasingly desirable this is an out-of-date, unrealistic approach. The limited valve choice on the market has a direct implication on operational cost. Technology such as ours is hugely exciting because it is enabling and disruptive. We are changing the way the industry has been conditioned to operate," Sangster emphasized.

BOP valve redesign eliminates shock

Subplate-mounted (SPM) valves have been around for more than 30 years on subsea BOP stacks. The pressure and shearing requirements have gone from about 1,500 psi to 5,000 psi. The fundamental design had not changed much in that time, said Frank Springett, director of engineering for research and development and the NOVOS product line for NOV.

The SPM valve uses a water (98%) and glycol (2%) mix as the hydraulic fluid in an open-loop system. With an open-loop system, the fluid is pumped subsea and then exhausted into the ocean since the fluid is mostly water.



NOV discovered that the opening and closing of the SPM valves caused the shock in subsea BOP systems. By designing a closed-center valve system, the company was able to virtually eliminate shock. (*Photo courtesy of NOV*)

"SPM valves have an open center and are two-position [open and close] and are three-way [work port, pressure port and tank port]," he explained.

After researching how the valves work, NOV discovered that the opening and closing of the valves is what causes the shock in subsea BOP systems.

"That shock is not a function of opening fluid to a piston or something like that. The reason you get this shock is because of the open-center configuration. Pressure is actually venting to the tank. The short burst and sudden stop of pressure creates the shock in the system," Springett said.

After instrumenting a system to see how everything works, the company took a look at the valve itself, including the design of the spool and cage.

"We designed a system that was a closed-center valve. What that means is that as the valve is transitioned all ports are not open to each other. It was pretty remarkable how we were able to virtually eliminate the shock in the system," he continued.

"The big plus to that is BOP reliability. One of the big pieces of BOP reliability is hoses, piping and tubing. By eliminating the shock that we produced from the fundamentals of a conventional, old-school SPM valve, we not only impact the reliability of the valve because we don't have the shock associated with it, but we also impact the reliability of the entire system since it increases the life of all the components that hydraulic fluid comes in contact with such as pressure regulators, shuttle valves, piping, etc.," Springett emphasized.

On the stream side of the valve, NOV saw high shock loads, and the SPM valve is right next to the regulators. Shuttle valves were also affected by the shock.

"We confirmed that eliminating the shock was a really, really important aspect in robustness and reliability," he added. "We could have stopped a eliminating the shock in the system but we didn't. We looked at every aspect of the valve and designed around reliability.

"We redesigned the seals to handle large extrusion gaps. We can rework the valve pockets in the field, which allowed us to fundamentally redesign the pod to eliminate leak paths. We eliminated troublesome fasteners from the design and utilized and placed wear bands that are more tolerant to contamination. We designed components symmetrically so parts can't be installed backwards or upside down. The list goes on and on," Springett said.

For existing systems, the valve block is changed and the new one is bolted in. There are no fundamental changes to the control system, he added.

"When our engineers are looking at designing for robustness and reliability, the first question is not, 'How do I make that item more reliable?' Their first question is 'How can I eliminate that item?' This is the essence of the design philosophy of the Low Shock SPM valves," he said.

Remote partial stroke testing

Safety in today's hazardous process piping environment is critical. "At Emerson we want to do our part to make sure our customers who work in these plants go home safe to their families at the end of the workday," said Shawn Statham, global product manager—actuated safety systems for Emerson Automation Solutions. "We're a manufacturer, yes, but we want to come together with the people who operate these offshore platforms and production facilities and partner with them to develop more reliable and safer solutions.

"Safety shutdown systems (SSDS), or safety instrumented systems (SIS) to be specific, continue to be a significant area of focus around the world. SSDS provide an additional layer of safety that help to protect personnel, the environment, and assets, etc.," he continued.

Over the last 20 years the industry has seen a

Emerson has provided four HIPPS top-entry API 15000 FCT valves with Biffi actuators for an offshore platform in the North Sea. *(Photo courtesy of Emerson Automation Solutions)*

continued evolution of standards designed to address safety including the International Electrotechnical Commission (IEC) standards 61508 and 61511 along with International Standards Association (ISA) Standard 84.01. Recently a new revision of IEC 61511 was released.

"As the standards come out and get applied, we see good things that come out of it; however, we also see areas where we might be able to improve those standards down the road," Statham added.

> "Safety shutdown systems continue to be a significant area of focus."
>
> —Shawn Statham, Emerson Automation Solutions

Current standards don't adequately address the integration of individual components in an SSDS. For example in an emergency shutdown (ESD) system, you typically have a valve from one manufacturer, an actuator from another manufacturer and controls from a third manufacturer.

"Most customers rely on best practices to guide the integration but everyone seems to be doing something different, communication in this field is also a challenge, and we often don't have the same taxonomy for that matter," he said.

For the upstream sector, Emerson is talking about high-integrity, pressure-protection systems (HIPPS) and ESD valves. "These two SIS subsystems are being applied in both drilling and production. HIPPS systems are applied in some overpressure cases where high pressure systems will potentially need to be brought to a safe state if there is an upset condition," Statham explained.

The SIS is comprised of sensors, logic solvers and final elements. The sensors measure temperature, pressure and flow, and act as initiators sending a signal through the logic solver. The logic solver then sends a signal to the automated valve package to open or close the valve. Companies like Emerson now manufacture all of these components. "There is potential for improvements to these systems as we begin to look at them more holistically and not as individual parts," he emphasized.

The automated valve also referred to as the final element often contributes the greatest portion of probability of failure on demand, and it's where the majority of failures occur. "This is largely due to the fact that the valve is a mechanical device and not instrumentation; it's in contact with the media and typically sitting static for long periods of time. The media can degradate the operational capability of the valve in many ways," he continued.

"It's critical that these valves be tested to ensure they can be counted on to work when we need them, and a full stroke test is not always possible due to process demands. Some of the more recent advancements we've made are in the area of partial stroke testing. Utilizing the Fisher Digital Valve Controller enables our customers to partially stroke a valve 5% to 10% to verify the valve moves, and the actuator and solenoid are working, etc. This test does not shut the process down while still allowing a test to ensure the system is functional," Statham said.

Another strong focus in the industry in general is the Internet of Things (IoT). "IoT offers new capabilities such as redundant monitoring of SSDS as well as remote diagnostics monitoring capabilities. The ability to perform partial and full-stroke testing on valves on an offshore platform via the internet and get all the diagnostic feed backremotely are areas where we're going to see more development in the future," Statham added.

In-riser 20,000-psi, HP/HT shear-seal valve

A new HP/HT in-riser shear and seal valve has been designed by Interventek Subsea Engineering. The

valve can withstand working pressures of 20,000 psi (20K) and temperatures of 350 F (177 C) for in-riser landing string systems. The Revolution Valve was designed for emerging HP/HT and deepwater well environments, particularly in the Gulf of Mexico, and is believed to be the first of its kind.

"The 20,000-psi valve was developed from our 15,000-psi form with very compact internal components and external rotary actuators. The simplicity of design makes it very eligible for fulfilling other configurations," said Gavin Cowie, managing director, Interventek.

The 20K in-riser valve is able to cut slickline, braided cable and coiled tubing up to 2 in. in diameter with wall thickness of 0.203 in. and 148-ksi tensile strength. The bore size is up to 5.125 in.

"The valve is utilized during installation and workover of wells completed with horizontal type christmas trees. The unique design is comprised of two elements. The first is a sealing flapper component, which is pivotally mounted to a second component—the structural saddle that allows the back and forth rotation," he explained.

"The saddle delivers the cutting forces and incorporates a hardened cutting insert. The primary sealing boundary is elastomer-free, relying instead on high-specification, resilient seals to contain produced fluids. It uses metallic sealing for the temperature piece of the system. The seals, like all the valve components, can be accessed for inspection or maintenance," he added.

"Conventional ball valves were never originally designed to be cutting tools. The same leading edge of the surface that is required to create a seal is now used as a cutting edge, so is vulnerable to damage and may not seal effectively," he said.

New Ultrasonic Flowmeter

Technology boosts critical accuracy of subsea, low-flow chemical injection.

By David Simpson, Cameron, a Schlumberger company

The accuracy of injection rate is the key component in delivery of cost-efficient, effective low-flow chemical injection. Historically, achieving critical accuracy has not been a simple task. Traditional flow measurement technologies used in subsea chemical injection metering valves for low-dose inhibitors (LDI) typically use either Venturi-type flow measurement (whereby a pressure drop is measured across a precision orifice) or a positive displacement flow measurement technique that employs a rotating or stroking piston to measure volumetric flow rate.

Accuracy with these techniques can be heavily influenced by the properties of the injected chemicals, requiring project-specific chemical calibration during manufacture of these chemical injection metering valves (CIMVs). However, CIMV system designers are often not provided with critical chemical data while the CIMV is in the design stage. Inaccuracies in flow measurement can also stem from particulate contamination and blockage in the CIMV.

These events can result in potential CIMV system under-performance. Blockage happens because of particulate contamination of chemicals being injected through the CIMV, blocking onboard filters or tightly fitting moving parts or orifices used for flow measurement.

Deepwater long step-out projects utilizing subsea distributed chemical injection are dependent on CIMV technology that demonstrates maximum particulate tolerance; consistent high accuracy of reading; independence to changes in chemical properties, such as viscosity; and increased reliability in measuring chemical flow rate.

Criticality of inhibitor dosage

Costly under- or overdosing is often tied to chemical injection metering valve accuracy, which can be heavily influenced by the flowmeter design and properties of the injected chemicals. Under-injection can result in scale or wax buildup in production strings or pipelines, for example, lowering the production rate.

Should the scale or wax exist in the line for an extended period, the well may have to be shut in to undergo a batch treatment, incurring deferred production and intervention costs. In the case of corrosion inhibitors, SURF (subsea, umbilicals, risers and flowline) facilities may have to be taken offline until failed components are replaced.

Revolutionary flowmeter concept

Cameron, a Schlumberger company, has introduced the microbore, nonintrusive PULSE LF low-flow ultrasonic chemical injection metering valve for injection rate control of LDIs, offering a highly reliable, debris-tolerant CIMV with best-in-class injection rate accuracy. This flowmeter addresses the key limitation of present LDI chemical injection technology (sensitivity to blockage) by having capability to accurately and reliably meter chemical inhibitors without the need for filtration.

The microbore ultrasonic flowmeter at the heart of the PULSE LF CIMV delivers nonintrusive, debris-tolerant flow measurement (based on the "delta T" time-of-flight measurement technique) with no moving parts, is chemical independent with a very low native pressure drop and does not require any subsea filtration.

This single, retrievable unit offers an injection range from 0.25 to 600 l/h (achieving a turndown ratio of 2,400:1) with an injection rate accuracy of better than 2% of reading above 2 l/h compared to the Venturi-type, low-flow chemical flowmeter technology that may only deliver accuracy of 5% to 10% full scale.

The PULSE CIMV system architecture combines the ultrasonic flowmeter with an electrically actuated needle-and-seat throttling valve in closed-loop control. Flow rate monitoring and valve actuation via the onboard closed-loop control algorithm, along with external communications, are managed by the electronic control module that streams back operational performance data to the operator via the master control station.

Real-time feedback from the flowmeter is used to autonomously control the throttling valve, maintaining a user-defined injection rate set point indefinitely regardless of up- or downstream system disturbances. ■

David Simpson is the subsea flow control product champion for Valves and Measurement, Cameron, a Schlumberger company.

Interventek's Revolution Valve separates the cutting edge from the sealing surfaces. *(Image courtesy of Interventek)*

"In its Revolution Valve, Interventek separated its cutting edge from the sealing surfaces, so the sealing components are protected from damage cause by the cutting. After they have rotated past the shearing edge, the components are lifted into position to seal," he continued.

The external rotary actuators provide the required cutting force while keeping the hydraulics separate from the wellbore. The actuators are rated for 10,000-psi working pressure. The total fluid requirement for the actuator is 1.5 liters (0.4 gallons).

The new technology within the Revolution Valve allows it to be tailored to suit a variety of applications with different operating challenges, such as new subsea well development and heavy intervention from mobile floating drilling rigs using a drilling riser or BOP stack. It is also suitable for surface intervention, subsea in-riser completion installation and intervention, an open-water control package, exploration drilling program valves, abandonment tree saver valves and subsea lubricator valve assemblies. ■

Midstream Faces Myriad Valve Challenges

Multiple issues confront a busy midstream's need for valves.

By Paul Hart
Editor-In-Chief, *Midstream Business*

The old pipeliner took a long sip of coffee, leaned back in his chair, pushed his shop cap back and slowly smiled, thinking how his career—in what today we call the midstream—began long ago. The Korean War's fighting had ended and he was back home in Wyoming, job hunting, he told his listeners. The state's oil and gas industry was growing and that seemed to be the place to find work, so he hired on with a contractor building a natural gas processing plant.

Once the plant was complete, the plant's owner asked him to stay on to help operate the new facility. His first job was to man—literally—one of many valve stations spread through the complex.

A loud whistle behind the central control room across the way would blow coded, short and long blasts alerting him and co-workers at other stations when to open and close valves as the lean-oil operation hummed along, he explained. Protection from the elements was minimal so, depending on the season, plant operators had to contend with hot, dusty wind or bitter snow squalls.

Shortly after the plant started up, the pipeline company that had integrated the operation into its system installed an in-plant telephone network and the whistle went away, replaced by ever-ringing phones. "We thought we were really modern!" he added with a chuckle.

How far we have come.

Thank automation, the internet and now the Internet of Things (IoT) for replacing whistles, telephones and lonely outposts. But the midstream now, as then, relies on an assortment of valves to control product flows. A later job transfer later put the old pipeliner in a pickup, driving right-of-way across the Wyoming prairie for many years, where he was checking meter runs—and valves—manually until he retired.

Current challenges

Remote operation is but one of multiple valve-related issues confronting midstream management today as the sector continues the buildout across North America. Sourcing, new applications, cost, delivery delays—even politics—enter into the decision of what to buy and how.

"The main challenge today is lead times," said John Bowhay, senior vice president of supply chain management, valve and technical product sales, for MRC Global Inc., the largest distributor of pipe, valve and fitting products and related services in the energy industry.

Consider just one type of valve, he said. "Lead times for pipeline ball valves are extended due to the upturn in demand in North America. Investments in transmission lines to transport gas and oil are extensive and therefore supply channels are challenged. Consumption is further complicated by our midstream customers not following any industry standard specification—they all have their own requirements."

Further complicating all of these questions is the sometimes stunning number and variety of valves required to operate a sprawling gathering, processing, transportation and storage network.

As one expert in gas processing plant valving observed following a discussion over a GPA Midstream Association technical paper, "Take a big LNG plant or a big gas processing plant, there are a quarter-million valves in there; that's a lot." Gate valves, check valves, pinch valves, specialty valves—and yes, ball valves—the variety and type seem endless. All must work together to ensure safe and efficient operations.

Clicking a mouse beside a keyboard in Houston may actuate a pipeline valve in Wyoming today, rather than someone standing on the gravel pad

next to it, but the valve itself remains as necessary as always.

Midstream's outsized role

Bill Sandler, president of the Washington, D.C.-based Valve Manufacturers Association of America (VMA), said the oil and gas industry represents an significant share of the valve industry's business and—within the oil and gas sector—the midstream represents an outsized chunk of that business as it responds to customers at both ends of the value chain.

"Last year was not a good year in general for the valve industry, the first down year after five or six up years," Sandler added. Thanks to the oil and gas price downturn, "VMA members have had some tough times. We're slowly recovering. We're seeing upward movement in 2017, as oil prices have come back up somewhat, so we're cautiously optimistic."

Seaport Global Securities said in a recent report to investors that is sees a stronger 2017 for its flow control and engineering and construction segments. Both sectors underperformed the broader stock market in the first half "but we look forward to optimistic second-half commentary that signals a continuation of improving trends along with seasonally strong cash flows, which enable the group to grow into its valuation and re-engage investor interest, in our view."

Six energy-related industries counted together represent just over 50% of total U.S. valve demand in a typical year among 16 industries VMA monitors, ranging from energy to wastewater to HVAC (heating, ventilation and air conditioning).

MRC Global echoed Sandler's view in a corporate assessment of 2017 business trends. But it noted North America is an exception—in particular because of a comparatively busy midstream in the U.S., Canada and Mexico.

"In North America, rig counts are increasing, midstream infrastructure projects are moving forward and downstream refining and chemical activity continues to be solid," the MRC report said.

'Steady demand'

The firm's InSight publication said in a recent article: "The demand for valves and actuation products in much of the midstream, pipeline and gas utility markets saw little to no decline over the last two years and, in some cases, increased as a result of numerous major infrastructure projects that continued to move forward. Ongoing and newly approved pipeline activity, both for new projects and mandated integrity work, continues to provide steady demand for valves and actuators going into these applications.

The bustling Marcellus Shale has emerged as a major valve market as the midstream plumbs Appalachia, linking what may emerge as the world's largest gas field with major North American markets. *(Photo courtesy of MRC Global Inc.)*

"We expect this trend will continue over the next few years," the story added. "As a result, we have increased our inventory position on pipeline ball valves up to 42 inches, slab and expanding gate valves to 24 inches, as well as double-block and bleed-plug valves used in most terminals. The midstream gathering market has shown positive signs of improvement in line with the uptick in the upstream market, and MRC Global is well-positioned to meet the increased demand."

Automation continues

That automation trend that put a phone in the old pipeliner's hand continues to be a major issue, Sandler said, as valve manufacturers respond to customers' needs to increase efficiency and cut costs.

"There seems to be a trend toward more sophisticated valves that are controlled from somewhere else, much more automation than we've seen in the past, the ability to fix a problem without going out in the field," he said. New valve designs may focus more on electronics that control actuator assemblies than on seals or metal alloys. The trend is likely to continue as the IoT grows in importance.

For example, Emerson, a major player in IoT technology, recently unveiled its DeltaV Mobile, a software platform that leverages IoT technology to provide real-time data, trends and insight for designers and operators.

The system removes "the confines of the control room and [will] enable the digital worker— managers, engineers, operators and subject matter experts —to monitor operations and see critical operational data when, how and where they want, without waiting for regular business hours, manual reports, or being tied to a computer," the firm said in announcing the new system.

Specialty valves are an important niche in the business and always will be. Consider just one example of a specialized critical application: molecular sieve dehydration processing valves, used to remove water from natural gas processing, ammonia and LNG liquefaction plants.

Mass produced gate valves, check valves and such are very different from specialty isolation valves, control valves, switching valves, those types of applications.

LNG's role

And there's little in the midstream valve arena more specialized than gas liquefaction, requiring sophisticated engineering and materials.

Multiple valves make up a meter run connecting a Permian Basin well pad to a gathering system. *(Photo courtesy of Navitas Midstream Partners LLC)*

Gas liquefaction, which relies on several patented and competing processes, chills natural gas to -260 F, requiring 1/600th the space for storage and transport compared to gaseous methane. All of those processing techniques depend on specialized valves made of exotic alloys and seals that can function at temperatures so cold that rubber seals, stretchy and spongy at room temperature, turn as brittle as glass.

Commercial-scale LNG has been around for some 50 years but research in how to make and handle the cold liquid continues. Last year, GE Oil & Gas and Technip signed a memorandum of understanding for a joint project to explore areas they could co-develop in the LNG industry, with a particular focus on the design-and-build phase of new LNG projects. Valves and the software that control are a part of that joint effort.

Sandler mentioned another trend impacting gas transmission: the switch by electric utilities to gas-fired plants, replacing coal.

"It's slow but it's there," he noted. The trend adds to the overall demand for midstream-related pipeline components.

Going global

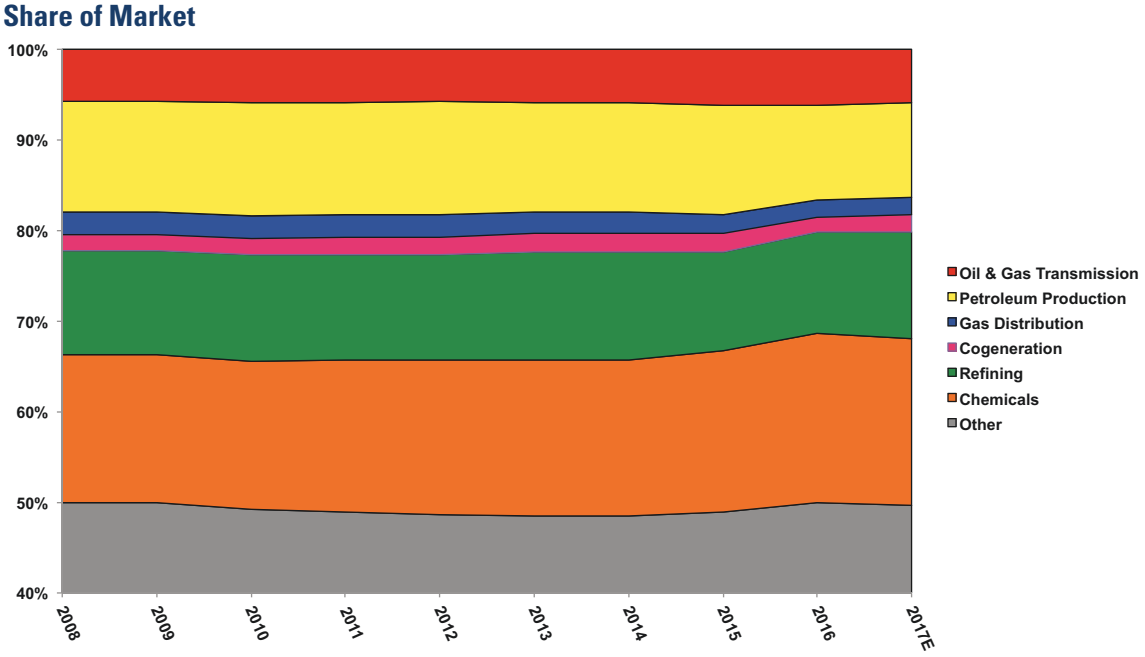
Consider globalization: Common valves, where cost is the greater consideration, increasingly are made abroad, thanks to lower labor costs. But that may be changing, according to the VMA's Sandler.

"People seem to be realizing that quality and timeliness are important factors," he said. "Obviously, it's usually cheaper to buy overseas. But especially in special operations where the quality of the product is important, I think we still make the best product here." Sandler noted a move back to domestic suppliers may be occurring, but added "no one's building new valve plants."

Instead, the atomized valve design and manufacturing industry—with scores of players—continues to assimilate into fewer and bigger players. In a recent example, Denholm Valvecare, based in Aberdeen, Scotland, announced a strategic partnership with Spain's IBOR Valves. Both are players in the international oil and gas valve business and their new agreement will allow them to focus on the specialized valves that are in greatest demand.

"The deal between the two companies will see bespoke products and services offered in both directions," Denholm said in announcing the agreement.

Going abroad can complicate completion of a new gas plant or terminal due the distance—and shipping time—involved.



(Image courtesy of Valve Manufacturers Association of America)

MRC's Bowhay said contractors and midstream operators can help expedite delivery by planning ahead.

"The simplest way to avoid supply issues is to purchase out of inventory," he said. "Lead times are extended in some cases to 40 weeks. That is difficult to plan for, and the original bill of material produced by any contractor is never the final one. There are always emergency buys in the life of any project.

"Supply contracts are also helpful as they will also smooth out price changes and allow the end user to leverage the aggregated spend of a distributor like MRC Global," he added.

Emissions rules

Valve industry observers also mention another important challenge now to valve design and usage is the government's increasingly stringent rules on fugitive emissions. U.S. Environmental Protection Agency rules and other federal government regulations push low-emissions technology (Low E) for valves that limit volatile organic compound emissions. Some state emissions rules are even stricter.

A Low E valve is defined as a valve, including its specific packing assembly or stem sealing component, for which the manufacturer has issued a written warranty that it will not emit fugitives at greater than 100 parts per million and that, if it does so emit at any time in the first five years, the manufacturer will replace the valve.

The American Petroleum Institute's Standard Committee on Piping and Valves issued updated standards on fugitive emissions, API Standard 622, in 2016. "While other standards do address the issue of fugitive emissions, the API standards have also attempted to address leak rates and other aspects of valve performance," Valve magazine, published by VMA, said in an article following issuance of the energy trade organization's standard.

The updated API standard establishes requirements and parameters for the following tests, according to the publication:

- Fugitive emissions;
- Corrosion;
- Packing material composition and properties; and
- Oxidation evaluations.

"The fugitive emissions testing includes 1,510 mechanical cycles with five thermal cycles—ambient to 500 F. The test methods apply to packing for use in on-off valve rising stem and rotating stem motions," API noted.

Meanwhile, API is proposing its Rule 641, a new standard under consideration that would set fugitive emissions standards for the testing of common quarter-turn valves, including stem seal materials. Also, API's Specification 6D, which covers pipeline valves, is scheduled for an update that would develop a separate standards, done in conjunction with the Association of Wellhead Equipment Manufacturers.

Political considerations

And yes, even politics has an impact nowadays on the valve business. The buy-American drive currently supported by President Trump often enters customers' thinking when they launch a new midstream project. However, those American-made valves may produce sticker shock compared to imports. Also, many standard, off-the-shelf valve types aren't made in the U.S. anymore, valve industry observers said.

MRC noted in its 2017 report that "As we move through this new climate of activity, our teams are keeping a close eye on issues that have the potential to impact both manufacturers and customers, such as U.S. President Donald Trump's 'Buy American' domestic policies. This new administration's position on global sourcing could have a significant influence on the balance between supply and demand for the products our customers rely on and the projects they have planned.

"Of note, in January 2017, the President directed the Secretary of Commerce to draft a plan requiring the use of U.S.-sourced materials for all newly constructed, retrofitted, repaired and extended pipelines located within U.S. borders. The regulations resulting from this plan have the potential to impact demand for those products and the supply of these materials to our customers. We are taking this issue very seriously and are monitoring any new developments," MRC added.

Looking ahead

Multiple issues and questions will continue to complicate midstream investment decisions in a basic asset found all long the energy industry's value chain. Valves—like any other component—will evolve as the marketplace changes, whether that market is for a processing plant, a railroad tank car or a crude oil terminal.

The energy industry must be open to change to improve its efficiency and profitability, according to a presentation at the Valve World Americas Expo and Conference, held in June 2017 at Houston's George R. Brown Convention Center. Brindesh Dhruva, chief technology officer for Bray International, a major valve supplier, stressed in his conference presentation the importance of continuing innovation.

"Light bulbs weren't invented by someone trying to make a better candle," he said. A Valve magazine review of his speech noted that "Innovation comes in terms of process innovation, like LEAN and Six Sigma. It can also manifest in technological or customer experience improvements."

"Take for example horizontal drilling and fracturing for oil and gas. Those were complete game-changers," Dhruva said. "And more are coming now, like stemless valves. You torque them through magnetic conduction."

Dhruva also reviewed the potential impact of 3-D printing on the valve industry. "You can have a prototype in days rather than months. It infuses innovation into the design process, because you can try things right away."

Certain specialized instrumentation valves must work at high pressures and in hazardous atmospheres. *(Photo courtesy of Parker Hannifin Corp.)*

"Valves typically used in pipelines are engineered and therefore not commodity items," Bowhay added. "It's difficult to buy engineered products through a B2B [business-to-business] system without a large degree of intervention, so IoT is not changing the traditional methods of valve procurement for pipelines—yet.

"Technology is, however improving, safety and integrity of valve performance in critical applications," he said. "Valve monitoring and detecting valve 'margin' is essential to ensure that valves operate when called upon in critical situations. MRC's ValveWatch technology, which is the most advanced option in this area, should be of great interest to any end user that operates pipelines or plants where certainty of operation is essential."

But whatever happens, it will beat listening for a whistle on a cold Wyoming night. ■

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New Valve Technologies for Various Applications

This technology showcase features an assortment of valve technologies for onshore and offshore.

The following is a small sampling of valve technologies for subsurface safety valves, wellhead valves for subsea and surface trees, and pipeline valves that are available to operators in the industry.

Editor's note: The copy herein is contributed from service companies and does not reflect the opinions of Hart Energy .

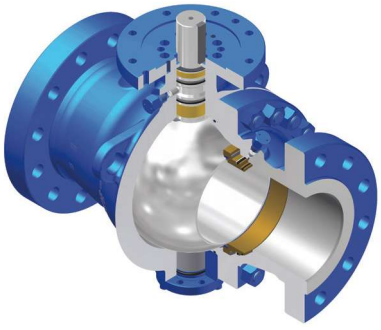
Managing Valve Assets Digitally

Baker Hughes, a GE company (BHGE), is a provider of full-stream digital industrial solutions for oil and gas. BHGE offers two new digital tools to better manage valve assets—whether it's on a platform, pipeline or plant location. ValvKeep is an asset management tool that helps users manage their valve life cycle. It acts like a medical record system, like that used by a family doctor, to provide life-long critical testing and maintenance data. To further optimize efficiency, condition-based monitoring tools like ValveAware monitor performance and proactively determine the health of the valve fleet to increase plant profitability and avoid unplanned downtime. Using digital solutions helps keep valve technology healthy, which improves safety and quality while maximizing profits. *bhge.com*

BHGE's ValvKeep tool is an easy-to-use, icon-driven software program that records the life events of valves, providing status reports on valve health, future maintenance planning and other resource-maximizing functions. *(Image courtesy of Baker Hughes, a GE company)*

Streamlined Trunnion Valve Gets Safety and Seal Upgrades

A new generation of Schlumberger's WKM D Series valves, commonly selected for specialized applications such as gas distribution, gas transmission, oilfield production and industrial applications, has been released by Cameron, a Schlumberger company. Engineered for heavy-duty, long-lasting performance in a variety of body and seal materials, the streamlined WKM 370D6 trunnion-mounted ball valve now features a new seat design that enables better sealing across a range of material options like Teflon and PEEK, while lowering the torques required to operate the valves. The entire size, pressure and material trim range has been successfully certified to the API 607 6th edition fire test, giving operators confidence in valve performance in many situations. Safety integrity level certifica-



The WKM 370D6 trunnion-mounted ball valves are designed for heavy-duty performance in general purpose petroleum and chemical process applications. *(Image courtesy of Cameron, a Schlumberger company)*

tion is available along with internally self-relieving seats, block and bleed capability in both the open or closed position, and explosive resistant O-rings in every valve. *cameron.slb.com/wkmd6*

Compact Valve Designs Offer Minimal Space and Weight

As deepwater projects such as managed-pressure drilling and subsea tiebacks become increasingly common, operators are faced with the difficult task of implementing increased functionality on facilities or vessels with limited, expensive real estate. This presents a challenge to minimize the footprint of additional equipment without sacrificing safety, quality or performance. CORTEC is pushing the boundaries of conventional valve manufacturing by utilizing compact ball valve designs to produce turnkey manifold systems that place high levels of functionality in very small spaces. By incorporating advanced technology in raw materials, manufacturing processes and seal mechanisms, valve performance can be offered at the highest level while space and weight are significantly reduced. These designs are manufactured under the framework of API 6A and certified in accordance with API 6AV1, which rates them for boarding shut-down valve service in the Gulf of Mexico. *uscortec.com*

CORTEC's compact API 6AV1-rated 15,000-psi boarding shut-down valve assembly supplied for Gulf of Mexico project features a 5-in. bore flowline, 1-13/16-in. bypass line and full inconel cladding. *(Image courtesy of CORTEC)*

Keeping Operational Costs under Control

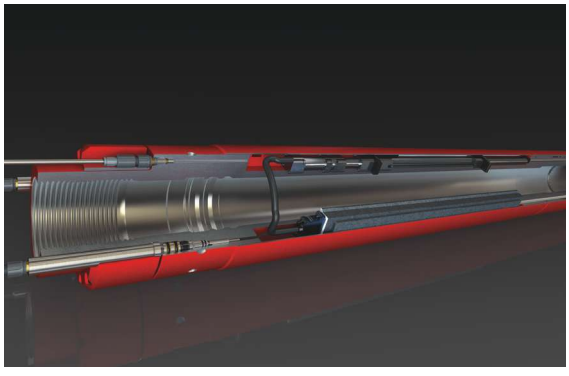
With more than 10% of an offshore operating budget spent on chemicals, platform operators are challenged by flow assurance issues. Operators risk platform shutdowns by under injecting chemicals, leading to costs of up to $1 million per day in lost production. Conversely, over injecting a well by 5% can cost up to $90,000 per chemical, per well. Emerson's TESCOM 56 flow control valve series is specifically designed for offshore chemical injections and allows users to accurately control the flow rate of chemicals over the life of the well regardless of changes in temperature, inlet and well pressure, and well flow. When combined with Emerson's Micro Motion Coriolis meter, the system can automatically adjust injections when well conditions change. Users can benefit from a complete injection solution that cuts chemical injection costs and reduces waste and platform downtime. *emerson.com*

Emerson's TESCOM 56 series is designed for offshore chemical injections. *(Photo courtesy of Emerson)*

Control the Valve at any Distance from Subsea Architecture

The Halliburton EcoStar electric tubing-retrievable safety valve (e-TRSV) solves the challenge to remove hydraulic actuation and its limitations from the subsea architecture. The constraints of hydrostatics and fluid friction between the control center and the wellhead when closing the valve in an emergency situation are eliminated. This enables a fully electric completion system with zero risk of exposing electronics to produced wellbore fluids

and removing all negative environmental effects of purging fluid to the subsea environment. Developed in collaboration with, and successfully field trialed in a well for Total, the EcoStar e-TRSV allows the operator to control the valve at any distance from the subsea architecture and provides faster response time for command and control of the system with immediate response in emergency shut-down situations. When used as part of an all-electric control system, the EcoStar e-TRSV allows substantially reduced capex and opex in more complex field developments. *halliburton.com*



The EcoStar e-TRSV helps eliminate potential environmental impacts due to loss or spills of control fluids over the long-term field life. *(Image courtesy of Halliburton)*

Cutting, Sealing in One Compact Device

Interventek's Revolution Valve is a new shear and seal safety valve for well control and intervention in the upstream oil and gas industry. It is the only valve that provides a reliable method of cutting and sealing in a single compact device. The cost-effective valve is suitable for a number of applications. Since its launch, Interventek has delivered a surface version of the valve, a subsea 15,000-psi in-riser valve, the world's first 20,000-psi in-riser valve and an open water well control valve for light well intervention. The technology allows one valve to be used instead of multiple stacks, reducing costs and increasing safety. The valve is the world's first in-riser valve suitable for 20,000-psi HP/HT applications. Being lightweight and compact, the valve suits the restrictions of both in-riser and light well intervention operations, and the open water version is the only wireline class valve that can also cut sinker bar. *interventek.com*

The Revolution Valve is a new shear and seal safety valve for well control and intervention. *(Image courtesy of Interventek)*

Control Valve Carries Flow in Applications Less Than 45 psi

The E-LO is a low-pressure electric control valve designed to carry flow in applications less than 45 psi. The valve features a module control board with three module options: 1) analog, which uses a 4-20 mA signal for proportional control; 2) discrete, which uses dry contacts for on/off control; and 3) RS-485, which allows control and communication via Modbus RTU. Common applications include gas compression, combustion and burner management, and it can also be used as a dump valve or pressure regulator. The E-LO solves a variety industry challenges depending on its application. One example application is for temperature regulation. Whereas pneumatic valves can cause erratic temperature swings inside a production vessel, the E-LO can precisely control fuel gas and maintain a constant temperature in the vessel. *kimray.com*

The E-LO control valve is a technology that provides precise valve regulation for flow control. *(Photo courtesy of Kimray)*

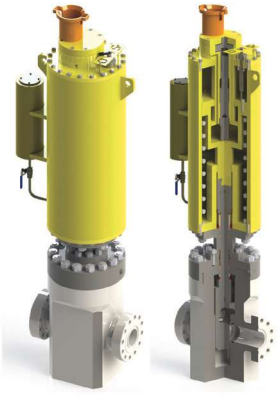
Valve Controller Delivers an Improved User Experience

The Neles NDX is Metso's latest addition to its comprehensive valve controller offering. The valve controller offers accurate and reliable performance in a wide range of applications, regardless of industry or the brand of valves being used. The Neles NDX offers control accuracy that will have a direct and positive effect on process variability and, subsequently, on profitability. Improved control accuracy can help ensure production quality and minimize the amount of production losses. It also can assist in the optimization of raw material, chemical and energy consumption. These devices are simultaneously inspired by the latest technologies and more than 50 years of experience in valve controller manufacturing. They are designed and manufactured to perform in demanding operations and process conditions. The smart and durable design improves safety in both installation and operation. *metso.com/ndx*

The Neles NDX is easy to install and use. *(Photo courtesy of Metso)*

Through-conduit Slab Gate Valves for Subsea Applications

OMB is conducting an extensive R&D program, which is aimed at extending the product range to include through-conduit slab gate valves for demanding subsea applications. The targeted application for this new product is deep water to a depth of 10,000 ft and high pressure up to API 15,000 (1,034 bar) with a size range from .5 in. to 7-1/16 in. All newly developed valves will be equipped with linear subsea actuators and/or gearboxes, which is a new product line, entirely engineered, assembled and tested within OMB. An ROV interface is available for all subsea assemblies as well. The Qualification of Subsea Through-conduit Slab Gate Valves is currently an ongoing project with testing equipment in place and testing underway. Hyperbaric testing, full PR2 qualification testing and endurance testing form the basis of the qualification program. All of the testing carried out is witnessed by a third-party inspection agency. International design standards together with customer specifications are incorporated into the test procedures being used to qualify the valve/actuator assemblies with the objective of creating a through conduit slab gate valve range capable of meeting the most stringent industry demands. *ombvalves.com/subsea*

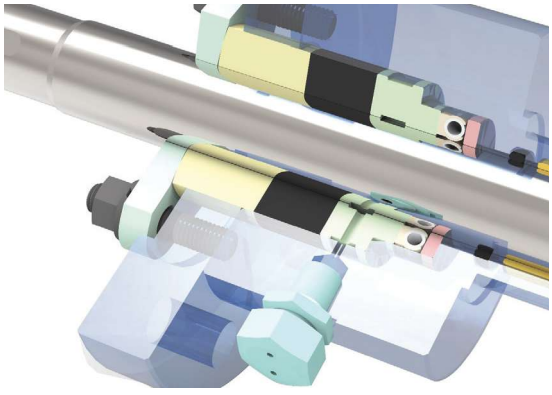


OMB's R&D program aims to include through-conduit slab gate valves for demanding subsea applications to its product line. *(Image courtesy of OMB Valves)*

Ball Valves Offer Various Design Options

Rays Flow Control's RAYS API 6D Ball Valve has a soft-seated or metal-to-metal seated design that can be applied to various working conditions and temperatures (-196 C [-321 F] lowest temperature). Top entry design can realize online repair/accessories replacement, reduce maintenance cost and extend service life. The integral body design could also minimize leakage point. The rising stem ball valve has no friction during the open/off process, has a self-cleaning spherical and has a stronger self-seal with more reliable sealing. The high-pressure pigging valve with patented design offers easier sending/receiving with more safe and reliable operation. In addition, the company's new fugitive emission design is a more assured fugitive emission design. Packing comes from a certified API 622 manufacturer with many options available, which depends on temperature/medium. The lip seal ring design can meet the requirements of ISO 15848/

SPE 77/312/TA-LUFT/API 624, and it is suitable for toxic and harmful mediums to better meet the increasingly serious worldwide environmental requirements. *raysvalve.com*



The lip seal ring design is suitable for toxic and harmful mediums. *(Image courtesy of Rays Flow Control)*

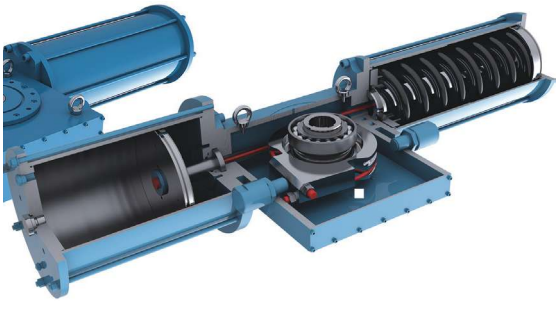
Valves Designed to Address Severe Service Demands

The oil and gas industry continues to move toward further utilization of trunnion-mounted ball valves in various isolation and control applications. ValvTechnologies is a Houston-based manufacturer of high-performance, zero-leakage valves with a focus on the design and manufacture of metal-seated ball valves for severe service applications. The company's TrunTech valve is designed to address the critical demands of the upstream and midstream oil and gas industries including but not limited to high-integrity pressure protection systems, emergency shutdown, manual isolation, injection, gas transmission and storage applications. TrunTech's protected seat seal design provides long life and tight shut-off in abrasive and erosive conditions as well as meets stringent fugitive emission requirements. The valve is designed to API-6D and API-6A, fire-safe per API-607 (API-6D) and API-6FA (API-6A), tight shut-off per ISO-5208 Rate A (API-6D) and PSL-3 (API-6A). TrunTech is designed to offer low operating torque, very high flow rates (Cv), protected sealing surfaces when in the open and closed position as well as the ability to operate in the presence of solids and other contamination. *valv.com*

The TrunTech design from ValvTechnologies withstands severe thermal swings, meets stringent emission requirements and provides long life in abrasive and erosive conditions. (*Photo courtesy of ValvTechnologies)*

New Cable Drive Actuator Offers Lower Maintenance

Velan ABV's new patent-protected cable drive actuator benefits from a transmission system with constant torque and high accuracy along the entire quarter-turn rotation. Its modular construction comprises a center body, pneumatic or hydraulic power cylinder and a spring cartridge for emergency action. It is the actuator's newly designed center body with its cable drive system that separates it from the standard scotch yoke actuator and provides 30% more running torque. Fewer components and less friction mean lower maintenance, smaller actuators and additional safety. Scotch yoke actuators are most often used for on-off rotary valves, but they are limited when they are used for accurate control services, fast-closing operations and heavy-duty cycles. The cable drive actuator's design overcomes these limitations, guaranteeing optimal position control in the most demanding conditions. *velan.com* ■



Velan ABV's new patent-protected cable drive actuator provides 30% more running torque. *(Image courtesy of Velan ABV)*

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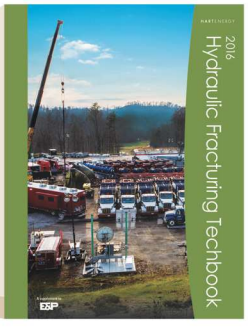

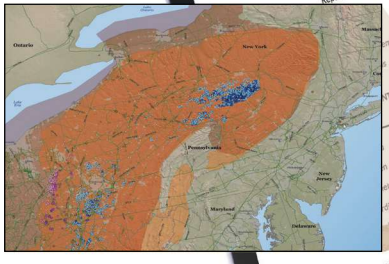

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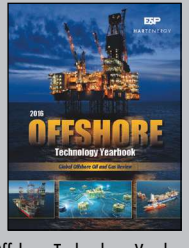

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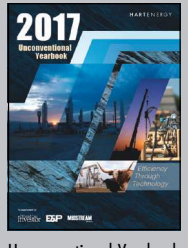

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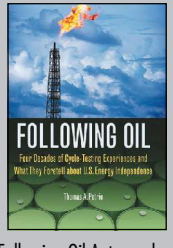
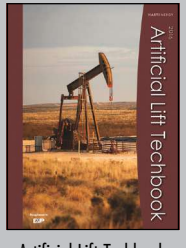


Following Oil Autographed



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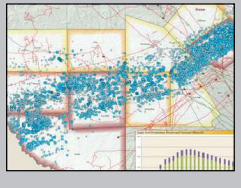

Eagle Ford Shale Map

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North American Outlook

New study forecasts global valve marketplace to 2023.

By Nitish Pande
Contributing Editor

The industrial valve market is dominated by the oil and gas, water and wastewater, and power industries. Industrial valves are used in these industries to regulate, manage and control the flow of media (gases, liquids, fluidized solids or slurries) by opening, closing or partially obstructing various passageways, ensuring safe and efficient operation of the industrial processes.

The slowdown in the oil and gas industry in 2013 severely impacted the industrial valve market, but the recovery phase of this industry is likely to have a positive impact on this sector. The increasing consumption of oil and gas as a fuel in developing economies creates a demand for increased valve production. This trend indirectly drives the industrial valve market for the oil and gas industry, and North America is likely to account for about 27% of the industrial valves market in 2017.

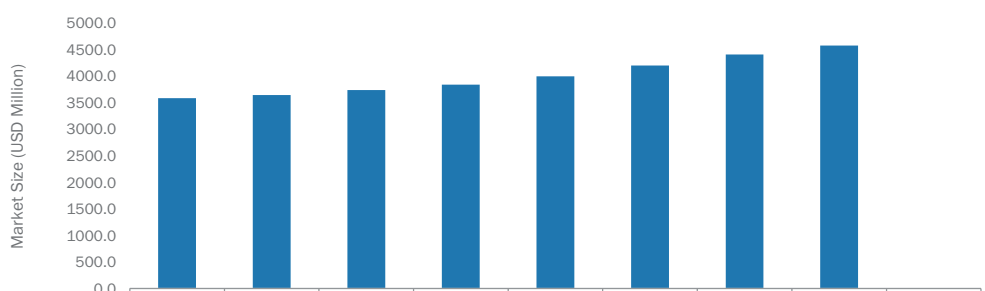
A majority of the leading players in the industrial valves market are based in this region. The increased R&D in the ecosystem of valves, in terms of actuators and automation technologies, and the increasing demand for safety applications are the two crucial factors driving the market in North America. R&D is broadening the application areas of the valves in different industries such as energy and power and chemicals, especially in the U.S.

The North American industrial valves market for the oil and gas industry is expected to witness a CAGR of 3.9% from 2017 to 2023. At this CAGR, the said market is expected to grow from $3,587.5 million in 2016 to $4,580 million by 2023.

North America is an early adopter of new technologies. The innovative quotient of this region is much higher than the other regions. The region is expected to hold the lion's share in terms of the innovations related to the industrial valves in the near future. This innovation would not be in terms of design or mechanism but rather with respect to the inception of Internet of Things (IoT) in rational industrial valves. However, the introduction of IoT-enabled valves in the oil and gas industry is a challenging task. The oil and gas industry players are still reluctant to use IoT-enabled valves in their mainstream business due to security issues. However, this reluctance is expected to decrease in the coming years as IoT-enabled valves transit from the "unproven technology" phase to the "proven technology" phase. ■

Nitish Pande is a research analyst at MarketsandMarkets. For more information on the company's study, "Industrial Valves Market by Material Type," visit marketsandmarkets.com.

Industrial Valve Market for Oil and Gas Industry in North America



	2016	2017	2018	2019	2020	2021	2022	2023	CAGR (2017-2023)
North America	3587.5	3647.9	3740.1	3844.1	4000.8	4204.2	4410.2	4580.0	3.9%

(Data courtesy of investor presentations, expert interviews and MarketsandMarkets analysis)

Triple Offset Valves Can Replace Ball, Gate and Butterfly Valves

They are proving effective across a wide range of offshore applications.

By Marco Ferrara and Sergio Casaroli
Emerson Automation Solutions

Owners and operators of offshore platforms, floating production storage and offloading units (FPSOs) and floating liquefied natural gas (FLNG) facilities face important challenges due to valve size, weight limitations and high levels of corrosion in the marine environment. Boosted by the constant need for higher production capacities, offshore applications require more robust and compact products. Emerson's Vanessa triple offset valves (TOVs) have proven effective in addressing these issues due to innovative product designs and material selection with a history of successes in this industry dating back more than 20 years. Three brief case studies that validate the effectiveness of Vanessa TOVs for offshore applications are included in this article.

Emerson's Vanessa Series 30,000 triple offset valves address the need for higher production capacities and more robust, compact designs for offshore applications. *(Images courtesy of Emerson Automation Solutions)*

Why triple offset valves for offshore?

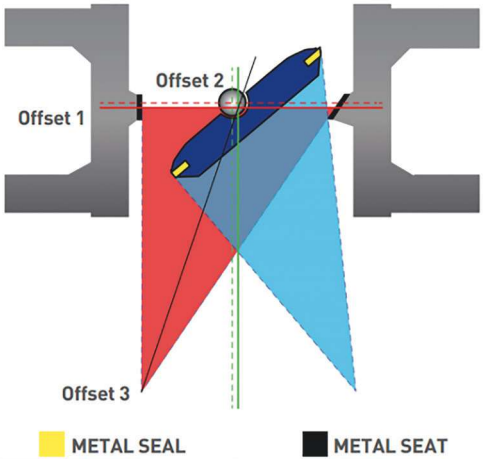
Significant technological developments have been made in the butterfly valve segment over the past 40 years--the reduction or complete elimination of rubbing during rotation is part of the evolution of this type of valve. These relatively new designs (double offset, also known as high performance, and triple offset) ensure longer life cycles, require lower maintenance and provide an improved leakage performance compared to concentric types.

Nonetheless, the differences in terms of capability and functionality between double offset valves and triple offset valves are still somewhat confused. The Vanessa valve was the first to provide a triple offset valve capable of performing zero leakage by using a non-rubbing design across the entire 90° rotation (differently from double offset valves), delivering a single, instantaneous contact between sealing elements only when a closed position is achieved. (Zero leakage means no visible leakage when tested at high pressure with water and low pressure with air according to existing international standards.)

Vanessa TOVs are able to handle bidirectional flow and tightness in both sealing directions up to ASME class 1,500 pressure due to the combination of such non-rubbing rotation with torque seating (a key difference with position seated concentric butter-

fly valves) achieved with three "offsets":

1. The shaft is placed behind the plane of the sealing surface;
2. The shaft is placed to one side of the pipe/valve centerline; and
3. The seat and seal cone centerlines are inclined in respect to the pipe/valve centerline.



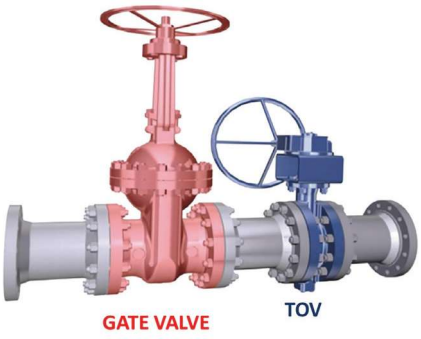
Vanessa TOVs are capable of achieving zero leakage by using a non-rubbing design across the 90° rotation capable of delivering a single, instantaneous contact between sealing elements only when a closed position is achieved.

On these premises, the seal ring (and not the disc itself, as is in the case of other butterfly valve designs) is the critical component as it represents the key flexible element necessary to perform sealing against a seat that is integral to the body and overlaid with Stellite grade 21. A dynamic spiral wound gasket ensures an adequate expansion and contraction of the seal ring during opening and closing.

Isolation applications

For centuries, linear (multi-turn) movement valves such as gate valves have been used in process isolation based on a simple design principle (i.e., a stem pushing a wedge into a seat to achieve shutoff.)

Although this design is quite safe, over the past decades there has been a surge in the use of soft-seated quarter-turn valves. Ball valves in particular have gained popularity in view of their tighter shut-off capabilities because of the use of soft sealing materials, their functional versatility and a more compact design (which is a feature common to all other quarter-turn valves). Recently, end users have come to face tighter Health, Safety and Environment



Vanessa TOVs can be adopted for both positive and double positive isolation setups in place of a gate valve for their zero-leakage capabilities and reduced footprint.

(HSE) regulation. As a result, revisions to the design concept behind the idea of "positively" sectioning a line (i.e., with no admissible leakage downstream) are continuously made. This function ensures that equipment can be safely removed and maintenance/inspection requirements can be addressed without shutting down the entire facility. Based on their inherent characteristics and zero-leakage shutoff capability, Vanessa TOVs have been adopted for both positive and double positive isolation set-ups in lieu of both gate and ball valves, providing significant benefits in terms of operability, performance and overall cost of ownership.

On-off applications

An on-off process functionality implies initiating/blocking the flow of a medium to manage the startup, operation and shutdown of a plant. From a process functional perspective, such actions are carried out to shutdown pieces of equipment, blow off/blow down media and redistribute flow to different lines (also known as switching).

Usually handled by ball valves, these functions are subject to several challenges, mainly correlated to the degree of severity of the service and the consequent need for valve maintenance which generates important down time costs. Ball valves are typically pressure seated valves with a cavity that requires a relief system--which is non-standard and varies from manufacturer to manufacturer. Such cavity relief requires installation on the appropriate side, depending on pressure differential, to be effective.

Vanessa TOVs are capable of overcoming all these issues with a low maintenance solution combined with reduced weight and footprint.

Emergency shutdown applications

The IEC 61508/61511 standards set up key provisions

for implementing a safety integrity system (SIS). The design purpose of an SIS is to protect personnel, equipment and the environment by mitigating the likelihood and severity of the potential risk. In a modern industrial facility, the SIS is designed to prevent or reduce hazardous events by taking the process to a safe state when predetermined conditions are violated.

SIS is commonly an emergency shutdown system (ESD), high integrity pressure protection system (HIPPS), safety interlock or safety shutdown system. SIS typically includes the design and implementation of a variety of shutdown and/or blowdown valves. Based on the probability of failure, there are four safety integrated level (SIL) classes going from SIL 0 (none, lowest risk) to SIL 4 (highest risk).

Higher reliability/plant availability is achieved by using proper safety components (design), installing such components according to manufacturer's guidelines and testing them both at initial startup, as well as at specified intervals or after any modification. This is why an inherently safer SIL 3 Vanessa TOV, coupled with appropriate automation and controls, can contribute to delivering an overall safer system.

Vanessa TOVs feature a non-symmetric design which implies that, depending on installation direction, the valve can fulfill a safety function facilitated by the flow (open to close) or pressure (close to open). This is possible in view of extremely low running torque values due to the non-rubbing rotation and the asymmetric trim design.

Case Studies

Early Vanessa TOV adoption in the Norwegian North Sea

For most offshore platforms in operation in the Norwegian North Sea, ball and gate valves had been considered by a major oil and gas company the standard for most of their flow isolation applications for decades. However, in 1994, this oil and gas customer chose to test Vanessa TOVs during a yearly routine production shutdown as a means of exploring a lighter, cheaper and potentially more reliable solution. When the end user overhauled the crude oil pump, the Vanessa valves—which were operated by an actuator--were also deployed to manage the isolation of the pumps from the main oil header under full pressure. The test was so successful that these Vanessa valves were kept in service. Since then, Vanessa TOVs have been installed in numerous offshore applications around the world.

Further developments in offshore Brazil

Reducing weight while also maximizing space is a constant quest for EPCs and end users who are building platforms and FPSOs. To address these critical needs, a major oil and gas company operating in fields off the coast of Brazil replaced all heavy top-side ball and high-performance butterfly valves with Vanessa triple offset valves on two of their FPSOs. This type of valve had been installed previously on the cargo tank piping system on the main deck and in the pump room, and proved difficult to operate and disappointing in terms of long-term performance. As an alternative, Vanessa valves were adopted in these areas instead to address both isolation and ESD functions with a single product. Several years later, these Vanessa triple offset valves were in operation. Subsequently, because of the success of the first installation, this customer also chose Vanessa valves for installation on three additional FPSOs.

New TOV applications in E&P

In recent years, with the newest developments of FLNG (including floating storage regasification units or FSRUs) technology has leaped forward, and so has the TOV range of applications. While utilities (including the ones used on topsides and floating units) have been easily handled by Vanessa valves for many years, there have been new groundbreaking adoptions within processing areas. To name a few, TOVs have been specified in separators (used to separate oil from gas and other debris including sand), in vapor recovery units (where waste gas in a FLNG is recovered instead of being flared), HIPPS and as isolation valves in gas flaring systems.

Furthermore, another important process in which TOV adoption is gaining traction is the dehydration and purification of gas through molecular sieving. Used in both gas FPSO and FLNG applications, molecular sieving has historically been handled by heavy rising stem ball valves. These valves on larger sizes and pressure classes are extremely heavy and have a large footprint, generating a number of direct (material use) and indirect (installation and increased floating vessel weight) costs that engineers must account for during frontend engineering design (FEED) project phases. The tilting mechanism itself, a variant on a standard quarter-turn ball valve, is subject to wear and can degenerate over time. Although the valve sealing elements may not involve rubbing capabilities, friction is transferred to both the shaft cam (towards core pins) and the S-shaped pin slot. This valve design requires specialized maintenance, including the use of costly spare parts, significant time and effort.

Since 1999, Vanessa TOVs have been used on molecular sieve offshore operations in Malaysia. Some of the Vanessa valves replaced rising stem ball valves for a CO2 membrane system that featured a two- to four-hour open/close cycle; those valves are still in operation. Hundreds of rising stem ball valves have also been replaced in gas plants in solid bed molecular sieve applications, and there are many more cases of TOV evaluation and adoption in response to the recommendations by major molecular sieve process licensors.

Conclusion

In offshore applications, 100% metal-constructed TOVs such as Vanessa represent a robust fire-safe valve for services (e.g., crude oil) containing debris and other solid particles. Furthermore, TOVs are valves that are not affected in terms of performance by piping loads that may distort the valve body compared to sealing plane/trim. This differs from comparable ball valves, where two seating planes will become misaligned with each other, thus increasing the friction with the ball in between and, therefore, increasing operating torque. Such benefit is even more significant in emergency-type of operations.

Non-rubbing in a triple offset valve also means lower wear of sealing components. This is how a TOV fundamentally differs from high-performance butterfly valves (typically featuring rubbing for approximately 20 percent of rotation) and it is an extremely crucial feature whenever the valve is used in process applications entailing a high number of cycles, including those found offshore. Compared to gate and ball valves, the savings in terms of weight and footprint reduction are massive. Furthermore, TOVs are easier to operate than gate valves even with a manual gear because of a low running torque and no need for extra safety factors during actuator sizing. TOVs also have the ability to open against full pressure without any need for upstream depressurization, which is another collateral cost-reducing benefit compared with ball valves that may require a bypass line instead. ■

Marco Ferrara and Sergio Casaroli are Vanessa Triple Offset Valve subject matter experts For Emerson Automation Solutions.

Engineering Angola's Oil and Gas Future

One company supports the Angolan oil and gas industry by partnering on two major projects.

By James Moir
PJ Valves

At the mouth of the Congo River sits one of the world's most modern LNG processing facilities, capable of supplying 5.2 million tonnes of LNG to the global market every year: the $10 billion Angola LNG plant. Approximately 175 km to the southwest, the Kaombo offshore project in Block 32 will include two FPSOs, with a combined oil treatment capacity of 230,000 bbl/d, transferring the associated gas collected back to the Angola LNG facility.

Both projects are examples of an investment drive in the Angolan oil and gas industry, and both have relied on PJ Valves (PJV) as a key engineering partner in delivering cost-effective, made-to-order valves in a timely fashion to allow for safe and efficient operation.

Angola LNG: A natural evolution

Angola first discovered oil in 1955 and became the 12th member of OPEC in 2007. In 2014, it was the second largest oil producer in Sub-Saharan Africa, with only Nigeria producing more. However, it hasn't invested as much into harnessing its natural gas resources and in 2012, 91% of its gross natural gas production was re-injected, vented or flared.

This wasted gas resource, along with significant untapped reserves (together totalling 6.8 billion m3 per year), promised a significant source of revenue for Angola, as well as a way to meet more if its own gas needs domestically. As such, the decision was made in 2007 to build one of world's most modern LNG processing and storage facilities, and in 2012 construction of the Angola LNG project was completed.

However, in April 2014 the facility was unexpectedly shut down and production paused. The plant subsequently underwent a significant refurbishment process due to variations in the gas conditions.

Refurbishing valves

As part of the refurbishment process, a number of the facility's valves needed to be replaced.

First contact came from the client in September 2014, a few months after the plant had shut down. The priority was for high-integrity, bespoke valves delivered as quickly as possible to minimize downtime. PJV's approach was based on providing advice through its accumulated expertise to ensure the solution was fit-for-purpose rather than simply filling an order according to a specification sheet.

PJV quickly supplied supporting documentation to prove the integrity of its valves including reference lists, general arrangement drawings, procedures and type test certificates. Crucially, it was able to manufacture 10% of the valves early so that the client and Angola LNG could witness cryogenic gas testing and be assured of the valves' integrity.

Another key reason for PJV winning the contract was pacing. "The project was really in our sweet spot," said Spencer Linsell, sales director, PJV. "The client wanted the deliveries within an 8- to 12-week window, pushing to 14 at the latest. That's very easy if you're selling stock valves off the shelf–anyone can do that–but not many people can make significant numbers of valves to order in that time. On the other hand, if you go to 24 weeks or more and are ordering big numbers, the global manufacturers can step in. There aren't many that can fill orders to spec that quickly. We were receiving inquiries and turning them into quotations overnight."

PJV was also able to utilize its stock of more than 2,000 raw forgings, in a wide range of materials up to titanium grades, ready to machine to customer specification on a fast-track basis at its manufacturing plant in Italy.

NOV discovered that the opening and closing of the SPM valves caused the shock in subsea BOP systems. By designing a closed-center valve system, the company was able to virtually eliminate shock. (*Photo courtesy of NOV)*

The incremental nature of the orders made for an extra challenge. By going to the foundries and buying more equipment sporadically, it was much harder to plan ahead. Nevertheless, PJV continued to provide quality product and expertise at short notice.

The quick turnaround was crucial for the working relationship between PJV and the client as, rather than one large order, valves delivered were spread among 60 or so separate, fast turnaround orders, many with special requirements requiring a range of bespoke testing.

In the end, PJV delivered more than 1,000 valves for the project, including floating trunnion mounted ball valves in both side and top entry, and globe and check valves. All valves were cryogenically tested to -196C in accordance with Angola LNG specifications to ensure safe operation.

In doing so, PJV made a key contribution to the Angola LNG refurbishment. In May 2016, the plant came back online, shipping its first post-refurbishment cargo in June.

Kaombo: all at sea

Angola LNG, however, is not the only significant recent project for PJV in Angola. Another major development for the country's oil and gas sector is the Kaombo project, located offshore, about 175 km southwest of Soyo and Angola LNG in the country's Block 32.

Due to be completed in 2017, the Kaombo plan is to convert two very large crude carriers (VLCCs) into a pair of turret moored FPSOs, dubbed Kaombo Norte and Kaombo Sul.

These FPSOs will be connected via 300 km of subsea lines to 59 subsea wells at depths between 1,400 m to 1,900 m over an 800 sq km site that covers six of the 12 discovered wells in the block. The total estimated reserves across the six wells amount to 650 MMbbl, and daily production is expected to be 230,000 bbl/d.

Each FPSO will have an oil treating capacity of 115,000 bbl/d, a water injection capacity of 200,000 bbbl/d, a 100 MMscf/d of gas compression capacity and a storage capacity of 1.7 MMbbl of oil. The associated gas will be transferred to Angola LNG, demonstrating the plant's importance to Angola's plans for its oil and gas industry.

PJV and Kaombo

Effective treatment of seawater and produced water was crucial to the project for both maximizing oil recovery and maintaining a sufficiently processed resource for re-injection into reservoirs. However, the engineering (and cost) challenge of seawater filtration is its high salinity, making it extremely corrosive and threatening to rapidly eat away at any valves it comes into contact with. The system would require a specialist supplier

with considerable expertise to safeguard against costly offshore maintenance future maintenance issues.

While PJV originally discussed a separate job entirely with the client, the company was eventually asked to quote for a completely new job. It was a complex one, involving a high level of corrosive fluids, and PJV was able to help as both a supplier and as a partner contributing expertise.

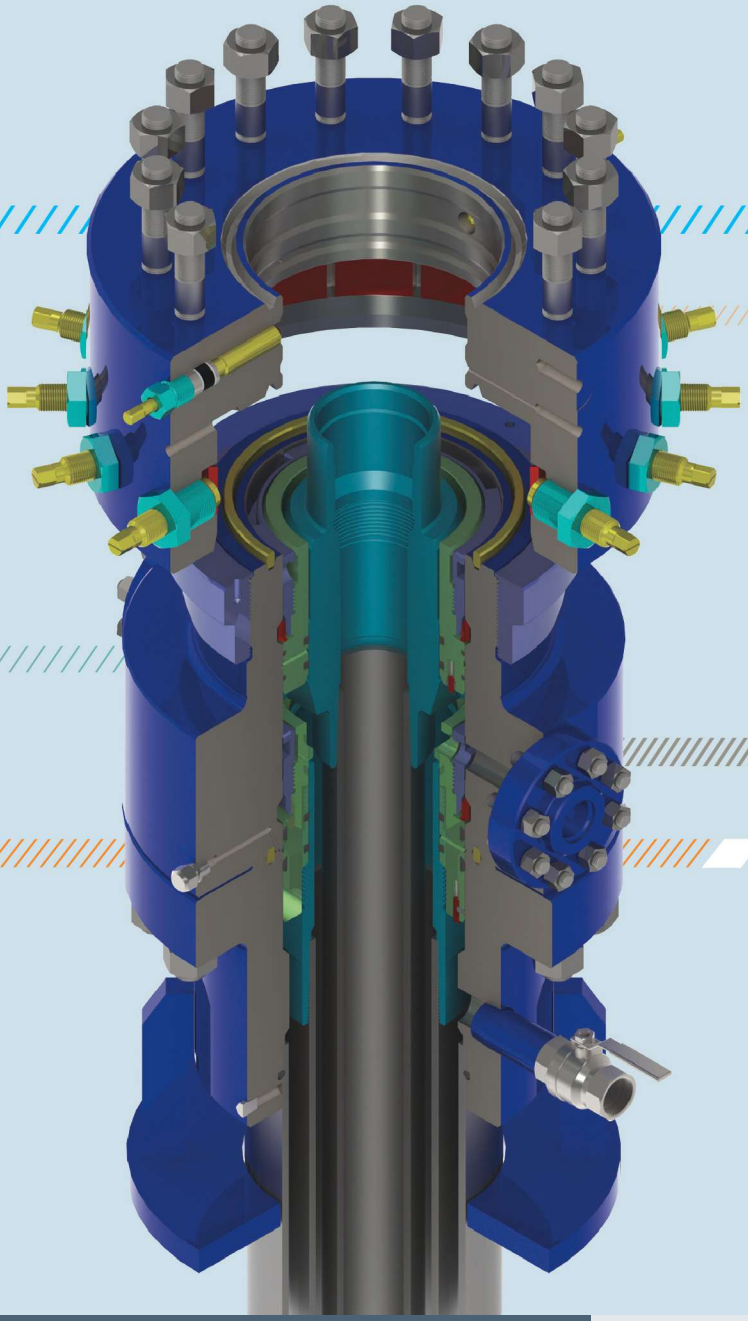
PJV recommended the use of side entry valves in places rather than top entry valves, saving money and resources. And the company also worked with the client to use special coatings to counter the effects of the harsh environment. This included stringent paint and internal PFA lining on ball valves. Tungsten carbon coating gave a wear- and erosion-resistant surface for the valves and electroless nickel-plated coating provided corrosion resistance. Material selection was also extremely important. Base materials such as nickel aluminium bronze and duplex stainless steel also ensured the valves could withstand the changing process conditions and rigors of use. These recommendations were vital for the long-term success of the project, without them the end user could be faced with countless, costly offshore maintenance issues with the package.

So far, PJV has supplied about 2,000 valves over a number of orders, including ball, globe, check and needle valves, and both single and double block and bleed valves. Orders included nondestructive testing and special paint systems and were filled working with some of the best foundries in the world, using both PJV's own manufacturing facilities and trusted partner factories to complete items outside of PJV's production range. PJV's ability to work with a company to contribute expertise and enhance the sales and procurement process, rather than on a purely transactional basis, meant they have remained a trusted and competitive supplier for future Kaombo work, ahead of first production in 2017.

Looking to the future

Newly refurbished, Angola LNG is set to take its place as one of the world's most advanced liquefaction facilities and a central component of Angola's growing oil and gas industry as well as helping to meet the country's domestic gas needs. Kaombo, when it begins production next year, will be another important piece of that plan and will rely on Angola LNG to make the most of its gas resource. ■

James Moir is the APAC managing director for PJ Valves.



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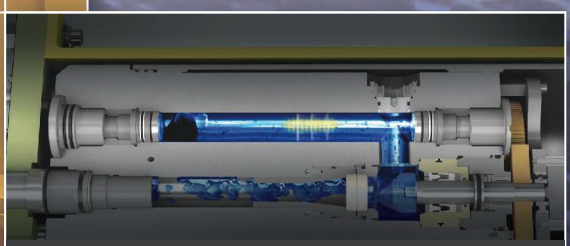

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