

WALWALVE

MAGAZINE
FALL 2017
VOL. 29, NO. 4



Outlook for 2018

Sunnier Attitudes
Drive the Market

- : THE MANY
- : INDUSTRIES
- : WHERE VALVES
- : ARE KEY
- : TRUNNION-
- : MOUNTED
- : BALL VALVES
- : CHECK
- : VALVES IN
- : LNG USE
- : PROCESS
- : INSTRUMENTATION

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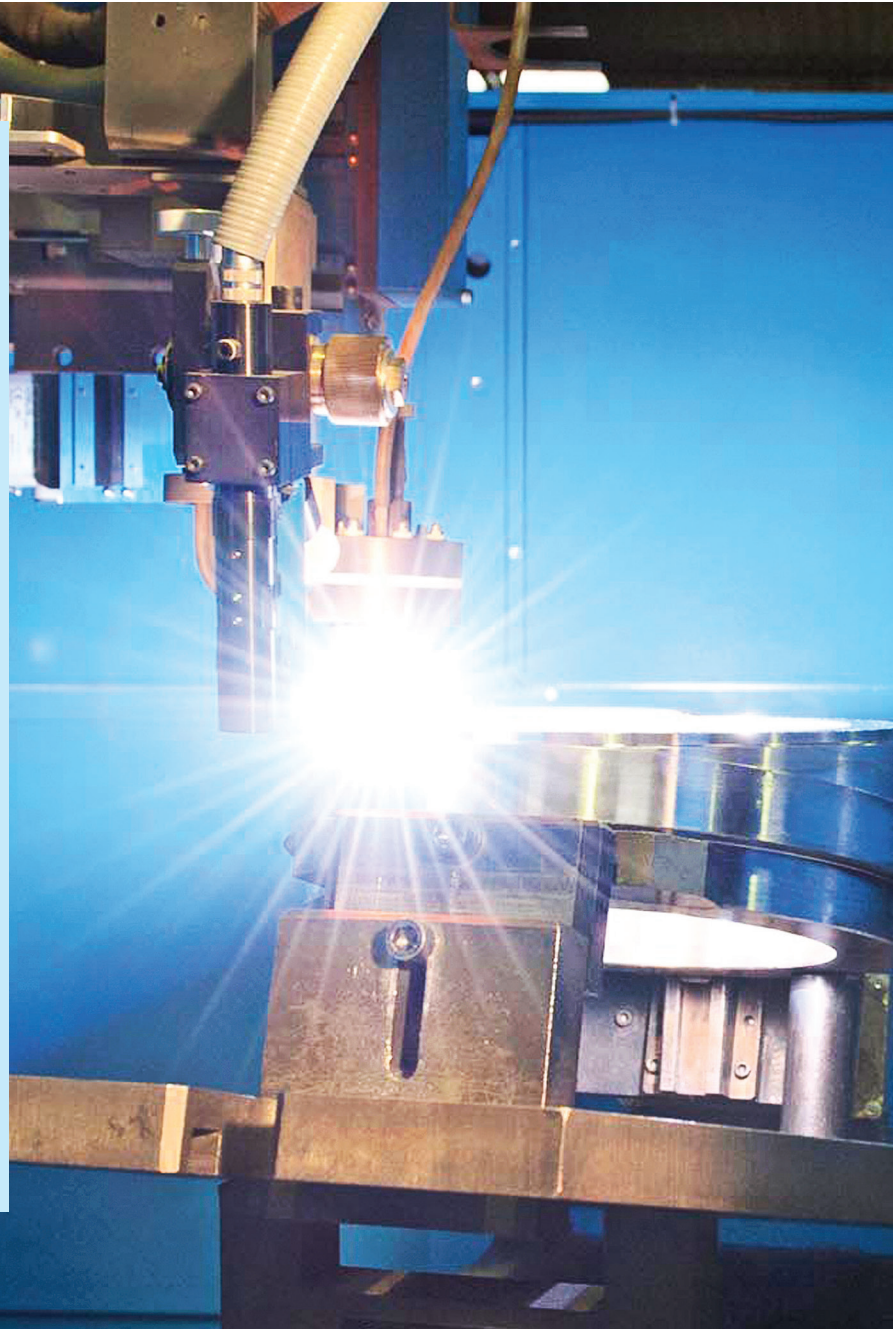


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VALVE

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VMA's Market Outlook speakers had mostly positive things to say about what's happening within valve end-user industries going into 2018. However, there also were several notes of caution.
BY KATE KUNKEL

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From our homes to plants to energy production facilities, valves truly drive the world's flow industry. Here's a wrap up of some of the vital end-user industries that depend on them. *(To read about even more industries where valves are used, visit VALVEmagazine.com.)*
BY GREG JOHNSON

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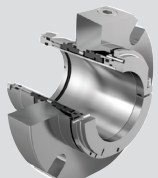
Study tests and computational analyses reveal that these valves can't always be operated at full differential pressure.
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- Extreme Temperature Metal-Seated Ball Valves

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Cybersecurity in Process Control

Industrial networks enjoy productivity gains from data exchange between control networks and business functions, but carry the risk of hacking. Understanding what can be done to protect networks against willful and unintentional damage is essential.

- » Choosing the Right Actuator
- » Make Sure your Valve is Ready for the Long Haul
- » Low-Cracking Pressure in Chemical Processing Lines
- » Remote Monitoring of Cooling Towers and Heat Exchangers
- » Machine Learning: A New World
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www.vma.org

The Industry Loses an Icon and Friend

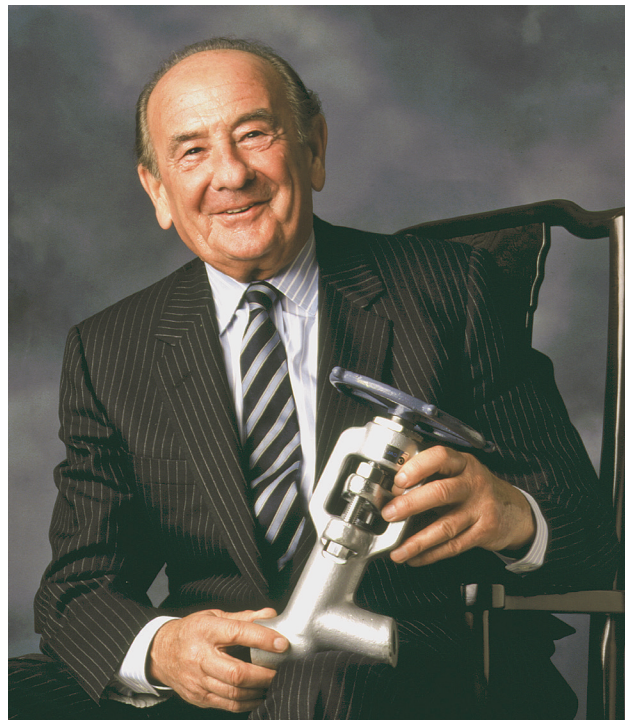
On Friday, Sept. 29, our industry and association lost a true icon, leader, teacher and, most importantly, a friend. A. K. Velan, founder of Canada's leading valve manufacturing company died just a few months short of his 100th birthday.

In my more than 40 years with VMA, I personally have worked with three generations of this very special family. First with A.K., then his three sons: Ivan, Peter and Tom, and recently with his grandsons Rob, Dan and Shane. A.K. was a presence until the day he died, retiring officially from Velan, the company he founded, only a few short years ago.

Ivan Velan said this to me regarding his father's passing: "We are choosing to celebrate a long, remarkable and successful life rather than dwelling on the sadness and finality." I'd like to add that, indeed, he led a very special life.

Everyone has an A.K. Velan story, including me. Back in 1998, Ivan was program chair for our annual VMA Leadership Forum held that year in Atlanta, GA. Ivan suggested A.K. as a presenter on "The Future of the Global Market." We allowed an hour for this presentation. That hour came and went, and A. K. was still going strong with much more insight to impart upon the attendees. Ivan pulled me aside and asked what he should do, indicating that his father could go on for quite a bit longer, and lunch was about to be served. I scanned the audience, which was comprised of about 60 industry leaders, and I saw a group that was so engrossed in what they were hearing that I told the hotel staff to postpone lunch. As he often could do, A.K. captivated the audience with both his knowledge and his charisma.

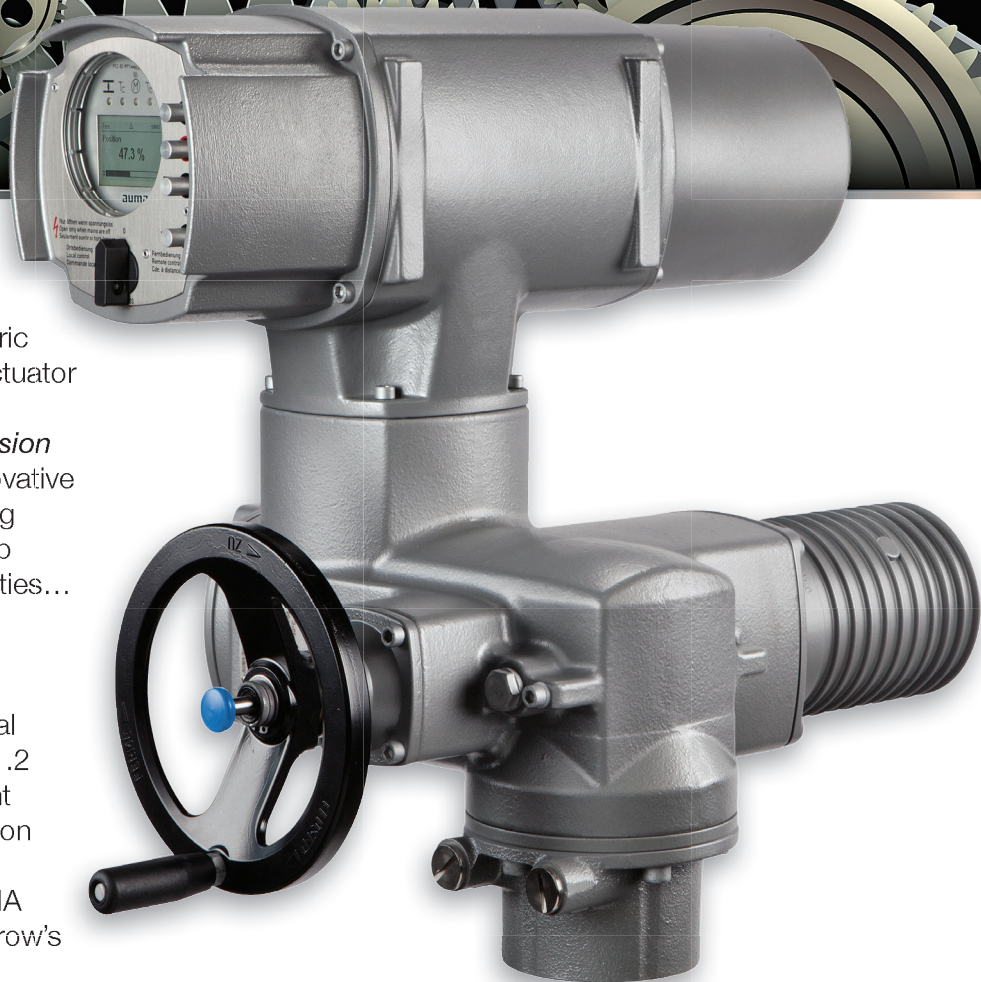
I know that all that knew him will do as Ivan suggests and celebrate a remarkable man and his remarkable life. That's how I will honor him. **WM**



Bill Sandler

President, Valve Manufacturers Association of America

PRECISION



The AUMA SQ.2 Part-Turn Electric Actuator is one of many valve actuator options that can bring unfailing reliability and unsurpassed *precision* to your plant operation. Our innovative engineering optimizes modulating solutions... Superb craftsmanship enhances torque output capabilities... Creative components simplify commissioning and service...

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NEW CONTRACTS

Agreements Strengthen Metso's Presence in India

Metso signed four non-exclusive distribution agreements for its valve products. The agreements with Fluidline Systems, General Energy Management Systems Ltd., SB Enterprise and Proflo Systems expand the coverage of Metso's Neles and Jamesbury product families into different regions and industries in the growing markets of India. The distribution network will also provide support in services.

Distributors will serve pulp, paper and several other process industries, such as refineries, chemical, fertilizer, steel, power and wastewater.

Rotork to Supply UAE Oil Development Project

Rotork has received an order for 220 pneumatic

actuators for the NASR Phase II Full Field Development Project in the United Arab Emirates. The aim of the project is to increase the field's oil production capacity to 65,000 barrels per day (bpd) from the existing capacity of 22,000 bpd.

Awarded by Hyundai Heavy Industries, the order included spring-return pneumatic actuators to operate 30-inch and 36-inch Class 1500 ball valves.

Curtiss-Wright Awarded Naval Defense Contract

Curtiss-Wright Corporation has been awarded a contract worth more than \$49 million to provide valves for the U.S. Navy's Virginia-class submarines and Ford-class aircraft carriers. The award was received from Bechtel Plant Machinery, Inc. to support ship construction and spare



□ The Semgas gathering station

parts procurement.

Curtiss-Wright is performing the work at its facility in East Farmingdale, NY, a business unit of Curtiss-Wright's Industrial division.

ATI Provides Actuators for Semgas, L.P.

ATI recently completed installation of its gas motor actuator at a gathering station for Semgas, L.P. in Oklahoma. As a result of the successful installation and operation, Semgas ordered 28 additional

ATI gas motor actuators for its pig-launching applications.

Semgas opted for the gas motor actuator as a solution. The installation also used a local auto-manual control module based on dual poppet valve control.

ExxonMobil Selects MRC Global as Primary Valve Provider

MRC Global (US) Inc., has signed an agreement to be the primary global provider of valve and valve products and services to ExxonMobil. The agreement includes all of ExxonMobil's global projects and maintenance, repair and operations. Initial implementation focused on the downstream U.S. business unit, followed by the European Union then the Asia Pacific region.

MRC Global has supported ExxonMobil with various products and services for more than 30 years.

Hunt Valve Awarded Multiple Contracts

Hunt Valve Co. won several federal contracts from the Defense Logistics Agency. One contract was awarded for globe valves under Hunt Valve's Waeco Valve brand.

Hunt Valve also won two other contracts from the agency—one for safety

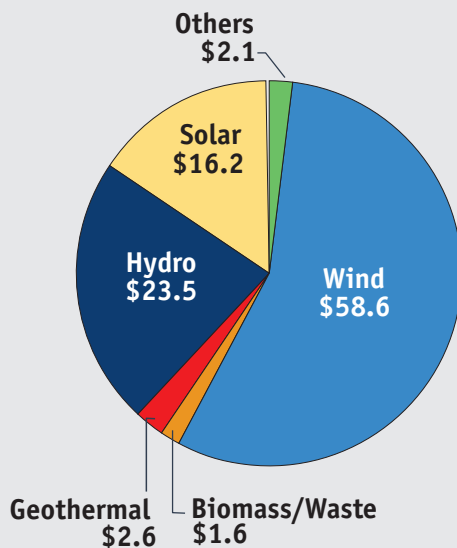
MARKET FOCUS: Gas Dominates; Renewables Growing

According to Britt Burt, vice president of global research for the power industry at Industrial Info Resources (IIR) Project, the dominant fuel for electricity generation in North America in the immediate future will be natural gas. Burt said 270 natural gas-fired projects are in the works and IIR predicts 64% will go through over the next five years.

At the same time, multiple factors are driving growth in renewables in North America, including federal and state tax credits, and the fall in nuclear and coal.

Burt reported that about 626 "high/medium probability" projects worth \$104.6 billion are planned over the next five years in renewables. Wind will take the greatest share (about \$59 billion), but solar (\$16.2 billion) and hydro (\$23.5 billion) will also have large shares. In the field of hydro, Burt says small projects and modernization of existing facilities will see the most growth.

New-build Renewable Energy Projects Kicking Off, July 2017–2022 (TIV \$Billions)



relief valves and the other for pressure relief valves, both under the Union Flo-netics brand.

EGC Adds MC Sales Solutions as New Sales Rep

EGC Enterprises, Inc. appointed MC Sales Solutions as its sales representative organization for the states of Arkansas, Louisiana, Oklahoma and Texas.

MC Sales Solutions is headed by Bill Vardeman, who brings more than 30 years of engineered sealing expertise. The MC team of outside sales, inside sales and marketing associates will work with EGC sales and engineering professionals to provide product design and technical support to the OEM, aftermarket and service providers in the region.

Schlumberger Gets Contract for Otter Subsea Development

OneSubsea, a Schlumberger Company, was awarded an engineering, procurement, construction, installation and commissioning contract for a subsea multiphase boosting system by TAQA for the Otter field in the UK North Sea. OneSubsea leverages Cameron flow control, process technologies and manufacturing and aftermarket capabilities.

Through the contract, OneSubsea and its Subsea Integration Alliance partner, Subsea 7, will supply and install a subsea multiphase boosting system including topside and subsea controls, as well as associated life-of-field services. This will be the longest subsea multiphase boosting tieback in the UK North Sea.

Emerson to Modernize San Francisco's Largest Wastewater Plant

The San Francisco Public Utilities Commission selected Emerson as the design-build contractor for a comprehensive automation project to modernize its Southeast Treatment Plant. Built in 1952, the plant is the city's largest wastewater facility, responsible for treating 57 million gallons of wastewater per day.

The automation project is part of the city's Sewer System Improvement Program, a 20-year, multi-billion-dollar investment to upgrade the aging sewer infrastructure that serves more than 800,000 customers.

GE Oil & Gas and EEA Sign Long-Term Partnership

GE Oil & Gas has signed a long-term agreement to collaborate with Eni East Africa (EEA) on the offshore Mozambique developments it operates. The agreement comprises a multi-year contract to supply subsea production systems, ancillary equipment and services. It covers the Coral South FLNG project and is the first phase of EEA's strategically-important development plans for the Rovuma basin Area 4 gas resources. The agreement also covers Area 4 future potential upstream projects.

RECOGNITION

Allied Valve Named Green Tag Center of the Year

Allied Valve's headquarters in Riverdale, IA was named the Consolidated Green Tag Center (GTC) of the Year for 2016. Each year, the

award recognizes a single GTC location that demonstrates exceptional growth, innovative changes and an overall improved environment for Consolidated customers. Allied Valve was selected for 2016 because of the company's many new initiatives focused on promoting safety and delivering an exceptional customer experience.

Allied Valve received its first GTC designation in 1982, the same year the program began. Allied Valve operates five GTCs across the Midwest.

VMA Members Take Home 2016 Plant Engineering Awards

Several VMA members took home awards recently from Plant Engineering, which recently celebrated its 29th anniversary of the Product of the Year award program.

Emerson Automation Solutions took home a bronze award in the Asset Management category. A.W. Chesterton won a bronze in Fluid Handling. Siemens took home awards in three different categories. The winners were honored at the annual Engineering Awards in Manufacturing dinner on April 3, 2017, in Chicago.

AUMA Actuators Pass Corrosion Certification

A new TÜV certificate confirms that AUMA's electric actuators passed the most demanding corrosion protection tests and meet the requirements of EN ISO 12944-6 for corrosivity categories C5-M long (marine, coastal and offshore areas) and C5-I long (industrial areas with high humidity and aggressive atmospheres).

OCTOBER

31-NOV 2
2017 Chem Show
New York, NY
www.ChemShow.com

DECEMBER

5-7
Power-Gen International
Las Vegas
www.power-gen.com

2018

MARCH

21-22
VMA Leadership Forum*
Arlington, VA
www.VMA.org/LeadershipForum

APRIL

11-13
VMA Valve Industry Knowledge Forum: Seminar, Exhibits & Tour
Savannah, GA
www.VMA.org/KnowledgeForum

30- MAY 3
OTC18 (Offshore Technology Conference)
Houston
www.otcnet.org

JUNE

6-8
Valve Repair Meeting, Exhibits & Tour
Houston
www.VMA.org/ValveRepair

AUGUST

8-9
VMA Market Outlook Workshop*
Chicago
www.VMA.org/MarketOutlook

SEPTEMBER

25-27
VMA/VRC Annual Meeting
Lake Tahoe (Truckee), CA

* Open to VMA/VRC members only. Visit www.VMA.org to learn if your company qualifies for membership.

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tor, at gparente@vma.org.

To achieve the C5-M, the products had to undergo a salt mist test for 1,500 hours and a constant humidity test with condensation for 720 hours. For C5-I certification, the devices had to withstand 30 cycles of a condensation alternating climate test containing sulfur dioxide.

Richard Industries Receives Honor from Top Shops

Four participating shops were named 2017 Honors Program winners, including Richards Industries. The awards were given at the inaugural Top Shops Conference, presented by Modern Machine Shop, Sept. 5-7 in Indianapolis.

As part of the event, a survey included submissions from shop principals (owners, executives, managers), who provided metrics and detailed insight for the Top Shops in four main categories: machining technology, shop floor practices, business strategies and human resources.

VMA Members Lead Industrial PVF Distributors List

Modern Distribution Management recently published its Top Distributors list for 2017. Four of the top five distributors in the Industrial PVF category are VMA members: MRC Global, NOW Inc., Wolseley Industrial Group and FloWorks International. The list was released as part of a special distribution trends issue by the magazine.

NEW FACILITIES

AIV and Gulf Coast Modification Opening NW Houston Facility

AIV, LP announced plans for a new 320,000-square-



AIV's and Gulf Coast Modification's new facility

foot facility at NW Lake Drive in northwest Houston. The 32-acre construction site allows for the future expansion of up to 700,000 square feet. This facility will consolidate AIV and Gulf Coast Modification's current headquarters at 7140 West Sam Houston Parkway near Highway 290, a separate modification facility focusing on mid-stream clients and a third building that houses AIV's automation division.

The new facility will consist of two stories of Class A office space to house the company's sales and administrative personnel, expanded warehouse space for AIV's extensive valve and actuation inventory and the fabrication facility to accommodate Gulf Coast Modification.

Wolseley Industrial Group Opens Harrisonburg, VA Location

Wolseley Industrial Group expanded its presence in Virginia by opening a new location in Harrisonburg that will serve customers in Shenandoah, Rockingham, Page, Madison, Culpepper and Greene counties. Wolseley Industrial Group has more than 160 locations nationwide.

The Harrisonburg location has distribution and delivery capabilities and will supply industrial pipe,

valves and fittings, and maintenance, repair and operations products to customers across several industry segments including food and beverage, pulp and paper, chemical, manufacturing and more.

AUMA Opens New Sales & Service Center in Dubai

AUMA has strengthened its presence in the Gulf region with a new sales and service center that opened recently in Dubai. Located in the Jebel Ali free trade zone, the new AUMA Middle East FZE office will become the hub for all AUMA's activities in the United Arab Emirates, Oman and North Africa.

AUMA's new Sales and Service Center in Dubai comprises modern offices, a workshop for valve integration, training facilities and the company's central spare parts stock for the region.

MERGERS & ACQUISITIONS

Forum Energy Technologies Acquires Multilift

Forum Energy Technologies, Inc. acquired the stock of Multilift from Pelican Energy Partners. Based in Houston, Multilift manufactures the patented SandGuard and the Cyclone completion tools; products that extend the useful life of an electrici-

cal submersible pump (ESP) by protecting it against falling sand and other solids after shutdown.

Weir Oil & Gas Completes Acquisition of KOP Surface Products

Weir Oil & Gas completed its acquisition of KOP Surface Products. The acqui-

sition, announced in mid-June, is for an enterprise value of \$114 million.

KOP employs 450 people and is a provider of well-heads, surface trees, valves, actuators and aftermarket services for the oil and gas industry. The business is headquartered in Singapore and has a manufac-

turing facility in Batam, Indonesia, in addition to a network of sales and service offices in Malaysia, Thailand, Vietnam, Qatar, United Arab Emirates, Saudi Arabia and India. KOP's current management team will continue to lead the business, reporting to Weir's Oil & Gas division.

Setpoint Integrated Solutions Acquires GE's Direct Channel Operations

Setpoint Integrated Solutions acquired GE's direct channel operations for the Consolidated and Masoneilan Sales and Services operations (formerly Dresser Direct Inc.). This transaction includes the

PEOPLE IN THE NEWS

SPIRAX SARCO... appointed **Javier Jimena** president and general manager. He assumed the role on July 17, 2017 and is responsible for the U.S. business.

Jimena brings more than 32 years of experience in leadership roles with demonstrated success in taking businesses to the next level in strategic development. He comes from Spirax Sarco Argentina where he was the regional general manager leading Argentina, Chile, Peru and Latin America.

VELAN... appointed **Duc Tran** as its new vice president, engineering. Tran will be a key member of the company's senior management team and is succeeding **Gil Perez**, who has assumed a new mandate as vice president, Product Technology and Strategic Initiatives.

Tran is a Canadian citizen who has lived in the U.S. since 1999. He has held successive senior leadership roles at other global valve companies, where he gained extensive knowledge and experience in valve engineering and technology commercialization, as well as pressure control products.

VALVTECHNOLOGIES... appointed **Michael Teele** director of global quality management. Based in Houston, Teele will be responsible for setting and maintaining global quality standards, systems and processes, as well as serving as a leadership champion of continuous improvement. He has a deep technical background and 25 years' experience managing quality programs.

FLOWSERVE... named **Mark William Welch** director of global systems. Welch will be responsible for leading and driving the total system business growth globally across the company's traditional mechanical seal piping plans, lube oil systems and additional varied system markets. He will have global financial and operational accountability for the systems business across all regions. Welch has been with Flowserve 24 years.

ROTORK... announced the resignation of **Peter France** as chief executive. The current chairman, **Martin Lamb**, will assume the role of full-time executive chairman until a successor can be appointed.

The announcement follows a period of reflection by the board, together with France, on the steps required to fos-



Jimena

ter a return to higher growth and margin levels in what is likely to be a generally lower growth macro environment.

WOLSELEY INDUSTRIAL GROUP... named **Daniel Hogge** district manager of the Mid-Atlantic region, which includes Georgia, South Carolina, North Carolina and most of Florida and Virginia. Hogge will be responsible for managing the financial results of Wolseley Industrial Group's Mid-Atlantic business, developing associates and ensuring customers in the region receive superior service.

Hogge joined Ferguson in 1997 and held several positions in the Hampton Roads, VA area including inside sales, outside sales, sales manager and branch manager.

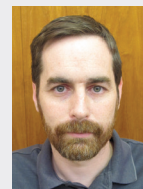
THE WM. POWELL COMPANY... promoted **Kyle Mills** to Mid-Atlantic regional sales manager. A graduate of Gordon State University, Mills will be responsible for sales and business development in South Carolina, North Carolina, Virginia, Maryland, West Virginia and parts of Tennessee and Georgia.

Powell also promoted **Mathew Reverman** to director of engineering. Reverman joined Powell Valves more than 16 years ago and had the opportunity to be trained by and work directly with the recently retired **Jim Hengehold**.

ITT... appointed **David J. Malinas** president of its Industrial Process business, reporting to **Luca Savi**, ITT's COO. In this role, Malinas will be responsible for delivering the strategic and operating plans of ITT's Industrial Process business.

Malinas joined ITT from Thermo Fisher Scientific where he progressed through a number of roles of increasing responsibility, most recently vice president and general manager of the Controlled Temperature Technologies business unit.

A.W. CHESTERTON COMPANY... expanded its global environmental solutions expertise with the addition of two highly experienced industrial emissions specialists: **Bronson Pate** and **Beau Stander**. Both joined FluidEfficiency, a Chesterton business group. Pate and Stander will serve in the role of global environmental consulting managers. The duo has extensive experience in low emission and leak detection and repair technology.



Reverman

sales, Green Tag Center and Masoneilan Authorized Repair Center operations located in Deer Park, TX; Richwood, TX; and Corpus Christi, TX.

Setpoint Integrated Solutions is the world's largest Masoneilan and Consolidated Channel Partner and will become the sales and service provider

for the newly acquired territories.

GE Oil & Gas and Baker Hughes Complete Merger

GE Oil & Gas has completed a previously announced merger with Baker Hughes. The new company is known as Baker Hughes, a GE Company.

Under the terms of the

agreement, the transaction resulted in a partnership structure, under which Baker Hughes was converted to a partnership and GE contributed its Oil & Gas business into the partnership. GE has a 62.5% interest in this partnership and legacy Baker Hughes shareholders have a 37.5% interest.

Wolseley is Now Ferguson

Wolseley plc became Ferguson plc at a general meeting of the company held on May 23, 2017. The company's website is available at www.fergusonplc.com.

Trading in the company's shares will commence under the new name Ferguson plc and the new TIDM code "FERG."

EVENTS

The World's Largest Power Show is Dec. 5-7

Power-Gen International brings together 20,000 people from over 100 countries who gather to discuss and learn about the latest developments and technology in the world of power.

Attendees will assemble this year from Dec. 5-7 at the Las Vegas Convention Center, Las Vegas to listen to more than 275 speakers and visit more than 1,400 exhibitors in the giant hall.

The conference is returning to its roots with a show that covers all forms of power generation in one conference. That conference has a 14-track program in areas such as gas turbine technologies, emissions control, digital power plants, utility-scale renewable power, flexible generation and on-site power, clean coal technol-



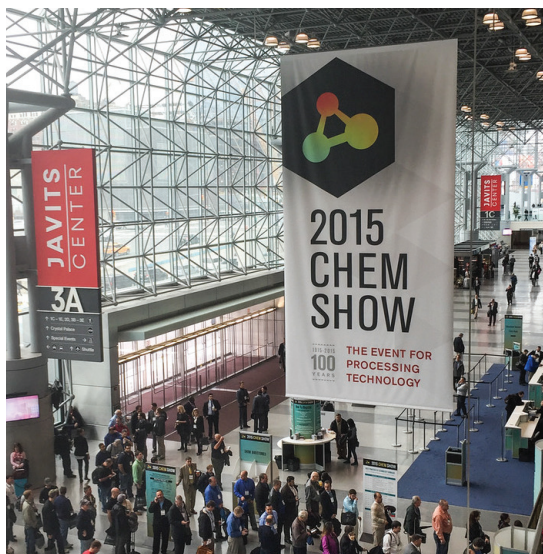
ogies, nuclear, gas-fired power plants and more. The conference used to be held in conjunction with several other conferences covering individual areas of power.

Power-Gen is attended by power

professionals representing a broad spectrum of the industry, from OEMs that make the equipment to run the industry to consultants and researchers in the vast field of power to individual plant designers, operators of plants and people who sell into the industry. They come from a wide range of organizations including independent power producers and giant utility companies.

Many VMA members can be found in the exhibit hall as well as VMA and VALVE Magazine, which will be exhibiting at booth 6044. Stop by and learn how the association and its members are connected to the power industry.

For information, go to www.power-gen.com.



An Event for Chem Processing

Engineers, plant managers and other chemical processing personnel will come together Oct. 31-Nov. 2 at the Javits Center, New York City for the 2017 Chem Show. The bi-annual event has information on the latest developments and tools for various chemical industries from petrochemicals & refining, pharmaceutical, food & beverage to more specialized fields such as stone/glass/ceramics and adhesives & sealants.

The exhibit hall features more than 300 booths displaying technology and services available to those attendees in areas such as control of pollution, processes and quality and areas of specialty such as automation, corrosion control, hazardous materials and more.

It's the largest North American show of its kind and has been held every other year since 1915.

For information, go to www.chemshow.com.

The Economic Effects of Fall's Hurricanes

BY KATE KUNKEL



□ The impact of Hurricane Harvey in Houston. (PHOTO: Thinkstock/ Karl Spencer)

When VMA's Market Outlook Workshop was held in early August, Hurricane Harvey was not even a blip on the radar. On Aug. 26, it made landfall and pummelled the Gulf coast for several days, leaving damage to infrastructure, petrochemical and refining operations. It was followed Sept. 10 by Hurricane Irma, which broadsided Florida, leaving more devastation in its wake, then several other hurricanes that caused major damage to Atlantic Ocean islands.

Jointly, these disasters have had a substantial economic impact on the U.S. as well as the areas where the disasters hit. The Federal Reserve blamed Hurricane Harvey's damage to the oil refining, plastics and chemicals industries for a drop of 0.9% in industrial output in August along with a 0.3% decline in manufacturing production for that month.

Still, when viewed in the long haul, the forecast is not glum. In a telephone inter-

view on Sept. 18, Alan Beaulieu of ITR Economics, said, "The bottom line is, we [at ITR] are not changing any macro forecasts because of either Harvey or Irma. There is enough excess capacity out there, that whatever disruptions in production occurred, there will not be any long-term effects."

At the same time, the storms presented opportunity for rebuild and repair dollars. While a lull in activity followed immediately after Irma, for example, Beaulieu pointed out that pick up in action would be next to come. Manufacturers may see a little demand pull from the slight shortages of valves that head to the southeast. But "to the extent that repairs need to be done, there will be a minor uptick for manufacturers," he said.

His words were echoed by Shawn Fitzgerald, vice president of marketing at ThomasNet.com. Fitzgerald said data from his company's platform shows that sourcing

for valves is on the upswing. "We looked at the sourcing history of 80 companies classified as 'Energy and Utilities' within 250 miles of Houston during the weeks after Harvey. The sixth most popular product/service evaluated was 'Valves' followed closely

by 'Valve Repairing & Reconditioning Services,'" he said.

Meanwhile the 5,000 miles of piping that are typical for an oil refinery must be inspected and repaired because of the potential damage.

"We expect our data to show a continued increase in sourcing for industrial products such as piping, valves, flanges, gaskets, pumps, filters, fittings, controls, hydraulic/pneumatic/ and electronic systems, etc., everything that would need to be replaced from impact or water damage," he said.

The company forecast an 1100% increase in valve repair and reconditioning services after the storms. **VM**

KATE KUNKEL is senior editor of VALVE. Reach her at kkunkel@vma.org.

WELCOME NEW MEMBERS

VMA recently added three new associate members to its ranks including:

QRC Valve Distributors (www.qrcvalves.com) is a master distributor of Cameron downstream products with six North American locations including two in Canada and four in the U.S. The company maintains an on-hand inventory of \$21 million.

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A Sunnier Mood with a Few Caveats

BY KATE KUNKEL

The atmosphere at VMA's 2018 Market Outlook Workshop was much more positive than what's occurred the last two years, with many members reporting bidding and orders up. The presenters themselves expressed cautious optimism and pointed to many signs that say the economy in 2018 will continue its slow, steady upward trajectory, contributing to a long-term outlook that's bright.

For 2017, global trade has grown higher than global Gross Domestic Product (GDP), a sign that many countries are sharing the upturn. Still, many of the presenters focused on the fact companies are not spending their cash on capital expenditures, nor are they taking advantage of the current low interest rates. As Simona Mocuta said in her presentation on the global economy, "We need business investment to pick up some of the baton for growth." (In the U.S., she pointed out, that growth is currently fueled mainly by consumer spending.)

Presenters also said they generally accept that the energy and commodity recession of 2014 is still not finished—gas, oil and metal prices show no signs of rising substantially in the next few years. However, cyclical momentum has improved substantially from 2016, and prices are expected to continue to rise slowly until at least 2020.

The most significant opportunities for growth in North America remain the likelihood natural gas exports will rise and that more petrochemical plants will be built or are in the planning, several outlook speakers said.

Meanwhile, the looming problem of the labor shortage and declining productivity also came up frequently in this year's comments as did Europe's strengthened economy and the good news that fears over Brexit have generally been allayed.

Some noteworthy developments

- North America, and in particular, the U.S., has become a swing producer of oil and gas—what happens here now affects the global picture.
- While the low unemployment rate is positive, the lack of growth in wages is keeping inflation below the ideal rate. Also, labor shortages in the U.S. are turning out to be a major issue because too much of the workforce is retiring or set to retire.
- Consumer spending has been the engine driving economic growth following the recession, but this is not sustainable. Government and private companies generally are not making capital investments in equipment and training, which is needed for real economic growth.

OIL AND GAS

Activity Up Substantially

The global oil market has entered one of the most transformative decades in its history as the U.S. becomes the world's swing producer, with implications for commodity price volatility, according to John Spears, president of Spears and Associates.

Global oil consumption is forecast to rise 1.6% per year from 2016 to 2020, exceeding 103 million barrels per day (bpd) by the end of the decade, he said. In industrialized nations, falling fuel use for passenger cars has been offset by rising demand from aviation, transportation and petrochemical feedstock use. Meanwhile, in emerging markets, oil demand is rising at 2.5–3% per year.

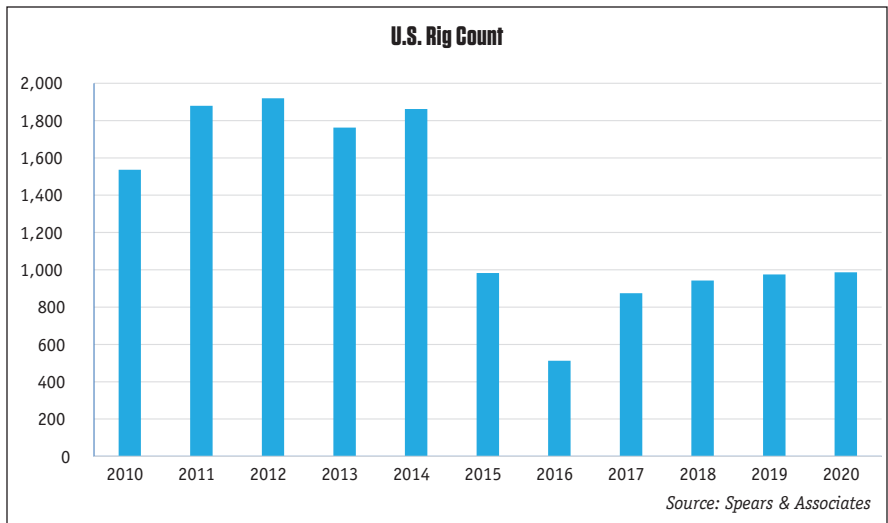
U.S. oil production is expected to increase 27% from 2016 to 2020 to 11.3 million bpd, while relatively little new production will come onstream outside North America during that timeframe.

The Organization of the Petroleum Exporting Countries (OPEC) producers have indicated they are returning to the traditional exercise of trying to manage end-use inventories as a way of managing prices. But the combination of rising U.S. oil production and surplus OPEC capacity (currently running at 3.5–4.0 million bpd) is expected to keep prices from exceeding \$55 for the near term.

Globally, production is expected to reach 100 million bpd, but that doesn't replace a decline from old wells, which is falling by about 2% (1.5 million bpd) per year. Since OPEC's spare capacity currently is about 4 million bpd that means falling capacity over the next 2–3 years will tighten the market, but not until after 2020.

Spears also noted fewer fuel development projects are being sanctioned. Traditionally, about 50 such projects are approved each year, but that compares to only about 15 new projects in 2015 and about 12 in 2016, a trend he said will extend in the short term.

"That means we've been under-sanctioning for 2015, 2016 and 2017," Spears said. It also means there will be many fewer barrels coming onstream



over the next three years because of the paucity of new projects and the decline of older wells.

Meanwhile, "There is the possibility of real disruption in Venezuela," which puts at risk about 2 million bpd.

Still, "Apart from that, the market is pretty well balanced," he said.

As far as consumption, domestic gas use now accounts for 90% of U.S. gas demand (the balance of gas is exported). Because of a warmer-than-normal winter and price-induced fuel switching within the power sector, gas consumption in this country is forecast to fall to 73.4 billion cubic feet per day (bcfd) in 2017 (down 2.3%). In the longer term, though, U.S. gas use is expected to grow 1.5–2.0% per year from 2016 to 2020 because of industrial and power sector demand.

Currently, imports are almost all by pipeline from Canada, while exports are almost all by pipeline to Canada and Mexico—nearly 4 bcfd. Spears

reported that the Mexican power sector is building up and using natural gas for feedstock and the cheapest source is U.S. pipelines.

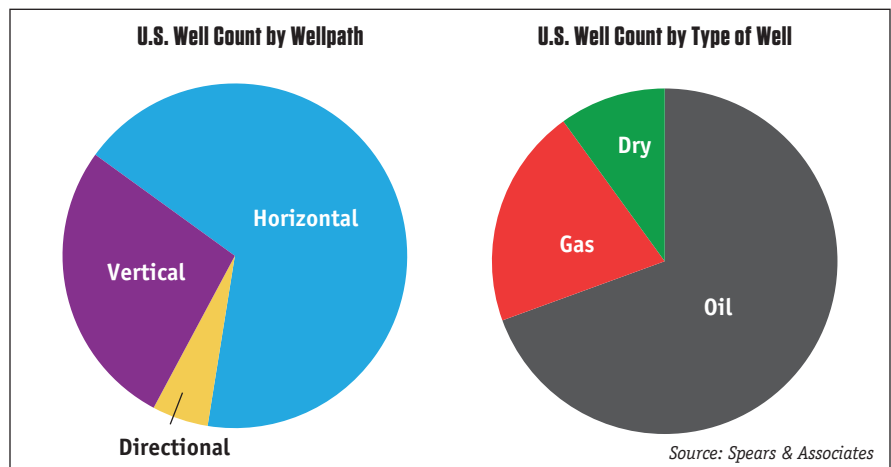
Rig Activity

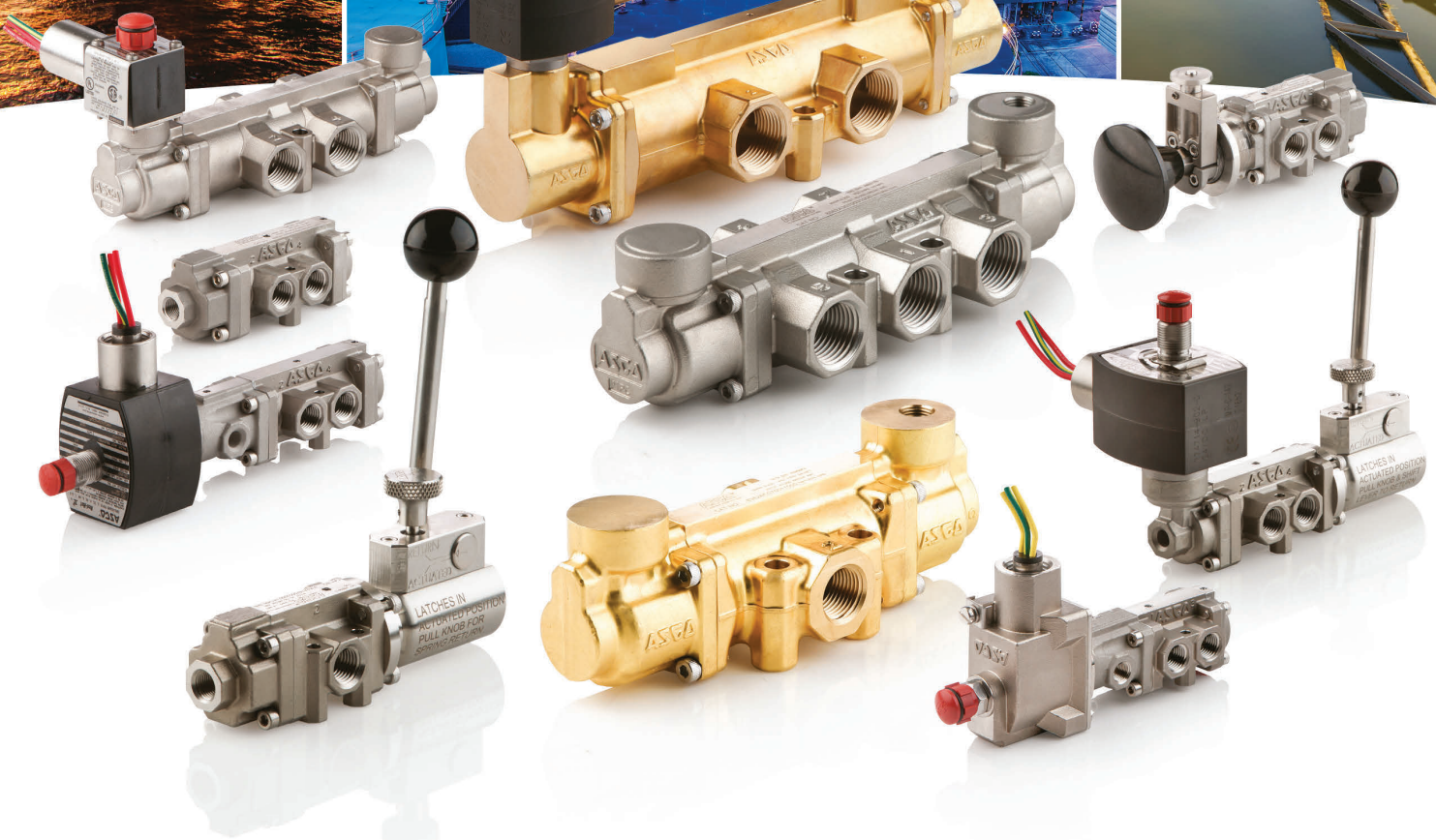
Spears pointed out that at \$50 per barrel rig activity flattens out.

"But despite the softness of oil prices in the second quarter of 2017, drilling plans for large operators seem firm through the end of the year while smaller operators are likely to scale back activity in the second half."

Of the 24,000 new wells expected to be drilled in the U.S. this year, 70% will be drilled horizontally. Canada expects about 7,000 new wells. Horizontal drilling/hydraulic fracturing will be the primary methods used by North American operators to manage cost and geological risk, Spears said.

Overall, Spears expects the global market for oilfield equipment and services will total \$225 billion in 2017, up 3% from 2016.





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“Based on the outlook for drilling activity and oilfield inflation, we expect that to jump to around 20% in 2018,” he said.

FORECAST

- Prices are expected to trade in the \$45–\$55 range over the next 2–3 years.
- For the first time since 2015, gas output rose in this country in the first quarter of 2017, and it is projected to average 74.1 bcf/d this year and rise 4.3% in 2018 as drilling activity recovers.
- U.S. rig activity is on track to rise 70% this year and about 8% in 2018 while Canadian rig activity is poised to jump 75% in 2017 and another 5% in 2018.
- In the U.S., drilling activity will be up 58% in 2017 and another 6% in 2018. In Canada, activity will be up 75% in 2017, with another 8% in 2018.
- The global market for surface and subsea equipment, including wellheads and Christmas trees used on- and offshore, is forecast to total \$18.6 billion in 2017, down 1% from last year, but is expected to rise 17% to \$21.9 billion in 2018.

LNG

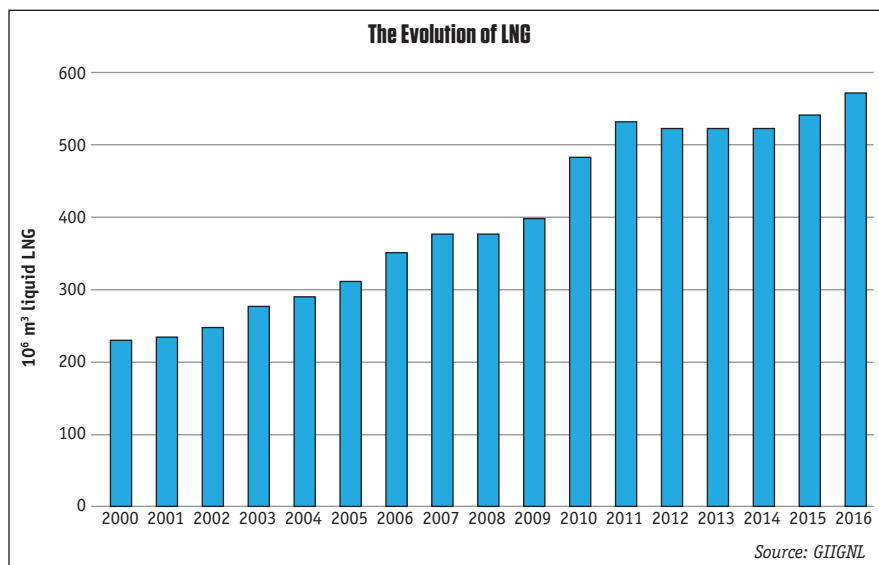
A Deepening Market

Ken Medlock, senior director, Center for Energy Studies at Rice University's Baker Institute reminded Market Outlook attendees that there are massive numbers of people today striving to achieve the same levels of economic development that we have in North America. The question becomes: How much fuel is needed to make that happen and where will the world get that fuel, he said.

Much of the projected demand will come from developing Asia, and LNG is likely to play a critical role, he said.

India's economic picture is similar to China's in the early 1990s, when that country started to become a driver of global oil market development, Medlock said. That influence continued into the early 2000s and was the impetus for oil price increases in 2008.

If India could do in the next 15



years what China did in the last 15 years, it would have a huge impact on energy needs, he pointed out.

While “You can’t assume that will be the case, you will see the lights get brighter and energy demand go up,” he said.

In North America, efficiency is reducing the amount of energy required to meet population growth, he continued. There is also declining demand in some European countries and Japan simply because the populations are aging, not growing. Weak economic growth also means lower energy requirements in developed nations.

All of these factors affect energy growth, which in turn, affects the LNG market, he said.

Shale Productivity

Questions remain regarding the opportunities for shale and other frontier resources outside the U.S., but overall, there has been tremendous growth in productivity in North American shale production.

“Productivity enhancements such as decreased spacing and shorter fracks have made Tier 2 acreage less expensive so you have bigger gains than in the Tier 1 acreage,” Medlock said.

That can have a significant effect. “If you’re between 25% and 35% recovery in a field, that’s good,” he explains, “but what if you expand that to 45% or 50%? That means a lot more natural gas.”

Meanwhile, LNG trade has more than doubled in the last 15 years and, although stagnation has occurred in the last five, that’s based on global economic events, which affects overall gas demand.

The Market’s Makeup

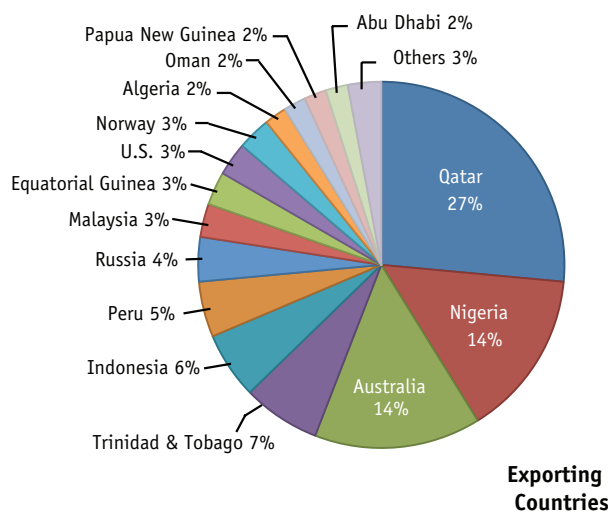
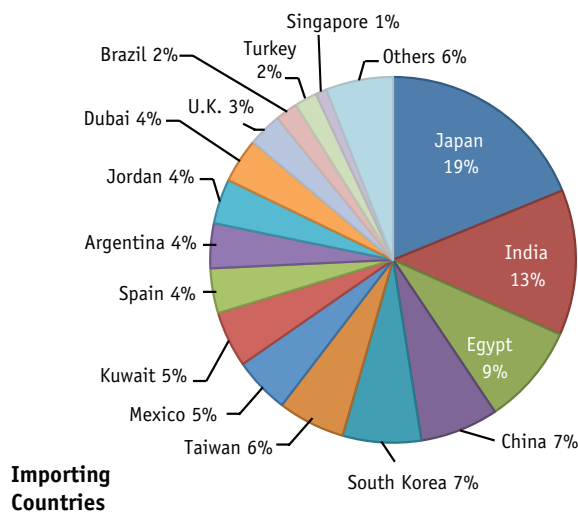
The composition of LNG importers has changed significantly. In the early 2000s, the market was Japan and South Korea. But in the last few years, China and Taiwan have increased their purchases. LNG exporters are also changing, Medlock explained, with countries such as Qatar sending more of the product out and Indonesia sending less.

This means that while the global LNG market is growing, it is also becoming deeper. Market depth matters because of how risks are shared and how money comes into the market. The trade of LNG has gone from 5% participation by countries to nearly 30% while spot and short-term trade as a fraction of all trade has more than quintupled. According to Medlock, this is consistent with economic theory and indicates a rapidly evolving global LNG market.

Opportunities in North America

There are about 2,500 trillion cubic feet of natural gas available in North America at wellhead prices below \$6 and 1,700 trillion cubic feet at wellhead prices below \$4, and if improvements in extraction continue, there will be even more. That does

Imports vs. Exports of LNG, 2016



Source: GIIGNL

not mean that North America could export 20 bcf of gas per day, however. Such a move would saturate the global market and crash prices worldwide. Also, the U.S. is not the only player. Qatar and Nigeria are just two other countries with huge resources.

Global demand for U.S.-sourced gas, which is a function of the cost of other sources of gas around the world, plus domestic demand are going to determine production figures in this area of the world, Medlock said. Shale is the driver of domestic supply, specifically the Marcellus field because its geographic footprint is large, giving producers there access to multiple markets. The only current constraint at getting to this supply is infrastructure.

Going forward to 2020, there also will be development of the massive Haynesville play in southwestern Arkansas, northwest Louisiana and East Texas.

Prices

U.S. prices for gas remain among the lowest in the world, and based on current costs of production and worldwide demand, Medlock sees little chance for drastically higher prices. The most significant impact that expansion of U.S. capability to move gas abroad will be felt outside the country, he said.

Medlock said those following the

world of gas need to be aware that five years ago, the spread between production cost and price was high; that situation is beginning to collapse.

FORECAST

- *LNG trade exports will increase in multiple locations, with the U.S. emerging as the third largest LNG exporter behind Australia and Qatar over the next decade or so.*
- *New consumers of LNG will enter the market as global demands for gas increase.*
- *The deepening market will alter trading paradigms. North America is positioned to capture an increasing role in the global gas market balance.*
- *Price will depend on multiple factors with weather the biggest short-term driver. It is important to pay attention to what Russia could do, because if Russia perceives a potential U.S. entry into the European LNG market, it will cut prices.*

PETROCHEMICAL

Economics are Key

The primary driver of the petrochemical sector is general economic growth—as long as global demand grows and North American oil and gas prices remain low, North America will be the most attractive place for new

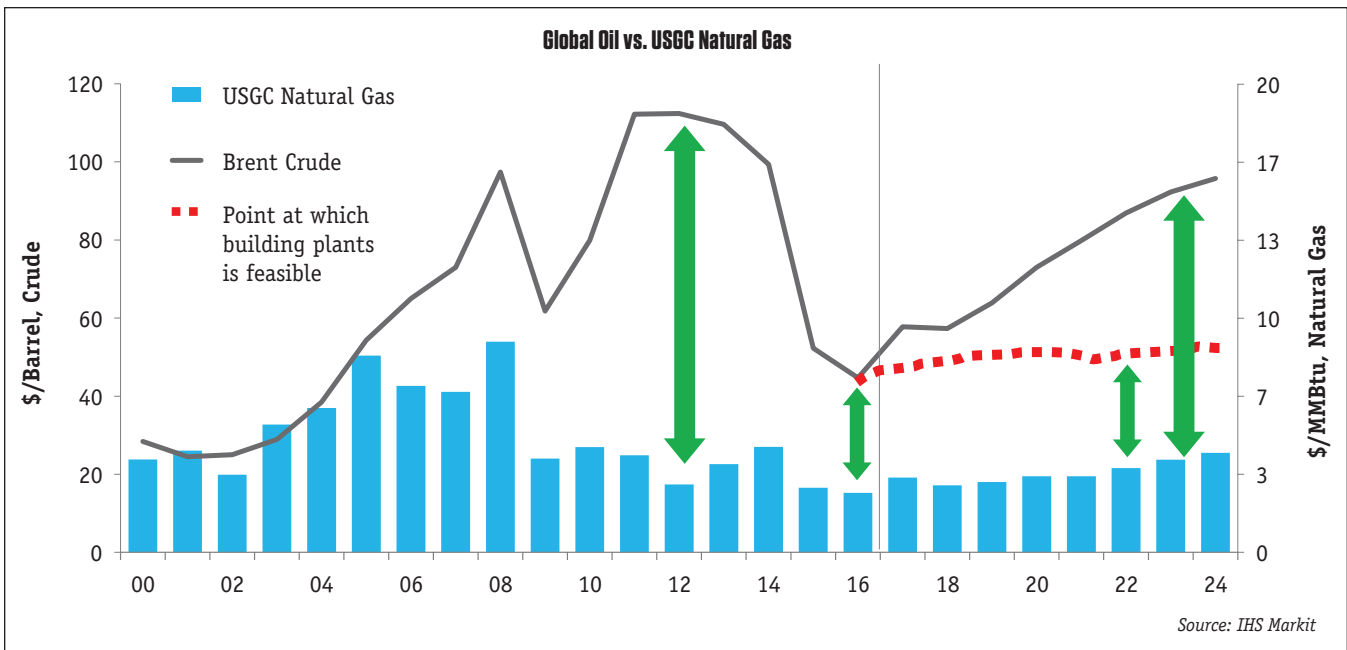
investment in this market, according to Mark Eramo, vice president—Oil/Midstream/Downstream/Chemicals, IHS Market.

Since global economic growth is expected at rates of 2.5–3% in the coming years, that means consumption of durable and non-durable goods will increase, which means petrochemicals will be more in demand.

Meanwhile, a need for plants grows. A world-scale polyethylene plant, for example, processes 1 million tons per year, which would mean that at expected growth rates, about five plants will be needed just in the next year. The picture is even more complicated by the fact that, when planning for demands and number of needed plants, the source of the feedstock must be analyzed as well as what price that feedstock will be and where else in the world demand may arise.

As long as natural gas has advantages in the energy market over crude oil in North America, that area of the world will remain an attractive region for base chemical and derivatives capital investments. If crude went significantly lower or gas much higher, building such plants would not be as attractive.

In 2014, when crude was above \$100 per barrel, packaging companies were looking for ways to use less plastic, including using paper, recycling plastic and making packaging less



dense. When the prices fell, producers looked for ways to lower production costs, margins got better, natural gas as a byproduct was produced and shale gas contributed to prices that are now low enough to give North America an advantage.

Today, the low price of oil is pushing out recycling because it's less expensive to use crude. But if prices go up again, or environmental concerns take precedence, the market forces could change how much plastic consumers use.

Because of all this, the outlook from IHS Markit is positive over the

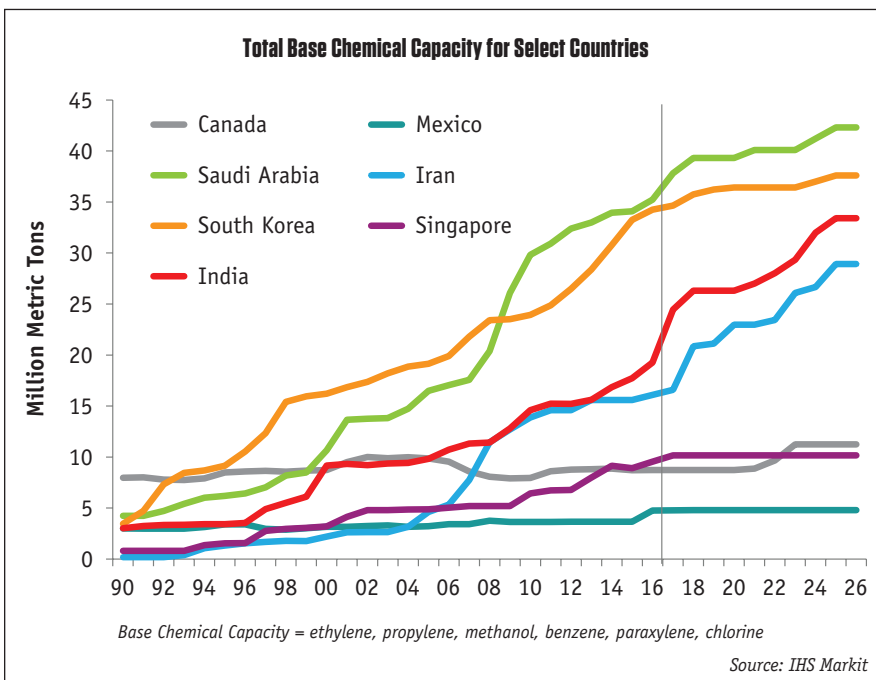
next couple of years as the demand for plastics and other chemicals grows and the need for more plants rises. The challenge is to align capacity additions with growth.

In the World

Driven by a number of major initiatives, Chinese investment in base chemicals has accelerated since 2000 and will continue into the 2020s. China has secure energy sources and a feedstock advantage. It can leverage current technology and build world-scale facilities. Investors in the Chinese market

also are close to local markets and access to trade routes and have plenty of opportunity to leverage their upstream and/or downstream integrated position (i.e., a company has access both to low-priced feedstock and a way to get finished product to market).

Saudi Arabia and Iran are currently leveraging the low cost hydrocarbons to drive industrial development while South Korea, Singapore and India are driven by strong demand growth. Mexico and Canada are linked to strong demand via the North American Free Trade Agreement, but limited by current energy prices.



FORECAST:

- Eramo projects the need for ethylene will grow 5.5–6 million tons this year, propylene 4–4.5 million tons and methanol 3.5–4 million tons.
- Because of current market uncertainty causing delayed project approvals, IHS Markit expects falling capital spending across global chemical markets by the early 2020s.
- Capital spending slowdown will create tight market conditions in olefins and chlor-alkali by the end of the decade.
- North America will remain an attractive region for petrochemical and related investments; investors will include both domestic and foreign companies.

Driven by Capacity

Although power generation in North America is a \$712-billion industry and more the \$5 trillion in projects has been proposed worldwide, not all those projects will go through, according to Britt Burt, vice president of global research for the power industry at Industrial Info Resources Project (IIR).

In 2010, for example, only about 39% of identified projects went ahead while in 2017 that number is slated to be about 44%.

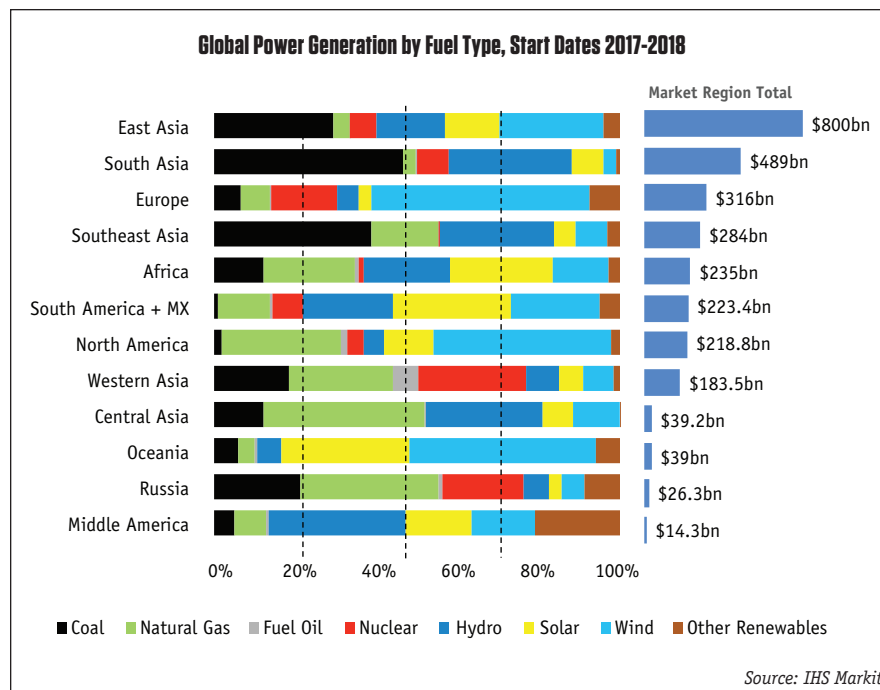
"There are many delays, project fallouts and cancellations because projects are competing against each other for the same capacity," he said.

In Europe and North America, the capacity is generally slated to be filled by renewable energy and natural gas—two markets already mature at a time when power demand is not growing much. However, in South Asia, the huge demand is growing at about 8–10% per year, and baseload plants will include coal to fulfill that need. Meanwhile, China is pulling back from coal power, and India currently is building 100 gigawatts (GW) of renewable energy, much of it solar, small hydro projects and some wind. In general, the developing countries are more likely to build coal-powered plants simply because of the low cost and availability of coal and the huge demand increases.

In the U.S., state and federal tax credits are in place for renewable power projects though Burt expects these to be removed by the current administration.

"Those I've talked to in higher-level executive positions in utilities and private energy producers say they have charted their course for more lower carbon fuel sources, and they are following that, no matter what the current administration says." Burt also pointed out that the nation is currently meeting another round of renewable standards, but that future generational mix will be defined by natural gas prices and electricity demand.

Demand for power in North Amer-



ica is only growing about 1% a year, thanks in part to the energy efficiency programs. Burt said he does not see that changing for the near term, and much of the natural gas-fired capacity moving forward is to replace capacity lost from retired coal plants. Over 85 GW have been retired since 2012, he pointed out, mostly coal and nuclear, and older, less efficient Rankin cycle natural gas facilities that can't operate competitively.

Burt also noted that environmental regulations continue to target coal-fired power plants, but that: "We will continue to see investment for aging assets that need repair and replacement of parts, so there are opportunities there as part of modernizations and life extensions."

Going Forward

IIR is following the progress of 270 natural gas-fired projects valued at over \$103 billion from 2017 to 2022. "When we apply a 'confidence factor,' it is 64% on natural gas-fired projects based on what has moved forward in the past," he said. Using those figures, about 184 of the projects would go through at \$64.4 billion, he said.

Some small hydroelectric projects are in the works along with modernization of existing facilities, which Burt believes is a potential market going forward. In-plant capital expenditures will include replacements,

refurbishments and closures, expected at almost \$10 billion, to be spent during this five-year period.

Other growth will come from industrial energy producers that have incorporated co-generation as part of their manufacturing or processing plant, he said. That includes metals and mining (because of isolated locations) but also the oil and gas and pulp and paper sectors. "Some of those [pulp and paper plants] can make more money selling power than they can making paper!" Burt noted.

Despite the Trump administration pushing for a comeback for coal, Burt doesn't see it happening any time soon in the U.S.

FORECAST:

- Burt projects 18 GW of natural gas-fired capacity to start in 2018 and said that Texas is one of the hottest areas for development. Also, in Pennsylvania and Ohio, coal closure and plentiful natural gas from the Marcellus make the potential for natural gas-fired plants good in those states.
- The transformation of the power industry will continue as North America shifts new builds away from coal to natural gas and renewable energy.
- Investment in the coal and nuclear sectors will be centered around in-plant capital and maintenance.

WATER AND WASTEWATER

Funding Remains the Issue

Funding remains the most significant issue for the water and wastewater sectors, according to Gene Koontz, senior vice president at Gannett Fleming.

"Federal funding is only about 10% of the money," he said. "WIFEA [the Environmental Protection Agency's (EPA) Water Infrastructure Finance and Innovation Act] is infusing money into municipal water and wastewater, but most funding for water is funded through customer rates."

*[*Ed. Note: As of July 2017, EPA had \$1.5 billion in available funds for 2017. These funds come in the form of low-interest loans that must eventually be paid back with interest.]*

Current State of the Industry

Koontz noted that the most pressing problem in the water and wastewater industry also has not changed in several years: The huge gap that exists between available financing and the need to renew and replace aging infrastructure.

Meanwhile, conservation is driving down water use while revenue is dropping, which means rates must increase. However, public understanding of the value of water is not good so rising rates are not accepted, he said.

Koontz said two factors that drive the water/wastewater market and their current state are:

- **Economics:** Most utilities are owned or otherwise controlled by municipalities, and when the economy is down, towns tighten spending. Continued economic growth of the area can help the sector, but it's also affected by factors such as when the price of copper doubles.
- **Regulation:** There have been few regulatory developments driving growth in the last year, Koontz said. One is the need to restructure combined sewer overflows, which is a \$40 billion project nationwide. Combined sewer overflow, in which the domestic sewage and stormwa-

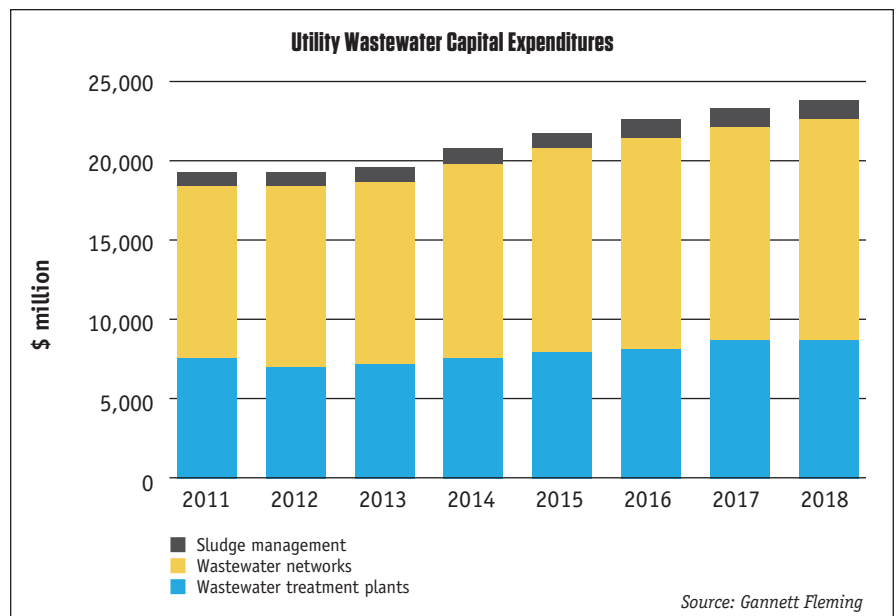
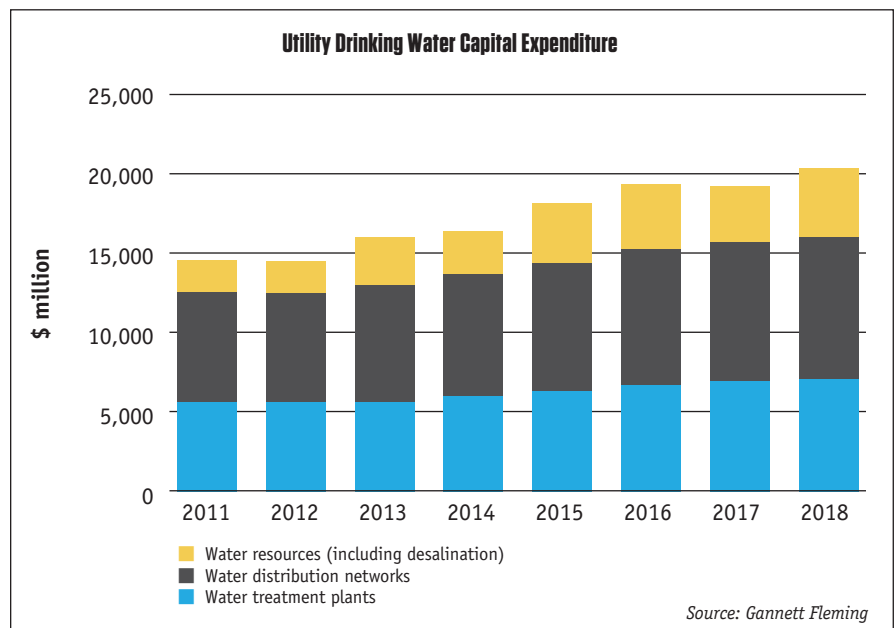
ter are in one pipe, was common in the 1960s and 70s, but that's no longer the case and systems are seeking to separate the two, he said.

No new major regulations regarding drinking water have occurred in the last decade, but Koontz expects that may change. He pointed out customers in recent times are driving what happens. "If something is found in the water supply, a customer demands action," he said. "That will drive work for new plants and alternative supplies," he said.

Another recent trend in the water

industry is the call for reuse, which is driven by water scarcity and wastewater discharge limitations. "It started in California, Arizona and Florida [which have suffered droughts] and is still predominant there, but is starting to creep into water-rich areas," he said.

Stormwater is emerging as an issue in many places because runoff can affect water quality by leaving behind micro-pollutants and sediment and taking away nutrients. Stormwater control has been estimated as a \$100 billion market over 20 years, but about 70% of that is for green infrastructure projects such as parks, streetscape, barrels. Only 30% will be



going into infrastructure, he said.

Koontz noted that, in the past, regulatory action drove work; currently it's inhibiting it. "Trump EPA cuts could have a significant trickle-down impact," he said.

Meanwhile, today's drivers include:

- **Repair and Rehabilitation:** The American Water Works Association estimates that, because the pipes and systems throughout the U.S. are in such bad shape, the repair and rehabilitation of buried water infrastructure could cost \$1 trillion in the next 25 years. "Few systems are keeping pace with these desperately needed repairs," Koontz said.

- **Efficiency:** Wastewater plants are now "resource recovery systems," reclaiming water, energy and nutrients coming into the plants. All utilities are also looking at renewable energy, including small hydro projects.

- **Water Scarcity or Disaster Recovery:** Events related to climate change, including drought and flooding are happening more frequently. Scarcity is the driver behind reuse where there are real and continuing issues in California, Arizona and Florida.

FORECAST

- *Water and wastewater in 2018 will be about a \$45 billion industry in this nation. However, needs are \$150 billion per year, which means the country is falling 70% short for the next 10 years.*
- *Expect growth of the market at about 3–6% annually in the immediate future, without any major disruptions. California, Texas and Florida will continue to dominate the market.*
- *Because of the lack of regulatory drivers, growth will be mainly from repairs. However, even if funding were available for everything that needs to be done, "there is no way" the nation could respond rapidly enough. "There are not enough skilled plumbers, electricians, carpenters to cover it," said Koontz.*

End Market	End Market Demand Conditions	
	Geography	
	Developed	Emerging
Upstream Oil & Gas	Improving	Moderating
Downstream Oil & Gas	Improving	Stable
Power	Declining	Stable
Chemical	Improving	Stable
General Industrial	Improving	Improving
Mining	Stable	Improving
Non-Residential Construction & HVAC/R	Moderating	Stable
Residential Construction & HVAC/R	Stable	Stable
Municipal Water/Wastewater	Stable	Improving

Current Demand: ■ Weak ■ Moderate ■ Strong

Source: Robert W. Baird & Co. analysis

WALL STREET

An Unusually Long Cycle

Michael Halloran of Baird and Company challenged attendees about why they should care what happens on Wall Street. The reason, he said, is that what occurs in the markets is a good indicator of sentiment, which makes it a good predictor of demand.

Where are We?

The nation currently is in an unusual economic cycle, according to Halloran. He said Baird's feeling is that the year 2017 is late in that cycle and that a recession is not imminent.

"This is particularly important in the context of the recovery from the Great Recession because this cycle is the third-longest expansion on record with persistent low growth and lagging industrial production," he said.

Significant central bank intervention has elongated the cycle and also changed its growth characteristics, he said.

The Macro Environment

The U.S. dollar strengthened in 2016 and although it was weakening at the time of the workshop, Halloran says the year will end with strength.

China's debt-fueled growth has given way to slower economic trends, and there are systemic concerns about

the country's financial sector. While China is currently considered healthy (especially when compared to other places around the world where political instability and gridlock are prevalent), uncertainty exists about what the government will do next.

In most countries, the biggest wildcard is the action of the central banks; their policies continue to drive markets.

For example, in the U.S., current lending standards are expected to continue to support business investment, but Fed rate hikes and other inflationary pressures could drive a tighter lending environment. Halloran said there is some indication that's occurring, which could lead the country into recession. But, "Don't get too caught up in timing," Halloran warned. "It is just an indicator."

U.S. and global industrial production growth slowed in 2016, but is improving in 2017. Still, industry participants have cited concerns about the health of the general industrial economy in the backdrop of overcapacity, indebtedness and political uncertainty globally, he said.

Global fixed investment (GFI) has slowed in recent years. Customers continued to push out investment decisions through 2016, but things seemed to be improving in 2017 (as of the workshop). There are still concerns about large project delays as

many end users continue their “wait and see” approach, Halloran said.

Current Process Industry Demand

The 2017 demand outlook for process industries both geographically and by end users is increasingly positive. However, continued uncertainty indicates that process control companies are not going to significantly increase business through 2017.

The demand globally is “driven by a combination of restocking from low

levels in 2016, replacement and after-market needs. Repairs just can’t be pushed out any longer,” Halloran said. Other factors boosting demand in 2017 included post-election enthusiasm and rising business confidence supported by expectations for fiscal stimulus, deregulation and tax reform.

Looking Forward

Halloran said to expect a low-growth environment for the remainder of this business cycle. Government and

central bank actions in 2009/10 staved off a Great Depression, but they left the global economy hobbled by effectively dismantling or limiting free market mechanisms that support much-needed economic rebalancing, he said.


Overcapacity remains a major problem across most industries because firms that would have exited the market via bankruptcy have been kept afloat by artificially low borrowing costs. Global indebtedness at all levels—government, corporate and consumer—is at or near peak historical levels and continues to worsen. High levels of debt generally result in tightening of money.

For process markets, this low-growth environment means commodity price volatility is here to stay until the supply/demand imbalances are resolved. It also means the project environment is likely to remain weak as persistent price volatility hampers investment decisions, Halloran said. Pricing power is unlikely to recover until capacity tightens or inflation gains traction, he said.

Halloran stressed there will be no help from Washington. “The uncomfortable truth is that many of the hoped-for tailwinds from government are unlikely to materialize.”

FORECAST

- *Upstream oil and gas markets are recovering with North American onshore drilling leading the way and offshore and international activity remaining soft.*
- *Midstream activity appears healthy, aided by the release of previously stalled North American projects in early 2017.*
- *General industrial demand is recovering but ongoing sluggishness offers little incentive for companies to invest in capacity expansions and facility upgrades for the immediate future.*
- *Chemical demand is robust, aided by low feedstock prices and growth in the North American export capacity.*
- *Municipal water and wastewater has been a serial underperformer for this cycle, but will improve going into the new year.*



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INTERNATIONAL OUTLOOK

Growth Elements Sluggish

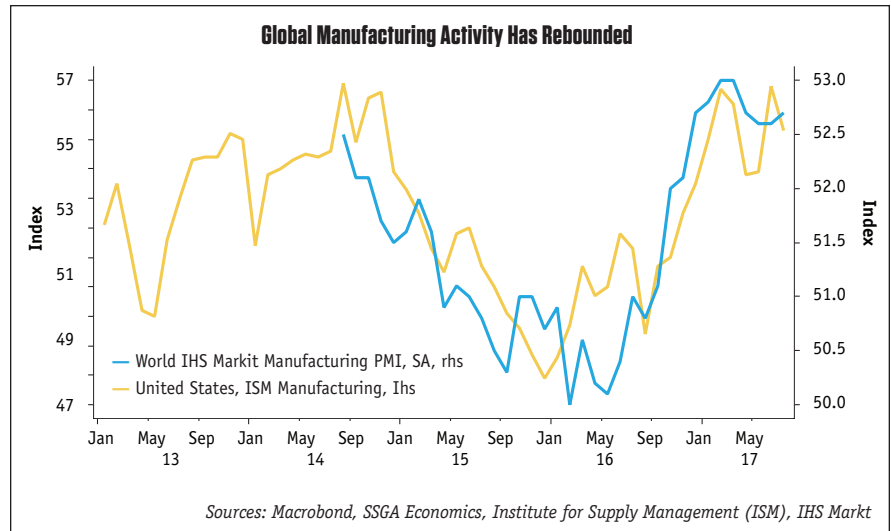
The world's economy has been struggling to get back to a traditionally normal rate of growth since the crisis of 2008, said Simona Mocuta, senior economist at State Street Global Advisors.

"There has been improvement but it is still sluggish. Part of the problem is that the ingredients for growth have weakened."

Those ingredients include labor, capital and productivity. Labor is currently a strong concern influenced by the aging workforce.

"The labor pool is shrinking, and there isn't much that can be done to change that. Even though there is nearly full employment, there is also a drop in participation, led by men," she said. "Additionally, those that are in the workforce are less productive, and nobody is able to understand why," she added.

As far as the final ingredient of capital, some economists insist that businesses are not investing enough so growth cannot occur. Mocuta believes,



however, that companies are investing at a rate justified by the current market conditions, and that slow growth in the U.S. can also be blamed on the lack of private domestic residential investment since the crisis of 2008.

She said she named her presentation, "Structural Headwinds vs. Cyclical Boost" because the structure of the economy that is currently with us will be with us for awhile. However, cyclical momentum has improved substantially from 2016.

The energy/commodity recession of 2014 is now over, she said, even though prices have not increased. Commodity exporters have stronger terms of trade and capital spending has stabilized and is picking up, she said. "There is reason to be optimistic as the increases in manufacturing this year are not just because of policy in the U.S. or the rise in the stock market. It is a world-wide phenomenon. We are on the upside."



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Other issues in the U.S. are wages and the low rate of inflation. If wages don't inflate, neither will the economy, she said.

"The question is, what is stopping wages from rising?" Mocuta asked. She said one possibility is older people retiring at higher pay to be replaced by lower-paid younger people. But, "There are also many people staying in existing jobs without any wage increases."

Outside the States

Mocuta noted that, cyclically, Europe is recovering, but the problem rests with the structural issues in the way the Eurozone is set up. It poses many challenges for countries like Italy that are not competitive.

The other issue is the United Kingdom and Brexit. "We are inching toward some sort of transitional agreement," she said, which is a better arrangement for companies unsure how to deal with the whole scenario. Despite Brexit and uncertainty, the European employment rate is growing rapidly and the labor participation rate is increasing.

Growth in Canada is broadening as

well, Mocuta said. "It's not just Toronto or Vancouver; the resource provinces are healing as well. In fact, the Bank of Canada finally started raising interest rates, so that's a good sign," she said.

Meanwhile, China is no longer as export reliant as it used to be, Mocuta said. "Even though we still hear the rhetoric of 10 years ago, today, Germany exports more than China," she said. "Services are now China's largest employer," she said. Meanwhile, the country's government has an industrial policy that aims "to produce champions; they're in the next stage of technology development," she said. In other words, instead of going after industries such as mining, they're going after more modern industries.

FORECAST

■ *While the global economy is strengthening, some structural issues remain. In the U.S., the unprecedented drop in labor force participation and wage stagnation is constricting growth while the Eurozone's fixed-exchange rate regime means some countries such as Germany will boom while countries such*

as Italy are doomed to stagnate.

- *Japan's growth will continue to be mediocre but steady while Canada's cyclical upswing is in full force and expected to continue over the next year.*
- *In the U.K., the labor market is still resilient, but rising inflation will hurt households' purchasing power throughout this year and into the next.*
- *China's producer pricing power has improved along with industrial profits, but China's debt is a drag on stability.*

THE U.S. ECONOMY

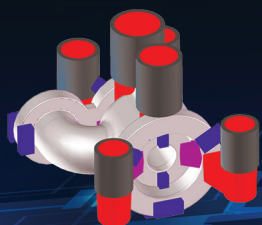
Good Signs

According to Maria Luengo-Prado, senior economist and policy advisor at the Federal Reserve Bank of Boston, the U.S. is seeing positive economic signs.

The U.S. labor market has improved substantially since the Great Recession and the unemployment rate is now below the Congressional Budget Office's estimate of the full employment rate, she said. (In

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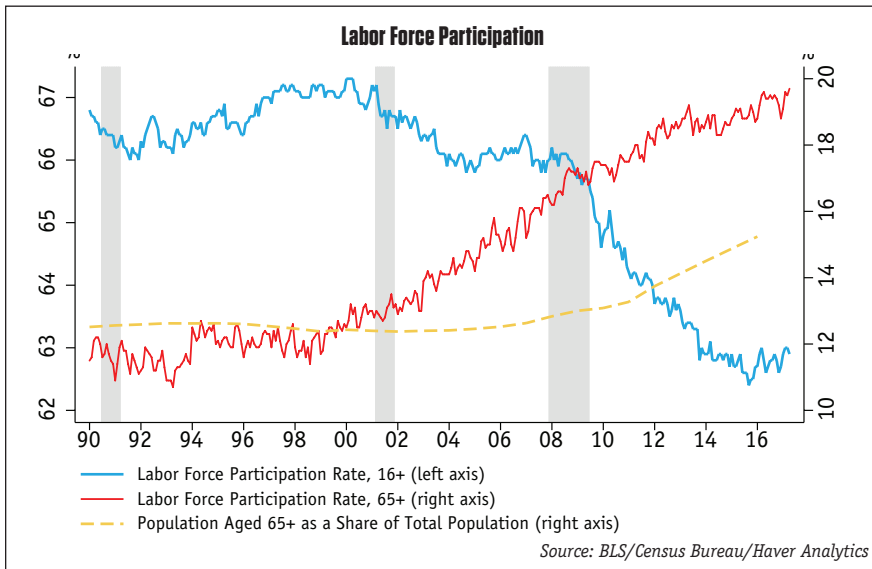
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today's economy, full employment means approximately 4.6%.)

On a 12-month basis, inflation has declined recently; the core measure is running somewhat below 2%, which is the goal set by the Federal Open Market Committee. However, the Fed believes that healthy wage growth will put some pressure on inflation.

Meanwhile, the labor force participation rate has remained relatively stable over the last few years at

roughly 63%, which points to a very strong labor market, especially considering the aging of the population.

GDP growth in the first quarter of 2017 slowed to 1.2%, but strong growth in the second quarter was expected to continue the rest of 2017. Luengo-Prado said the general consensus at the Fed is that the economy is stable; the recovery from the Great Recession is ongoing; and financial markets are doing well.

Even though those markets were at historical highs at the time of the workshop, Luengo-Prado said she sees little likelihood of a drastic drop in value.

Lending standards for commercial and industrial loans to large and medium firms have eased somewhat, which is helping investment gain momentum. But Luengo-Prado pointed out companies are still not investing much. "Only recently have companies begun buying things again. It's important to continue investing in your businesses with equipment, training, etc." she said.

THE FORECAST

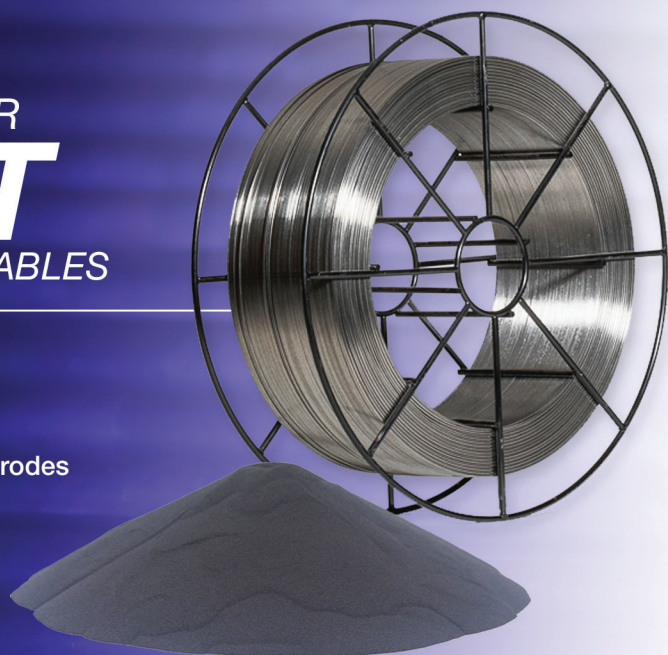
- *The Fed's dual mandate of meeting a flexible employment goal and an inflation goal of 2% is within grasp at this time, so the outlook for the rest of 2017 is strong.*
- *The Fed expects the growth rate of GDP will be around 2.2% in the near term.*
- *The unemployment rate will continue around 4.3%; the inflation rate will be about 1.6-2%*
- *The Federal Funds Rate will gradually be increased to 1.4%*

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WHERE
VALVES
ARE USED:

Everywhere!

BY GREG JOHNSON

Valves can be found just about anywhere today: in our homes, under the street, in commercial buildings and in thousands of places within power and water plants, paper mills, refineries, chemical plants and other industrial and infrastructure facilities.

The valve industry is truly broad-shouldered, with segments varying from water distribution to nuclear power to upstream and downstream oil and gas. Each of these end-user industries use some basic types of valves; however, the details of construction and materials are often very different. Here's a sampling:

Executive Summary

SUBJECT: The breadth of the valve industry is truly expansive.

KEY ISSUES:

- Issues end-user industries face
- Materials and other considerations
- Why certain valves are popular

TAKE-AWAY: Everywhere fluids are handled, valves are used to control those fluids.



WATER WORKS

In the world of water distribution, the pressures are almost always relatively low and the temperatures ambient. Those two application facts allow a number of valve design elements that would not be found on more challenged equipment such as high-temperature steam valves. The ambient temperature of water service allows use of elastomers and rubber seals not suitable elsewhere. These soft materials allow water valves to be equipped to tightly seal off drips.

Another consideration in water service valves is choice in materials of construction. Cast and ductile irons are used extensively in water systems, especially large outside diameter lines. Very small lines can be handled quite well with bronze valve materials.

The pressures that most waterworks valves see are usually well below 200 psi. This means thicker-walled higher-pressure designs are not needed. That having been said, there are cases where water valves are built to handle higher pressures, up to around 300 psi. These applications are usually on long aqueducts close to the pressure source. Sometimes higher-pressure water valves also are found at the highest-pressure points in a tall dam.

The American Water Works Association (AWWA) has issued specifications covering many different types of valves and actuators used in waterworks applications.

WASTEWATER

The flip side of fresh potable water going into a facility or structure is the wastewater or sewer output. These lines collect all the waste fluid and



solids and direct them to a sewage treatment plant. These treatment plants feature a lot of low pressure piping and valves to perform their "dirty work." The requirements for wastewater valves in many cases is much more lenient than the requirements for clean water service. Iron gate and check valves are the most popular choices for this type of service. Standard valves in this service are built in accordance with AWWA specifications.

POWER INDUSTRY

Most of the electric power generated in the United States is generated in steam plants using fossil-fuel and high-speed turbines. Peeling back the cover of a modern power plant would yield a view of high-pressure, high-temperature piping systems. These main lines are the most critical in the steam power generation process.

Gate valves remain a main choice for power plant on/off applications, although special purpose, Y-pattern globe valves are also found. High-performance, critical-service ball valves are gaining popularity with some power plant designers and are making inroads in this once linear-valve-dominated world.

Metallurgy is critical for valves in power applications, especially those operating in the supercritical or ultra-supercritical operating ranges of pressure and temperature. F91, F92, C12A, along with several Inconel and stainless-steel alloys are commonly used in today's power plants. Pressure classes include 1500, 2500 and in some cases 4500. The modulating nature of peak power plants (those that operate only as needed) also puts



a huge strain on valves and piping, requiring robust designs to handle the extreme combination of cycling, temperature and pressure.

In addition to the main steam valving, power plants are loaded with ancillary pipelines, populated by a myriad of gate, globe, check, butterfly and ball valves.

Nuclear power plants operate on the same steam/high-speed turbine principle. The primary difference is that in a nuclear power plant, the steam is created by heat from the fission process. Nuclear power plant valves are similar to their fossil-fueled cousins, except for their pedigree and the added requirement of absolute reliability. Nuclear valves are manufactured to extremely high standards, with the qualifying and inspection documentation filling hundreds of pages.

OIL AND GAS PRODUCTION

Oil and gas wells and production facilities are heavy users of valves, including many heavy-duty valves. Although gushers of oil spewing hundreds of feet in the air are no longer likely to occur, the image illustrates the potential pressure of underground oil and gas. This is why well heads or Christmas trees are placed at the top of a well's long string of pipe. These assemblies, with their combination of valves and special fittings, are designed to handle pressures upwards of 10,000 psi. While rarely found on wells dug on land these days, the extreme high pressures are often found on deep offshore wells.

Wellhead equipment design is covered by API specifications such as 6A, Specification for Wellhead and Christmas Tree Equipment. The valves cov-



ered in 6A are designed for extremely high pressures but modest temperatures. Most Christmas trees contain gate valves and special globe valves called chokes. The chokes are used to regulate the flow from the well.

In addition to the wellheads themselves, many ancillary facilities populate an oil or gas field. Process equipment to pre-treat the oil or gas requires a number of valves. These valves are usually carbon steel rated for lower classes.

Occasionally, a highly corrosive fluid—hydrogen sulfide—is present in the raw petroleum stream. This material, also called sour gas, can be lethal. To beat the challenges of sour gas, special materials or material processing techniques in accordance with NACE International specification MR0175 must be followed.

OFFSHORE INDUSTRY

The piping systems for offshore oil rigs and production facilities contain a multitude of valves built to many different specifications to handle the wide variety of flow control challenges. These facilities also contain various control system loops and pressure relief devices.

For oil production facilities, the arterial heart is the actual oil or gas recovery piping system. Although not always on the platform itself, many production systems use Christmas trees and piping systems that operate in the inhospitable depths of 10,000 feet or more. This production equipment is built to many exacting American Petroleum Institute (API) standards and referenced in several API Recommended Practices (RPs).

On most large oil platforms, additional processes are applied to the raw fluid coming from the wellhead. These include separating water from the hydrocarbons and separating gas and natural gas liquids from the fluid stream. These post-Christmas tree piping systems are generally built to American Society of Mechanical Engineers B31.3 piping codes with the valves designed in accordance with API valve specifications such as API 594, API 600, API 602, API 608 and API 609.

Some of these systems may also contain API 6D gate, ball and check valves. Since any pipelines on the platform or drill ship are internal to the facility, the strict requirements to use API 6D valves for pipelines do not apply. Although multiple valve types are used in these piping systems, the valve type of choice is the ball valve.

PIPELINES

Although most pipelines are hidden from view, their presence is usually evident. Small signs stating “petroleum pipeline” are one obvious indicator of the presence of underground transportation piping. These pipelines are equipped with many important valves all along their length. Emergency pipeline shutoff valves are found at intervals as specified by standards, codes and laws. These valves serve the vital service of isolating a section of a pipeline in case of a leak or when maintenance is required.

Also scattered along a pipeline route are facilities where the line emerges from the ground and line access is available. These stations are the home for “pig” launching equipment, which consists of devices insert-

ed into the pipelines either to inspect or clean the line. These pig launching stations usually contain several valves, either gate or ball types. All of the valves on a pipeline system must be full-port (full-opening) to allow for the passage of pigs.

Pipelines also need energy to combat the friction of the pipeline and maintain the pressure and flow of the line. Compressor or pumping stations that look like small versions of a process plant without the tall cracking towers are used. These stations are home to dozens of gate, ball and check pipeline valves.

The pipelines themselves are designed in accordance with various standards and codes, while pipeline valves follow API 6D Pipeline Valves.

There are also smaller pipelines that feed into houses and commercial structures. These lines provide water and gas and are guarded by shutoff valves.

Large municipalities, particularly in the northern part of the United States, provide steam for heating requirements of commercial customers. These steam supply lines are equipped with a variety of valves to control and regulate the steam supply. Although the fluid is steam, the pressures and temperatures are lower than those found in power plant steam generation. A variety of valve types are used in this service, although the venerable plug valve is still a popular choice.

REFINERY AND PETROCHEMICAL

Refinery valves account for more industrial valve usage than any other valve segment. Refineries are home to both corrosive fluids and in some cases, high temperatures.



These factors dictate how valves are built in accordance with API valve design specifications such as API 600 (gate valves), API 608 (ball valves) and API 594 (check valves). Because of the harsh service encountered by many of these valves, extra corrosion allowance is often needed. This allowance is manifested through greater wall thicknesses that are specified in the API design documents.

Virtually every major valve type can be found in abundance in a typical large refinery. The ubiquitous gate valve is still the king of the hill with the largest population, but quarter-turn valves are taking an increasingly large amount of their market share. The quarter-turn products making successful inroads in this industry (which was also once dominated by linear products) include high performance triple offset butterfly valves and metal-seated ball valves.

Standard gate, globe and check valves are still found en-masse, and because of the heartiness of their design and economy of manufacturing, will not disappear any time soon.

Pressure ratings for refinery valves run the gamut from Class 150 to Class 1500, with Class 300 the most popular.

Plain carbon steels, such as grade WCB (cast) and A-105 (forged) are the most popular materials specified and used in valves for refinery service. Many refining process applications push the upper temperature limits of plain carbon steels, and higher-temperature alloys are specified for these applications. The most

popular of these are the chrome/moly steels such as 1-1/4% Cr, 2-1/4% Cr, 5% Cr and 9% Cr. Stainless steels and high-nickel alloys are also used in some particularly harsh refining processes.

CHEMICAL

The chemical industry is a big user of valves of all types and materials. From small batch plants to the huge petrochemical complexes found on the Gulf Coast, valves are a huge part of chemical process piping systems.

Most applications in chemical processes are lower in pressure than many refining processes and power generation. The most popular pressure classes for chemical plant valves and piping are Classes 150 and 300. Chemical plants have also been the biggest driver of the market share takeover that ball valves have wrestled from linear valves over the past 40 years. The resilient-seated ball valve, with its zero-leakage shutoff, is a perfect fit for many chemical plant applications. The compact size of the ball valve is a popular feature as well.

There are still some chemical plants and plant processes where linear valves are preferred. In these cases, the popular API 603-designed valves, with thinner walls and lighter weights, are usually the gate or globe valve of choice. Control of some chemicals is also effectively accomplished with diaphragm or pinch valves.

Because of the corrosive nature of many chemicals and chemical-making processes, material selection is critical. The defacto material is the 316/316L grade of austenitic stain-

less steel. This material works well to fight corrosion from a host of sometimes nasty fluids.

For some tougher corrosive applications, more protection is needed. Other high-performance grades of austenitic stainless steel, such as 317, 347 and 321 are often chosen in these situations. Other alloys that are used from time to time to control chemical fluids include Monel, Alloy 20, Inconel and 17-4 PH.

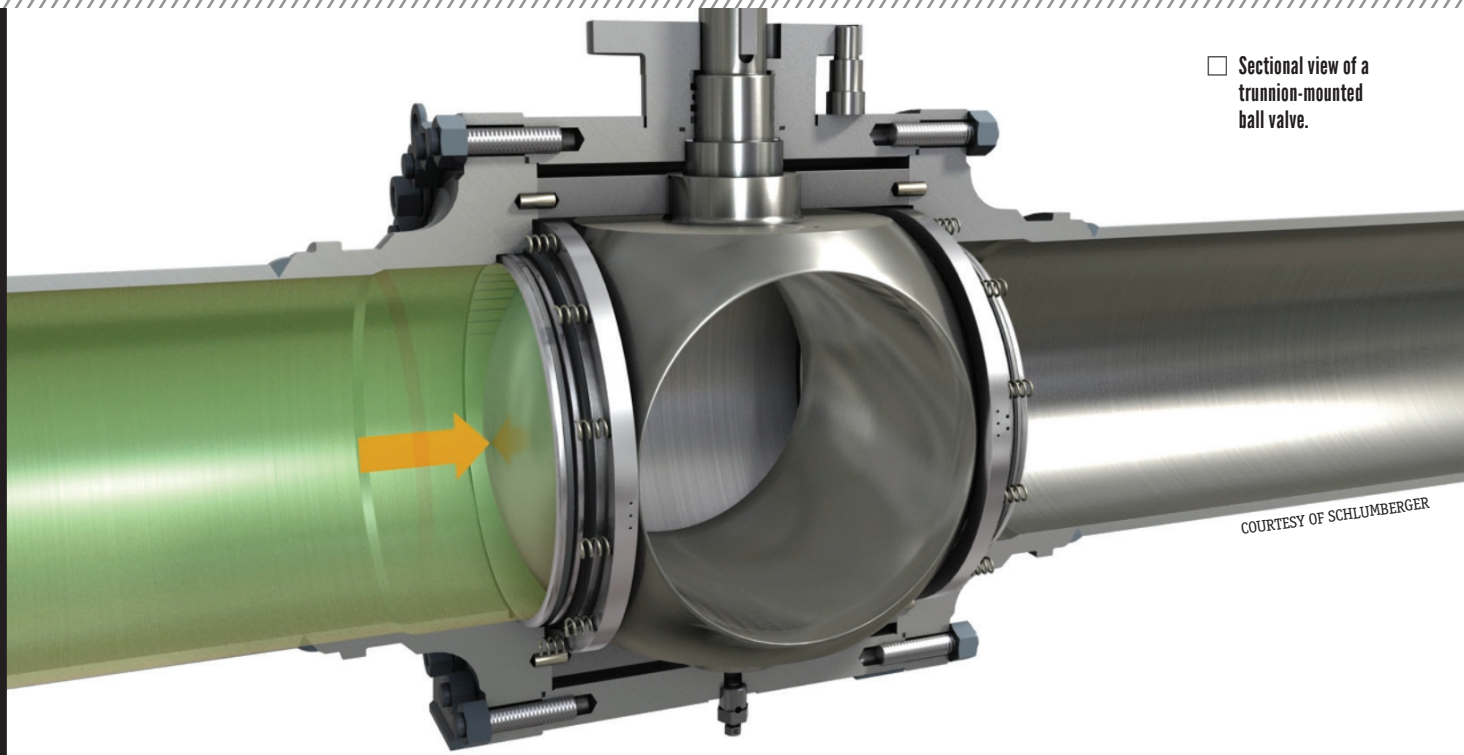
LNG AND GAS SEPARATION

Both liquid natural gas (LNG) and the processes required for gas separation rely on extensive piping. These applications require valves that can operate at very low cryogenic temperatures. The LNG industry, which is growing rapidly in the United States, is continually looking to upgrade and improve the process of gas liquefaction. To this end, piping and valves have become much larger and pressure requirements have been raised.

This situation has required valve manufacturers to develop designs to meet tougher parameters. Quarter-turn ball and butterfly valves are popular for LNG service, with 316ss [stainless steel] the most popular material. ANSI Class 600 is the usual pressure ceiling for most LNG applications. Although quarter-turn products are the most popular valve types, gate, globe and check valves can be found in the plants as well.

Gas separation service involves dividing gas into its individual basic elements. For example, air separation methods yield nitrogen, oxygen, helium and other trace gases. The

CONTINUED ON PAGE 48



□ Sectional view of a trunnion-mounted ball valve.

COURTESY OF SCHLUMBERGER

Unique Operating Dynamics of Trunnion-Mounted Ball Valves

BY RON MANSON

For a very long time, the idea has existed that a trunnion-mounted ball valve can be opened under full differential pressure if the piping system can withstand the rapid increase in pressure and the forces induced by it. As valve sizes and operating pressures increase, however, several factors need to be considered if that valve is opening with little or no pressure downstream.

OPERATING CHARACTERISTICS

The operating characteristics are similar for all trunnion-mounted ball valves. For decades, field technicians commissioning new pipelines reported that actuated trunnion-mounted ball valves would open to about 20 to 25 degrees then stop before moving to a full open position. This typically happened when filling a new pipeline, and it was brushed off as something that occurred because the actuator was either undersized or the supply pressure was not set properly. As valve sizes and operating pressures have increased, the issue is manifesting itself in factories where gas tests are performed.

Manufacturers have long known about the dynamic vaning effect that occurs when opening a ball valve in situations where a high flow rate goes through the valve driven by the pressure differential. During the initial opening, the vaning forces try

Executive Summary

SUBJECT: Conventional wisdom has always been that all trunnion-mounted ball valves can be operated under full differential pressure. A combination of testing and computational fluid dynamics analyses has provided insight challenging that perception.

KEY ISSUES:

- Differential pressure versus valve diameter
- Speed of operation
- Type of actuation

TAKE-AWAY: Taking the differential pressure for a given diameter against which valves can be opened into consideration can improve valve longevity and design of piping systems.

to close the valve again—at least until about 40 degrees of travel has occurred. When the valve is almost open, these vaning forces reverse and try to push the ball to a full open position. For this reason, manual trunnion-mounted ball valves are fitted with worm-type, self-locking gear-boxes. If a spur gear is used (which is not self-locking), the vaning forces can back-drive the ball, the gear and handwheel, which, in turn, may rip the handwheel from the operator's grip.

FACTORY TESTING

Testing valves for operability in a factory is quite different from studying how valves will perform in the field. This is because the factory testing typically has only the expansion of the fluid trapped by the upstream seat to generate a small amount of flow when the pressure is released. The test fluid also consists of a different mass and viscosity from what might be experienced in the field. However, in high-pressure or large valves, the small amount of gas flow appears to be enough to generate an opening effect similar to what occurs in the field, which may cause some damage to the seat sealing face. This is unlikely to happen during seat hydrotests because the volume of the water displaced when opening a valve in a test stand is very small.

This finding has led to extensive research to determine any root causes associated with the operating peculiarity experienced when trunnion-mounted ball valves are opened under full differential pressure. The research was only possible by using the latest technology in pressure measurement, optical recording and computational fluid dynamics (CFD) that were run on a considerable cluster of computing cores.

THE STUDY

Since there is a low-flow volume during factory gas testing, a study was performed at a company facility in Voghera, Italy to learn what is happening to the pressure in various locations of the valve. Millisecond pressure recorders were installed on a test valve to measure pressure upstream,

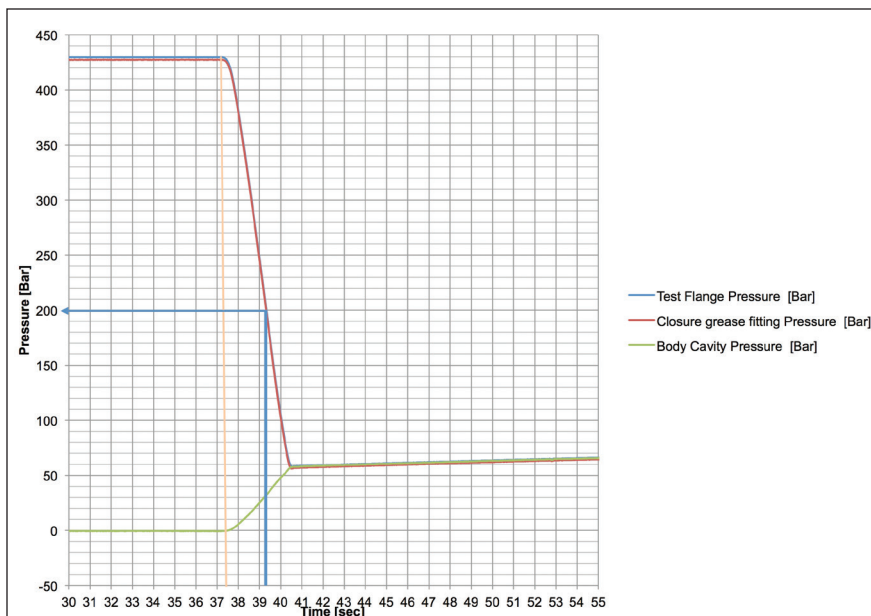


Figure 1: Graph of pressure changes during valve cycling

downstream, in the valve cavity and at injection ports that connect behind the seats. The results showed that at 23 degrees from open, the upstream pressure had only dropped about 47% of the starting pressure to 200 gauge pressure (barg) (Figure 1). This point was chosen because it is the angle at which slight indenting of the soft seat face material occurred (Figure 2).

The pressure in the ports behind the upstream seat followed the upstream pressure within milliseconds

and highlighted the fact the seat is still pushed onto the ball with considerable force during a large portion of the opening cycle; this in turn leads to higher torque than experienced in a typical hydrotest, where water expansion is negligible or nonexistent. The rate of decay of the upstream pressure (shown as pressure drop) is driven by many factors including speed of opening the valve, pressure differential, fluid viscosity, and upstream, downstream and cavity volume.

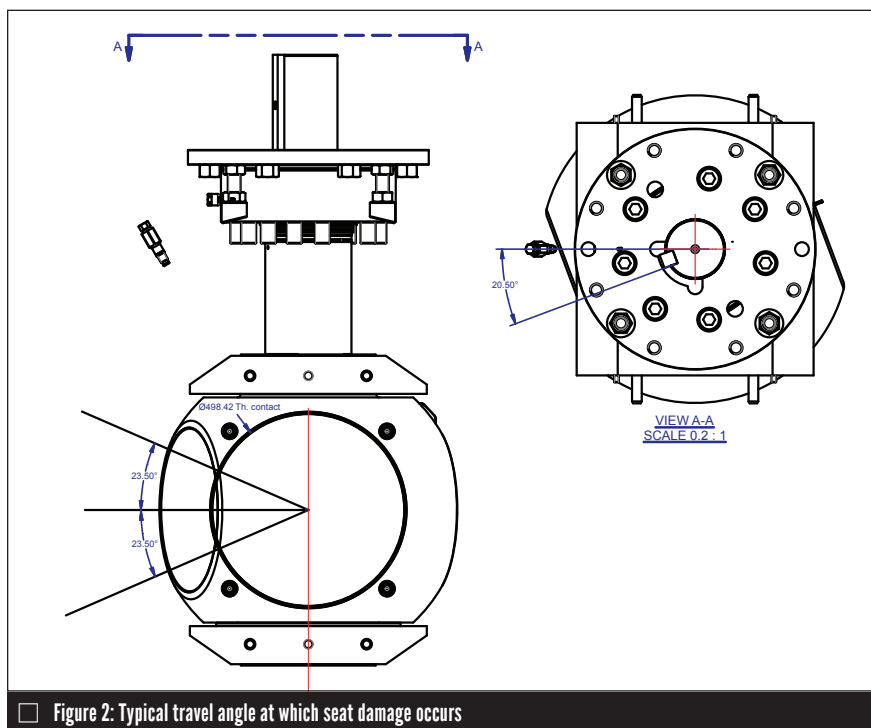


Figure 2: Typical travel angle at which seat damage occurs



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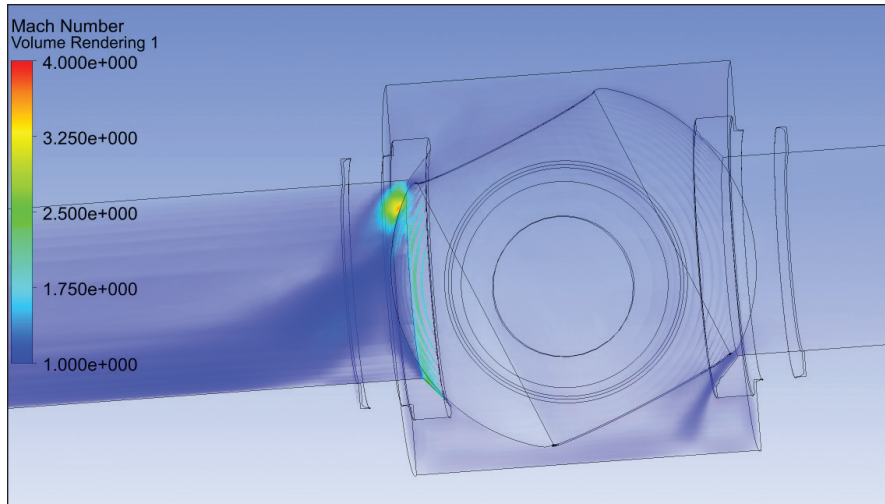


Figure 3. Valve opening cycle showing choked flow condition

COURTESY OF SCHLUMBERGER

The angle at which the slight damage of the seat face mentioned earlier occurred was translated to a time based on the fact that the actuator was a constant speed type as plotted in Figure 1. The graph shows that at 200 barg, the upstream seat is driven into the partially open ball.

Gas testing can be emulated using CFD. Test conditions are similar with natural gas as the medium, but volumes upstream and downstream of the valve are assumed to be infinite. Although this is the safer approach, limitations to testing a valve within a controlled system exist, including the fact the volume on the valve closure's upstream side is very small.

Although this scenario is extreme, it does mirror filling an empty pipeline with natural gas. Depending on the valve geometry and configuration of components, the analysis can take days or even weeks because of the memory required to run iterations. To facilitate this, the valve was positioned at selected angles of opening as opposed to every degree. Choked flow conditions existed up to 40 degrees of the opening travel with a significant pressure differential maintained upstream of the ball and behind the seat. Figure 3 shows the choke flow condition in a ball valve being opened under pressure with an infinite volume of pressure upstream.

TRANSIENT ANALYSIS

Following multiple runs, a full-blown transient analysis from break-open to 60 degrees was run. The previous com-

putational study was done under static conditions—the ball was analyzed at specific angles during specified times. For transient cases, the analysis examines the effects of the valve as if it were continuously opening, which provides a potentially more realistic scenario. However, the trade-off for this analysis is the amount of memory required to compute the example. Using a computational power of 200 cores, the transient analysis took six weeks to run because remeshing of the model needed to be done in minute fractions of a degree to achieve convergence of the results.

This type of analysis cannot be run for every operating condition, but it did validate the steady-state conditions previously run at various angles. The results clearly showed the seat continues to load onto the ball until the pressure is equalized between the valve cavity and upstream side of the ball. Hence, the increased torque associated with this extreme condition can be credited not only to the dynamic vaning effect, but also largely to frictional drag from the seat being loaded against the ball.

The analysis also identified the impact of the localized load on the seat face when the seat is partially supported on a half-open ball. Seat face contact load is normally studied in the closed position to evaluate sealing capability. But when the valve is partially opened, the seat is still loaded by pressure against the ball—part of the seat face is no longer supported so the section that is supported is sub-

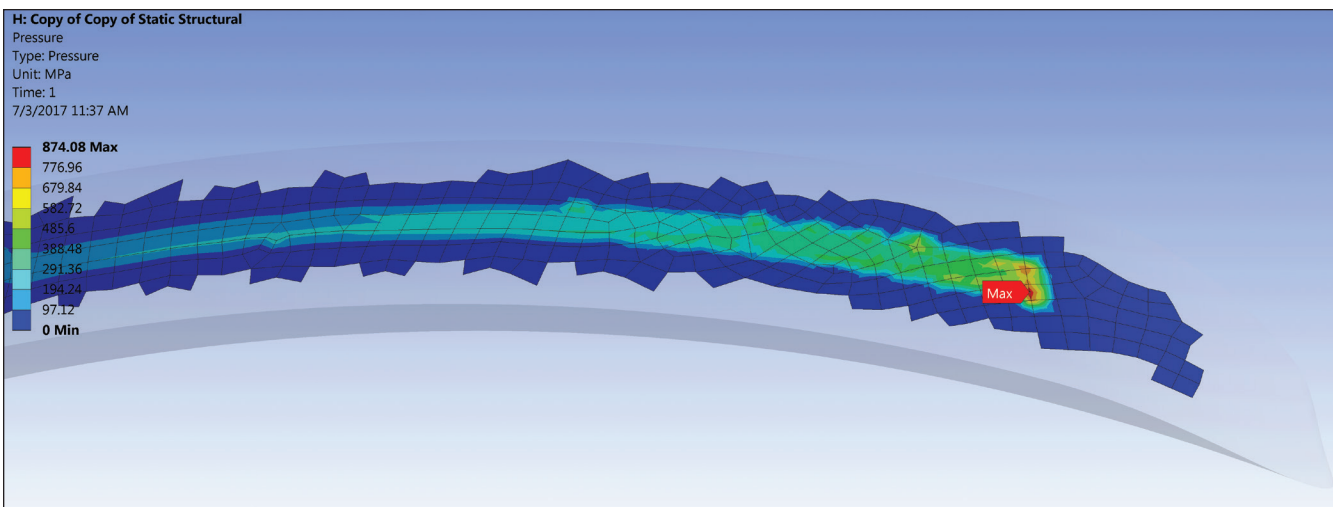


Figure 4. Contact stress on seat face during cycling

jected to a higher load. There also is an intensification of the contact load where the seat transitions onto the ball from its unsupported section.

This intensification of the load changes depending on the upstream volume, fluid viscosity and speed of opening. It typically manifests by indenting the seat face at 8 and 10 o'clock when performing factory gas tests. The 8 and 10 o'clock seat locations translate to an opening angle of about 20 to 25 degrees depending

on the design (Figures 1 and 2). This intensified load can be substantial, and given the wrong operating conditions, can be great enough to damage even metal sealing seat face surfaces (Figure 4).

The analysis work was validated by extensive gas testing where valves were subjected to an opening cycle with a high-pressure differential supplied from a large volume tank discharged to a much greater volume tank downstream. While this arrange-

ment did not provide infinite volumes, the results mirrored the CFD analysis.

Knowing that such key factors affect valve performance, it would seem providing a design solution would be easy; however, that is not the case because so many variables must be considered.

VARIABLES AFFECTING PERFORMANCE

The first variable to be considered is the medium—liquid versus gas. While the liquid is not highly compressible,

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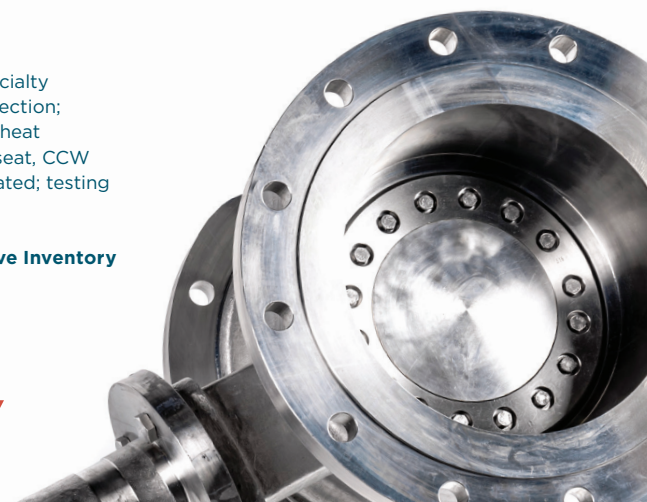
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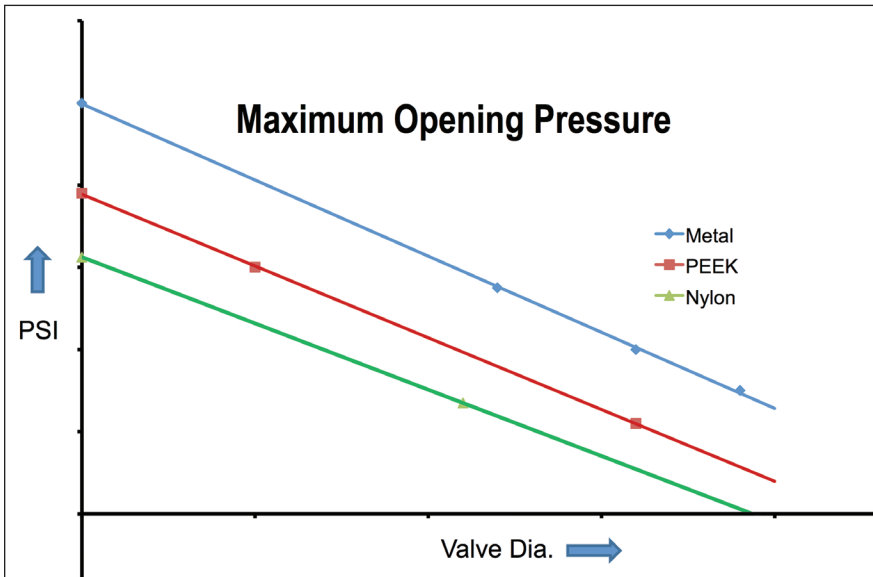


Figure 5: Chart depicting relationship between opening pressure and valve diameter

the strain energy in the pipeline upstream of the valve propels it through an opening valve in a manner similar to gas. The problem becomes more complex because the liquid may offer some lubricity, reducing the seat drag. The pipeline downstream may not be empty because such fluid acts as a buffer and equalizes pressure

before the danger angles identified above are reached. The fluid viscosity, differential pressure and temperature are also factors. Multiphase flow then takes the complexity of the problem to yet another level.

Pressure differential is a huge variable in this evaluation. Many questions need to be considered, such as:

- How often will the valve be opened against full differential pressure?
- At what temperature will the stroking occur? (This affects the soft seals and the galling propensity of metal-to-metal sealing.)
- What volume downstream is being pressurized?
- What size is the valve? (The seat load in a large bore valve is substantial.)
- What is the speed of actuation?
- Are there speed controls? What happens if the speed controls are adjusted in the field? (If the valve is opened too slow, the seat face is subject to erosion. If the valve is opened too fast, the danger angle associated with high load is reached before any pressure equalization.)
- What is the type of actuation? Is it hydraulic, electric or pneumatic? (The latter imposes more dynamic loading on the valve.)
- Does the actuation fail as is, fail close or fail open? (Snapping a valve open to a flare line is an arduous operating condition for a trunnion ball valve for the reasons explained above.)
- Will the actuator accelerate/jump quickly to the danger angle once the valve is cracked open and initial pressure is somewhat released as seen in valve testing?
- Is the actuator fitted with full stroke dampening?
- Is the actuator over- or under-sized?

The questions, variables and conditions are seemingly endless. A valve designed to meet every perceived operating condition would be extremely oversized for what is generally required. Also, every operating condition cannot be analyzed to determine performance boundaries.

It is essential to understand that these traits are common in all trunnion-mounted ball valves irrespective of design or manufacturer. The effects can be reduced somewhat by design, but cannot be removed if the



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valve has pressure-energized seats. It is also important to recognize that opening valves under full differential pressure with little or no pressure downstream also impacts other valve types (such as gate and butterfly valves) in a different manner.

WHAT CAN BE DONE?

The following summarizes recommendations for system, operational and actuation considerations for trunnion-mounted ball valve applications:

- End users and contractors designing systems in which large valves are used or large volumes will be filled, or where high pressures are present should consider adopting a bypass system whereby a small valve is used to prefill fluids prior to operating the main valves.
- Manufacturers should establish charts showing the valve bore size, seat material and pressures to which the valve can be opened without potential dam-

It is important to recognize that opening valves under full differential pressure with little or no pressure downstream impacts valve types (such as gate and butterfly valves) in a different manner.

age of the seat sealing surface (Figure 5).

- Operating speeds need to be more closely controlled or scrutinized. The industry-accepted value of 1 second per inch (s/in) of bore is allowed for closing (faster speeds for closing can be readily achieved depending on the design); however, opening time should be around 3 s/in of bore.
- Large pneumatic actuators should have full stroke dampening to inhibit the actuator from jumping to the dangerous angle associated with the high-seat load following the initial release of pressure. If the pneumatic

actuator is not dampened, the recommended opening pressure should be reduced by at least 15%.

CONCLUSION

Testing trunnion-mounted ball valves opening under full differential pressure shows that, by knowing what that pressure is for a given diameter, the valve's life can be increased and the design of piping systems improved. ▀

RONALD MANSON is an engineering fellow with Cameron, a Schlumberger company (www.cameron.slb.com/valves). He performs in-depth research in many areas from design to new coatings. In addition, he works with governmental bodies on major issues affecting the industry. Reach him at vm inquiries@cameron.slb.com.

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Check Valves in LNG Cryogenic Service

BY CARLOS DAVILA, P.E.

Because natural gas is currently considered a good source of energy for both environmental and economic reasons, it's growing in use. This trend promises to continue worldwide for many years to come.

As a result, the liquified natural gas (LNG) market also will see growth, which means more use of cryogenic valves. In the LNG industry, as well as some other cryogenic fields, the importance of check valves is indisputable.

HOW AND WHY THEY ARE USED

Cryogenic check valves are a critical component of the LNG supply chain. They have the sole purpose of directing fluids or gases in a single direction and preventing their reversal. One reason that's vital is that while LNG is a comparatively safe fuel, its vapors can pose a hazard if not properly contained.

Check valves are used throughout the process from conversion to storage to transport. All of these can be costly and inefficient if the right check valves are not used. Using the right engineered check valves, on the other hand, can help to ensure equipment is protected, productivity is maximized and operational safety is ensured.

Executive Summary

SUBJECT: Because of their ability to stop reverse flow, check valves are vital in cryogenic services such as LNG.

KEY ISSUES:

- Why check valves are important
- How they prevent backflow
- Sizing, selecting and modeling

TAKE-AWAY: Dual-plate and nozzle-style valves work well in this field.

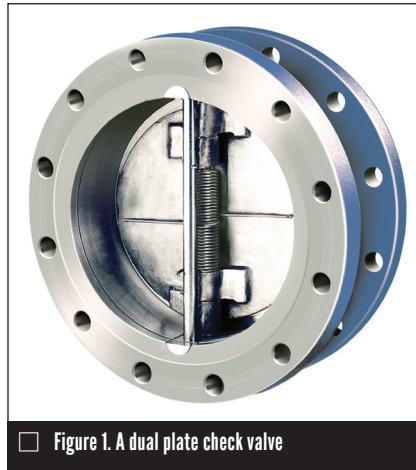
Backflow prevention is needed in almost every piping system. Most of these pipelines use pumps or compressors to generate the required pressure for movement of fluids or gases. When this equipment stops, flow reversal or backflow can occur (depending on downstream pressures). One of the most significant elements of the cryogenic production system design is integrating a means to prevent this backflow.

Not only does this minimize damage equipment, it also ensures plant infrastructure is protected and emission leakage is kept to a minimum. For these reasons, engineered check valves are paramount across the value chain of LNG whether that's in the gas field, liquefaction plant, storage tank, tanker or gasification terminal. These valves not only offer solutions for mitigating the destructive effects of flow reversal, they also provide reliability in the severe conditions presented in cryogenic applications.

HOW THEY WORK

Check valves are totally different from shut-off and control valves. While those valves can stop flow completely, check valves allow the flow of fluid in a single direction. They are intended primarily to protect pumps, compressors, piping systems and other critical components from dangerous conditions such as system deceleration and water hammer. Additionally, unlike on/off valves, check valves are flow sensitive. They rely on the line fluid to open and close them, which means they are one of the few self-automated valves.

As a result of constant exposure to fluid mediums, check valves are highly susceptible to wear, sticking, jamming and wedging. Traditional check valve solutions also can suffer from heavy slamming caused by turbulence, which in turn can compromise the ability to prevent flow reversal. Traditional solutions such as swing and tilted disc check valves do not close quickly, which can exacerbate the effects of dynamic pressure surges or water hammer. They also have significant pressure loss that results from the flutter or rapid movement of internal metal valve components susceptible

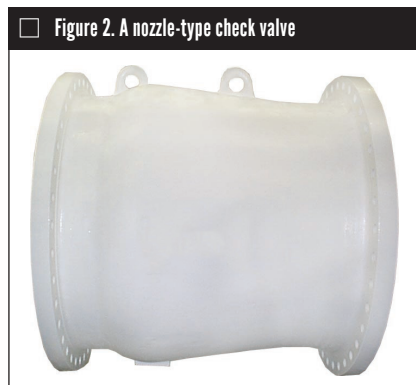


□ Figure 1. A dual plate check valve

to low-flow conditions that can cause wear and premature failure.

To address these challenges, the industry has sought out alternative check valve solutions that incorporate features and benefits that can directly address and counter problems. For example, a highly engineered dual-plate wafer valve design is a stronger, lighter, smaller and more efficient check valve in common use in this field (Figure 1). Using springs to increase the valve reaction and provide more efficient response time (faster closing), this type of dual-plate check valve can better protect equipment already in place in the liquefaction and regasification terminals within an LNG processing plant. The lesser closing time can reduce the dynamic surge effect in the pipeline for an improved non-slam performance as well.

To address the extreme cryogenic demands of the liquification process, certain dual plate check valves have been approved for sub-atmospheric to cryogenic temperatures ranging from -58°F (-50°C) through -321°F (-161°C). These valves are wafer non-slam check valves that can be



□ Figure 2. A nozzle-type check valve

modified and sized for the specific application. Another alternative check valve is the non-slam nozzle-style, which can be specifically designed and sized for fast-reversing systems, again to protect against backflow concerns (Figure 2).

These highly engineered check valves not only minimize the effects of water damage, they also eliminate the chatter associated with conventional valves, protect rotating equipment from flow reversal damage, minimize pressure loss in piping systems and provide fast dynamic response to reduce reverse velocity.

Also, for critical applications such as LNG, the internal geometry of check valves can be modified to suit the service conditions. A benefit of both the dual-plate and nozzle style check valves, for example, is the lack of a leak path to the atmosphere. Without this path, zero fugitive emissions escape for the life of the valve, and adjustments are not required.

Check valves typically have higher allowable leakage rates than isolation valves, but in cases where valuable equipment, pipes and other aspects of the plant's infrastructure need to be protected, a check valve that restricts backflow more efficiently will provide additional value in terms of protection for equipment, pipes and other aspects of the plant's infrastructure.

SIZING AND SELECTIONS

A concept not often understood about check valves is that the most critical time for them is during fluid deceleration. All valves need to close quickly to prevent reverse flow. Check valves are automatic in this process, and therefore susceptible to fluctuations in fluid flow. They require no outside stimulation and rely instead completely on the basic forces inside the valve, as well as external factors such as fluid type, temperature and more to determine when they will close. The actuator for these valve types, then, is the fluid system inside the pipe. The valves close only when the forward flow begins to decelerate below critical velocity. Because of this, varying internal system pressures can cause problems that influence check valve selection and functionality.



□ A valve coming out of a liquid nitrogen tank during LNG testing

To eliminate backflow, ensuring the valves in place are also sized appropriately for the application is critical. Generally, valve sizing is done by selecting a valve that matches the pipe size. However, this process can leave much to chance, which can result in impractical situations as far as investment and valve performance. The flow the valve can provide is just as important as the pipe or line size. In most cases, this flow can be determined by the principles of energy conservation in the flow calculations. For example, a valve that is too small will not pass the required flow rate

and could develop high-pressure loss. A valve that is too large will be expensive and create instability in the system. A valve that is too large also can wear out prematurely, ultimately leading to valve failure.

Knowledge of the process conditions for a particular application is also vital in determining proper valve size. Users must understand the process to select valves that can withstand those conditions. They include factors such as energy loss, pressure loss from friction and turbulence, flow coefficient and the Cv provided by the valve manufacturer. How a valve performs and holds up under these conditions and what is the listed service life, are key factors that must be considered before selecting a check valve for cryogenic applications. The total process system and its design must be part of the decision. Understanding what is needed, for how long, and under what conditions is paramount for safe and trouble-free performance.

In short, valve sizing and selection should consider valve material compatibility with the fluid medium, the

valve rating (ASME pressure class), application flow, design and operating conditions, the installation requirements of a particular facility, line size, end connections, system modifications and proper leakage regulations.

MODELING

Most valves are not geometric models of each other. Because of this, to predict the performance of various valve sizes requires a thorough and comprehensive modeling program. Manufacturers should test various sizes of valves and then apply the modeling criteria to accurately predict the performance of other sizes.

The direct method to determine valve performance is a laboratory test. However, that might not be practical when the valve is too large, a multiplicity of variables might cause the test to take too long or the facilities are not available to do the right type of testing.

For example, wind tunnels have been used to predict performance using fixed and small objects. However, valves that have moving internal

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components could complicate such a modeling process. Predicting performance of large valves such as 48 or 72 inches is not practical unless a geometric model can be tested.

Valve characteristics in the modeling process may include resistance to flow, flow areas, component thickness and inertia, spring forces and loop flow.

STANDARDS

Many world organizations such as the International Organization for Standardization (ISO), British Standards (BS), the Manufacturers Standardization Society (MSS) and individual end users such as Shell, have published standards for the cryogenic industry as well as for LNG applications. These standards govern the performance of valves, and some have existed for many years.

The specifications that require special testing of valves for particular applications will vary in methods and in acceptable valve seat leak rates. Many of these standards specify leak rates for check valves that are close to isolation valve rates. However, with the cur-

Table 1

Valve type	Cryogenic Leak Rate	BS 6364 - 1985	ISO 28921-2013	MSS SP-134	Shell TAT SPE MESC 77
Metal-seated Valve	mm ³ /sec./DN	100	50	134	-
	cc/min./NPS	150	75	200	-
Metal-seated Check Valve	mm ³ /sec./DN	200	250	267	900
	cc/min./NPS	300	375	400	1350

rently available sealing solutions, the manufacturers of cryogenic valves can struggle to meet the global seat leakage performance specified. Some of the standards are shown in Table 1.

Some standards recognize the big difference between metal-seated valves for isolation and metal-seated check valves for flow reversal control and allow a higher seat leak rate on metal-seated check valves. This type of leakage approach would make the valves less costly and still provide important back flow prevention.

CONCLUSION

Check valves play an important role in the protection of the expensive and critical equipment in liquefaction

and regasification facilities. Their sole purpose of preventing the damaging effects reverse flow can have on equipment and on the safety of plant personnel make check valves a critical addition to any operation.

As cryogenic applications and the LNG industry continue to grow, so, too, will the prevalence of check valves. It is important to ensure that highly engineered solutions are in place. Dual-plate and nozzle-style valves offer some benefits over more traditional check valves so they have emerged as essential components within the value chain. **VM**

CARLOS E. DAVILA, P.E., is product manager—Engineered Check Valves for Crane ChemPharma & Energy. Reach him at CDavila@CraneCPE.com.



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Process Instrumentation in Oil and Gas

BY CHIKEZIE NWAOHA

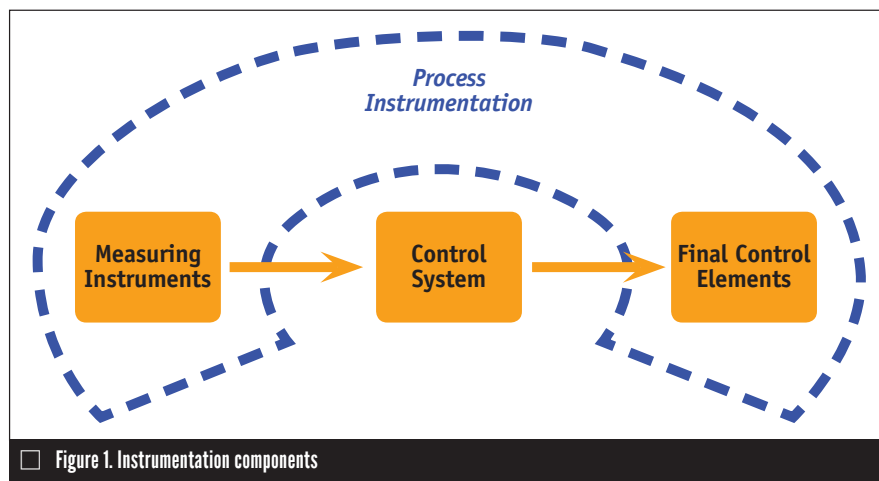
Process instrumentation is an integral part of any process industry because it allows real time measurement and control of process variables such as levels, flow, pressure, temperature, pH and humidity. With the right instrumentation, process plants can run effectively, efficiently, economically and safely through the integration of alarm signals.

Mohamed Salaheldin, currently quality and energy efficiency improvement manager, Sidi Kerir Petrochemicals Company (Sidpec) in Egypt, is a good source for gaining an understanding of best practices, maintenance and future prospects of process instrumentation from an industrial standpoint. The answers here are his. Salaheldin has more than 18 years of experience in instrumentation and control, engineering management, quality engineering and energy efficiency. His current responsibilities include implementation of corrective and preventive actions for critical problems and energy management system implementation according to the requirements of ISO 50001.

Q: What is process instrumentation, and why is it necessary?

A: In oil and gas industries, instrumentation is used to monitor and control the operating conditions of the facility, which helps to meet safety, environmental regulations, quality and productivity, profitable operation and stable plant operation objectives. It can be categorized under two main functions: 1) Input devices, which are measuring instruments that mainly look at the different process variables. 2) Output devices of the control system, which are called the final control elements. These act relative to the measured parameters to institute the required control action.

The input devices (instrumentation) measure four important operating parameters: pressure, temperature, flow and level. Advanced,



□ Figure 1. Instrumentation components

online analyzers that measure process composition are also considered an element of process instrumentation.

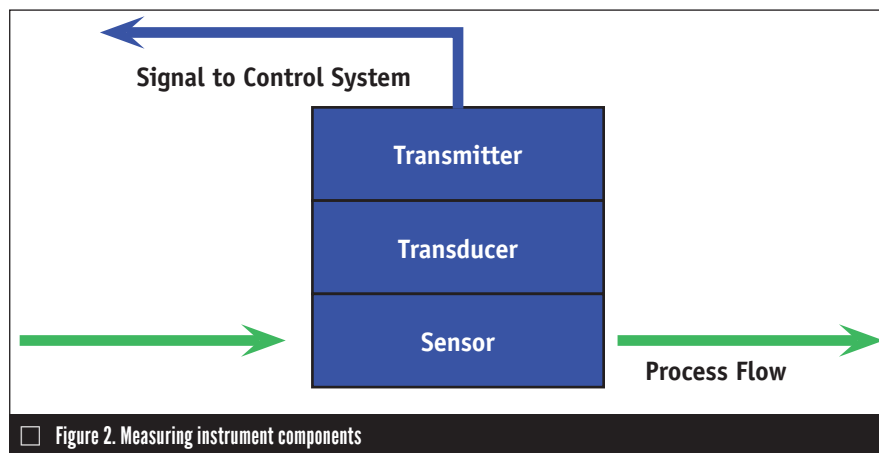
The instrumentation consists of three main components:

1. A sensor, which is sometimes called a primary measuring element, to measure required physical properties
2. A transducer, which converts the sensor signal into a standard signal form that suits the control system such as a pneumatic signal (3-15 psi), an electric signal (4-20 mA), a digital signal of Foundation Fieldbus, etc.
3. A transmitter, which prepares the transducer signal for transmission without loss and then transmits it. Smart transmitters also send meaningful data about

the status of the measuring instrument as a whole.

Process instrumentation includes the most common control element, the control valve, which consists of an actuator that converts the output signal from the control system into a signal that can allow the valve to respond, the positioner for adapting the response and the valve. Smart positioners can currently send and receive useful data to and from the control system for predictive maintenance purposes.

Q: What are key considerations an end user should make to ensure success when dealing with existing instruments and selecting process instrumentation technology?



□ Figure 2. Measuring instrument components

A: It's important to know the integrity of each of the existing instruments in a facility and the source of any malfunctions. This also allows determination of when an instrument needs repair or replacement and ensures the right preventive maintenance plan and predictive maintenance actions.

Selection criteria should be set according to the needs of the end user and must include at least the following parameters:

- **Performance characteristics:** This includes all the specifications regarding the required performance of instrumentation in a certain process such as accuracy, resolution, rangeability, sensitivity, repeatability, dynamic performance, etc.
- **Environmental conditions:** This is essential for specifying the necessary protection to ensure that instrumentation is working properly with regard to safety requirements and operational conditions.
- **Influences on processes:** The extent to which the processes will be disturbed during the measuring process should be included. For example, significant pressure loss can be caused by some flow measurement techniques.
- **Durability:** Durability and ruggedness of process instrumentation should be considered according to application requirements.
- **Maintainability and operability:** Maintenance requirements

and ease of use, as well as operation and effect on the running costs of instrumentation need to be weighed.

- **Purchase cost:** Initial cost should be considered according to the needs and situation of end-user requirements.

Q: What high-level best practices do you typically recommend for an end user to approach the process instrumentation design process?

A: Manufacturers always do their best to have good working relationships with end users, but often end users do not have qualified technicians and experienced engineers who can provide quality input to that manufacturer. Because of this, it is vital for end-user personnel to stay up to date on the latest developments by following the appropriate technical journals, contributing to surveys conducted by technical entities, becoming members of technical non-profit organizations that work in subjects related to process instrumentation and more.

Q: What are some common pitfalls you see end users encounter in the specification, design and/or application of process instrumentation and what can they do to avoid them?

A: Issues arise when engineers who may not have adequate training and background in a process write the specifications or follow the recommendations of sales representatives without the qualification to review the details. Another issue is equipment purchased strictly on lowest-priced bids.



Figure 4. Larger size capabilities of Coriolis flow meters allow greater applicability.

To avoid such pitfalls, an end user should weigh price against application requirements so that reputable vendors, usually with the higher-priced products, are not excluded. Instrumentation engineers need to be recruited properly and trained continually to follow the highest standards to keep them familiar with state-of-the-art technologies. Engineers also should not hesitate to ask for help from other departments within the facility. For example, when specifying a new control valve, instrumentation engineers commonly do not have the essential experience in material selection so they should ask for guidance from mechanical engineers.

Q: What are recent technology developments in process instrumentation?

A: Recent developments include modifications and adaptations to suit a wider range of applications with new levels of accuracy, reliability, integrity and better price.

For example, due to the criticality of flow measurements, manufacturers continually develop new features for hard and severe applications. One type of flowmeter used in a wide range of industry sectors is the Coriolis mass-flowmeter. Multiple process variables such as mass flow, density and temperature are simultaneously measured, leading to accurate information about other process parameters such as volume flow, concentration, etc.

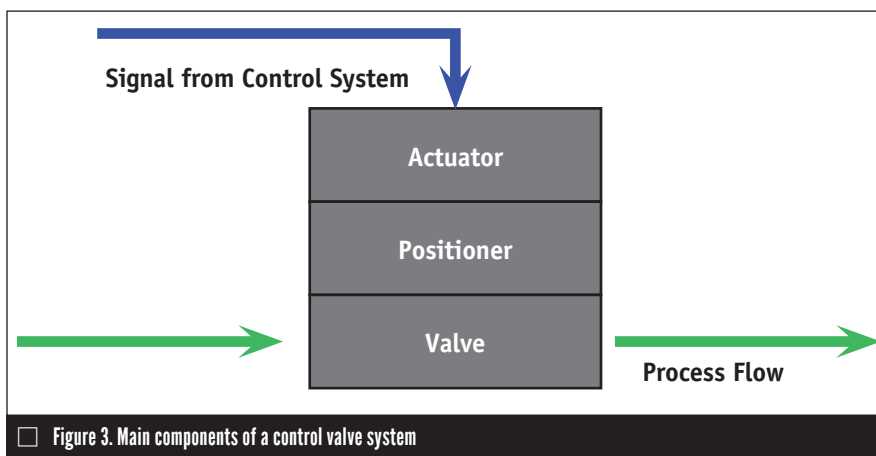


Figure 3. Main components of a control valve system

Coriolis flowmeters can be as large as 12 inches.

Clamp-on ultrasonic flowmeters with transducers attached to the outside of a pipe are considered effective as portable flowmeters. Although this type was found many years ago, recent technology improvements make them more accurate and reliable.

New technologies in control valves for severe applications result in greater reliability and operability. However, the most effective new technology is smart positioners, which supply new features about self-diagnostic and analysis capability.

The challenge is to get the most benefits from data by applying analysis techniques using special software tools to support decision-making regarding optimized cost, waste reduction and enhanced productivity.

Q: How does industry intend to expose applications that don't meet expectations?

A: In process instrumentation, like other fields of industry, there are both

The data supplied by new digital process instrumentation should be treated as valued information to be used in quality and productivity improvement within a facility.

products that don't meet expectations and those that do. Generally speaking, though, having the wrong application is not due to the wrong product; it is more often a mismatch between the actual needs and the process system ultimately ordered and installed.

An example might be a new control-valve technology for severe applications where there is high probability of flashing and/or cavitation. The end user may decide to use this new technology to deal with a certain application in the facility. However, misunderstanding the actual application itself could result in poorer performance because the new technology might reduce flashing but create another problem within the system.

Another example is when an end user installs new process instrumentation compatible with a new control

system and buys all the required software to get the best benefits of the new features. However, after the initial start-up, nobody in the plant can use the overwhelming data to work towards quality and productivity improvements.

Q: What are your thoughts on the future of process instrumentation?

A: End users should pay attention to the integration between the business layer and the operational layer of their process plants. Process instrumentation is the backbone of these systems and should be properly selected, especially with regards to reliability. The data supplied by new digital process instrumentation should be treated as valued information to be used in quality and productivity improvement within a facility. I believe wireless instrumentation will have an unbelievable role in the market in the next few years. **WM**

CHIKEZIE NWAOHA is research engineer at the Clean Energy Technologies Research Institute, and a faculty member in Engineering and Applied Science, University of Regina, Canada. Reach him at chikezienwaoha@LIVE.CO.UK.

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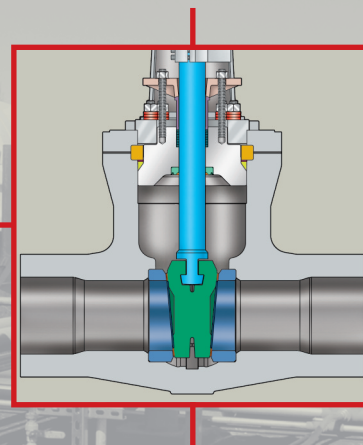
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Q: I HAVE CUSTOMERS THAT ASK FOR THEIR STAINLESS-STEEL VALVES TO BE PICKLED AND I HAVE OTHERS WHO ASK FOR THEM TO BE PASSIVATED. SOME CUSTOMERS ASK FOR BOTH TREATMENTS TO BE PERFORMED. WHY DO CUSTOMERS WANT THESE TREATMENTS? WHAT ARE THE DIFFERENCES BETWEEN THE TWO? IS IT ADVANTAGEOUS TO PERFORM BOTH TREATMENTS ON THE SAME PART?

A: Stainless steels readily create a protective passive surface film when exposed to oxygen-containing environments (such as air or moisture). Chromium in the steel reacts with oxygen in the environment to form a chromium oxide protective layer that is chemically inactive. Surface impurities (such as dirt, grease, free iron, oxide scale, etc.) from part manufacturing processes can interfere with the formation of this protective oxide film.

Pickling and passivating are both chemical cleaning methods used to remove impurities from the surface of stainless-steel parts and allow oxygen to interact with the stainless-steel surface more uniformly. The degree of cleanliness required on a surface depends on the application. Some applications such as food-handling, pharmaceutical or high-purity water require surfaces with very high levels of cleanliness to ensure their process streams are not contaminated with impurities that might be present from the part manufacturing process.

ASTM [ASTM International] A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts, defines passivation as the chemical treatment of a stainless steel with a mild oxidant (such as a nitric acid solution) for the purpose of removing free iron or other foreign matter—but which is generally not effective in removal of heat tint or oxide scale. The amount of material that this process removes from the part surface is in micro-inches, so it is normally done on a part in its final machined geometry. Nitric acid and citric acid-based solutions are the most commonly used chemicals for passivation. Many vendors add their own blend of proprietary chemicals and additives to enhance the effectiveness of these acid-based solutions.

Pickling, often referred to as chemical descaling, is a more aggressive

Pickling and passivating are both chemical cleaning methods used to remove impurities from the surface of stainless-steel parts and allow oxygen to interact with the stainless-steel surface more uniformly.

chemical treatment than passivation. This treatment is most often done on parts that are not in their final machined geometry. The process can remove heat tint and other heavy, tightly adhering oxide scales that form during high-temperature operations such as heat treatment or welding. A nitric-hydrofluoric acid blend is the most widely used acid pickling solution. Acid concentration, solution temperature and contact time need to be carefully controlled during this process to ensure parts are

not over-pickled. Over-pickling can result in damage to the stainless steel that would result in loss of corrosion resistance. Thorough rinsing is also important to ensure all residual chemicals are removed from the surface.


According to ASTM A967, after a surface has been pickled, a separate passivation chemical treatment is not necessary to create the protective oxide layer. However, some customers do ask for both to ensure all impurities are removed from the part surface. Post-cleaning operations, such as placing parts in a bath of sodium dichromate, can help to accelerate the formation of the protective passive film on clean stainless-steel surfaces. ❧

CHERRA MELOY is senior materials engineer, Advanced Technology Group, Emerson Process Management, Fisher. Reach her at Cherra.Meloy@emerson.com.

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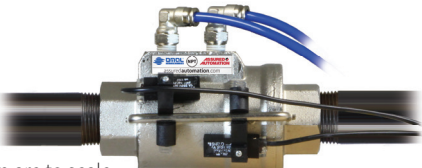
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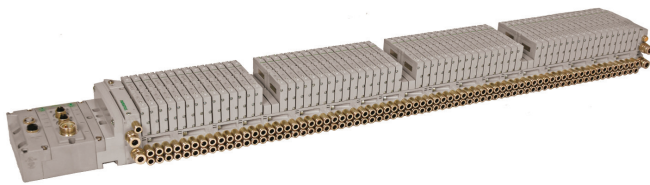
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Spirax Sarco

released the Steam Jet Thermocompressors, an energy-saving device that compresses low-pressure steam to a higher acceptable pressure that can be used by additional applications. This unit consists of three fundamental components: motive steam nozzle, suction body and a diffuser. A wide range of materials are available to suit process requirements including stainless steel, carbon steel, titanium, chrome and molybdenum.

The products have no moving or rotating parts. Minimal maintenance is required so units can be installed in remote or inaccessible locations.



ASCO announced its Numatics G3 Series and Numatics 580 Series electronic platforms have been expanded to control up to 128 solenoid valves on a single valve manifold assembly.

The expanded platforms feature flexible process control architecture that permits the design engineer or end-user specifier to optimize the size of the control cabinet for the number of required valves.

The products are the only ones available that can support 80 18 mm and larger valve sizes on a single manifold.

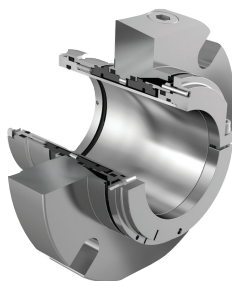


Emerson has launched DeltaV Mobile, a new platform that leverages Industrial Internet of Things (IoT) technologies to empower manufacturing engineers with complete access to real-time data, trends and insight securely

from anywhere in the world.

Part of Emerson's Plantweb digital ecosystem, the new platform fuses smartphone technology with process control data to make operational intelligence available 24/7 for customers.

A.W. Chesterton Company introduced its latest mechanical seal innovation—the Chesterton 250L Cartridge Double Seal with features that significantly simplify mechanical seal installation. The new product uses the company's double seal designs with the addition of a clamp



lock ring that allows single screw tightening. The seal also has internal centering clips that do not require removal.

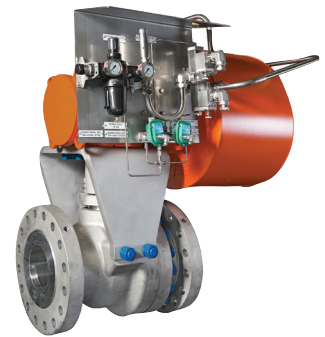
The 250L cartridge double seal is designed to fit ANSI pumps used in lower-duty chemical processes such as ethanol grain processing.

Rotork designed its CK range of modular electric valve actuators to meet diverse actuation applications in the power and water industry. The modular CK design provides flexibility and configurability, enabling quick selection from stock.




The modular construction presents a wide range of options and features ranging from a standard CK actuator requiring separate motor controls to sophisticated Centronik versions equipped with an integral state-of-the-art intelligent digital control unit. All CK versions can provide mechanical valve position indication.

Velan introduced the new Securaseal R-series cast metal-seated ball valves. The new R-series cast product line leverages the company's extensive severe service technology and places it in an optimized package suitable for most processes with fluid slurries and high temperatures.



The R-series cast is designed to meet process industry standards, including API 608, and stringent customer specifications. The new cast product line is available in all sizes and standard trims up to ASME Class 600 and is also offered on an engineered-to-order basis up to ASME Class 2500 and sizes up to 36 inches (DN 900).

Crane ChemPharma & Energy's new

Krombach KFO 9136 is an extreme temperature and wear-resistant metal-seated ball valve for use in coal gasification, refining and power applications. Featuring a uni-directional single seat, the valve permits tight shut-off, ensuring cavity-free performance. Its optimized energizing seat with low-friction-bearing design enables a permanent seat/ball contact under recurrent thermal cycling and offers a lower cost of ownership through the reduction in operating torque by over 20%. 





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Questions? Contact VMA President Bill Sandler at wsandler@vma.org or call 202.331.8105 ext. 306.



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WHERE VALVES ARE USED CONTINUED FROM PAGE 29

very low-temperature nature of the process means that many cryogenic valves are required.

Both LNG and gas separation plants have low-temperature valves that must remain operable in these cryogenic conditions. This means that the valve packing system must be elevated away from the low-temperature fluid through the use of a gas or condensing column. This gas column prevents the fluid from forming an ice ball around the packing area, which would prevent the valve stem from turning or rising.

COMMERCIAL BUILDINGS

Commercial buildings surround us but unless we pay close attention as they are built, we have little clue as to the multitude of fluid arteries hidden within their walls of masonry, glass and metal.

A common denominator in virtually every building is water. All these structures contain a variety of piping systems carrying many combinations of the hydrogen/oxygen compound in the form of potable fluids, wastewater, hot water, grey water and fire protection.

From a building survival standpoint, fire systems are most critical. Fire protection in buildings is almost universally fed and filled with clean water. For fire water systems to be effective, they must be reliable, have sufficient pressure and be conveniently located throughout the structure. These systems are designed to automatically energize in the case of fire.

High-rise buildings require the same water pressure service on the top floors as the bottom floors so high-pressure pumps and piping must be used to get the water upward. The piping systems are usually Class 300 or 600, depending upon building height. All types of valves are used in these applications; however, the valve designs must be approved by Underwriters Laboratories or Factory Mutual for fire main service.

The same classes and types of valves used for fire service valves are used for potable water distribution, although the approval process is not as strict.

Commercial air conditioning systems found in large business structures such as office buildings, hotels and hospitals are usually centralized. They have a large chiller unit or boiler to cool or

heat fluid used for transferring cold or high temperature. These systems often must handle refrigerants such as R-134a, a hydro-fluorocarbon, or in the case of major heating systems, steam. Because of the compact size of butterfly and ball valves, these types have become popular in HVAC chiller systems.

On the steam side, some quarter-turn valves have made inroads in use, yet many plumbing engineers still rely on linear gate and globe valves, particularly if the piping requires butt-weld ends. For these moderate steam applications, steel has taken the place of cast iron because of steel's weldability.

Some heating systems use hot water instead of steam as a transfer fluid. These systems are served well by bronze or iron valves. Quarter-turn resilient-seated ball and butterfly valves are very popular, although some linear designs are still used.

CONCLUSION

Although evidence of the valve applications mentioned in this article may not be viewable during a trip to Starbucks or to grandma's house, some very important valves are always nearby. There are even valves in the engine of the car used to get to those places such as those in the carburetor that control the flow of fuel into the engine and those in the engine that control the flow of gasoline into the pistons and out again. And if those valves aren't close enough to our everyday lives, consider the reality that our hearts beat regularly through four vital flow control devices.

This is just another example of the reality that: valves are truly everywhere. **VM**

Part II of this article covers additional industries where valves are used. Go to www.valvemagazine.com to read about pulp & paper, marine applications, dams and hydroelectric power, solar, iron and steel, aerospace, geothermal, and craft brewing and distilling.

GREG JOHNSON is president of United Valve (www.unitedvalve.com) in Houston. He is a contributing editor to VALVE Magazine, past chairman of the Valve Repair Council and a current VRC board member. He also serves on VMA's Education & Training Committee, is vice chairman of VMA's Communications Committee and is past president of the Manufacturers Standardization Society. Reach him at greg1950@unitedvalve.com.

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United valve has just put into operation the largest vertical boring mill installed in a valve service company in the United States. The massive 351,000 lb. machine stands nearly 40 ft. tall and can machine parts up to 19' tall and 20' in diameter. Combined with our 40-ton overhead crane capacity and 37-foot under-hook height, parts up to 80,000 lbs. are easy to manipulate and machine. The tremendous swing allows us to machine many very large valves without disassembly as well. Due to the huge mass of the mill, extremely fine, chatter-free finishes are easy to accomplish and extremely hard materials are easily cut.

The machine has already proved its worth in large valve repair work. A recent project involved refurbishing 48" Class 300 alloy gate valve bodies lined with 310ss. The seating surfaces of extremely hard Tribaloy T-800 (55-60 HRC) were also machined and polished on the big mill.

Machine time is available for large components, very large valves or vehicles needing a moon roof. Please contact United Valve for more information.

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