MARCH 2017
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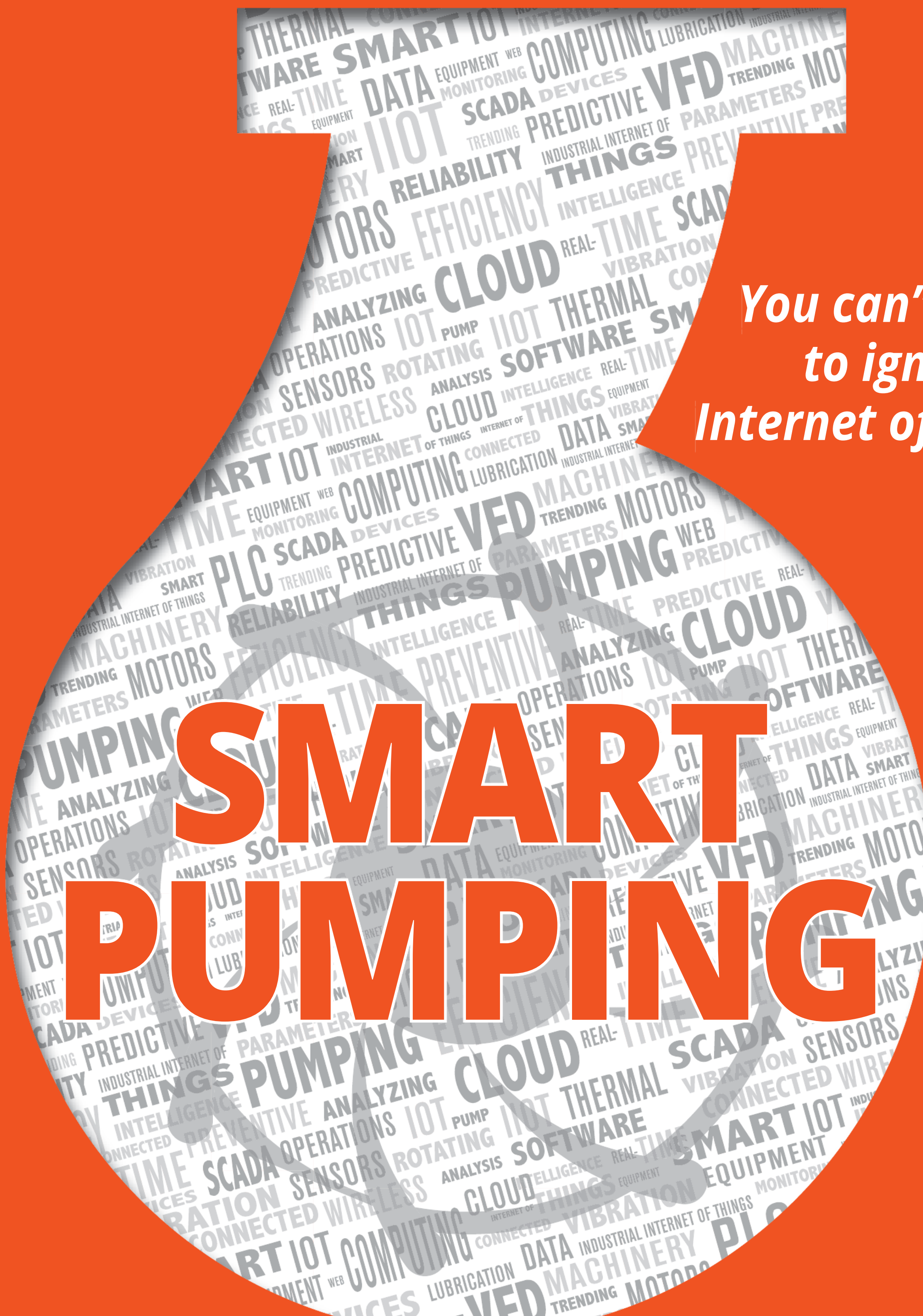
PUMPS & SYSTEMS

The Leading Magazine for Pump Users Worldwide



SMART PUMPING

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HYDRAULIC INSTITUTE'S 100TH ANNIVERSARY | 7 STEPS TO GROUTING A PUMP BASE | A BEGINNERS' GUIDE TO FLOW METERS

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This month's issue of *Pumps & Systems* takes a look at the pump industry's history and future. Within these pages, we commemorate the Hydraulic Institute's centennial and explore the evolution of technology that is shaping the way pump equipment operates.

J.R. Vidmar awards J.B. Freed the presidents plaque for Hydraulic Institute service in 1976.

The Hydraulic Institute (HI) will celebrate its centennial at the 2017 Annual Conference at the JW Marriott Grande Lakes in Orlando, Florida, March 8-13. This event will recognize the organization's history and the outstanding achievements of its representatives, while serving as a critical gathering to discuss trends and issues in this industry.

The importance of this organization in our industry is tremendous. As Hydro Inc. President and CEO George Harris told *Pumps & Systems*, "HI provides a forum for a wide range of topics from world and industry economic outlooks to highly technical industry pump standards. ... To all past and present members, I thank you for your contributions throughout the years which have enabled HI to become more influential and relevant today than ever before on the important issues facing our industry."

The Hydraulic Institute's centennial is the focus of our Special Section that starts on page 20 and showcases an excerpt from a commemorative coffee-table book recognizing this important achievement in HI's history. *Pumps & Systems* partnered with HI to create the book, available this month. Send an email to pumpeditors@cahabamedia.com to find out how to order a copy of the book and visit pumps.org to learn more about centennial events this year.

This issue's Cover Series delves into how smart pumping and the Internet of Things (IoT) continur to impact our industry and the way we look at industrial processes. Todd Loudin of Flowrox explains how IoT monitoring is critical for process performance starting on page 24. Other articles explore technological advancements for water utilities (page 27), the Industrial Internet of Things (page 32), optimizing pump systems (page 38) and overcoming barriers to IoT adoption (page 40).

Thank you for reading *Pumps & Systems*. We always look forward to hearing from our readers. Please feel free to contact me with any questions or suggestions.

Sincerely,

Managing Editor Martin J. Reed
mreed@cahabamedia.com

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This issue

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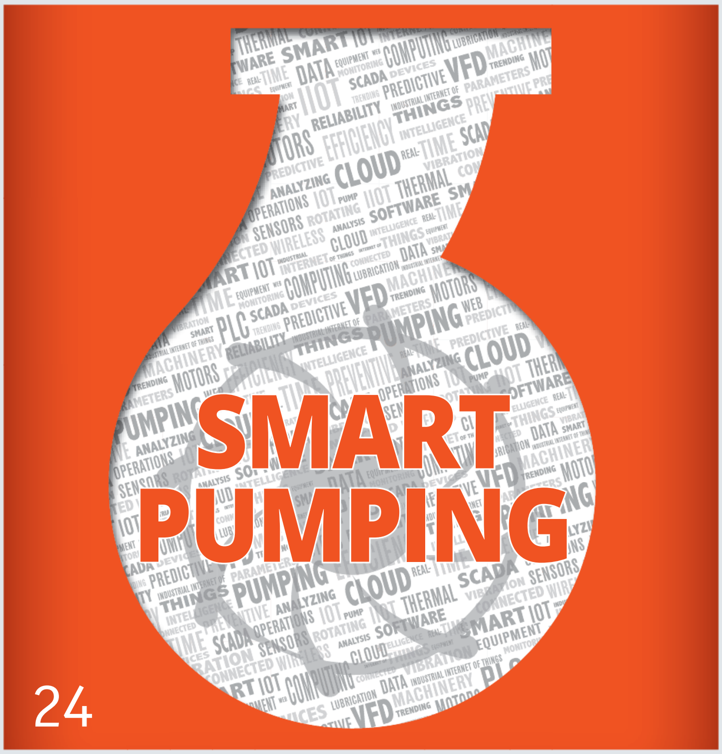
Volume 25 • Number 3

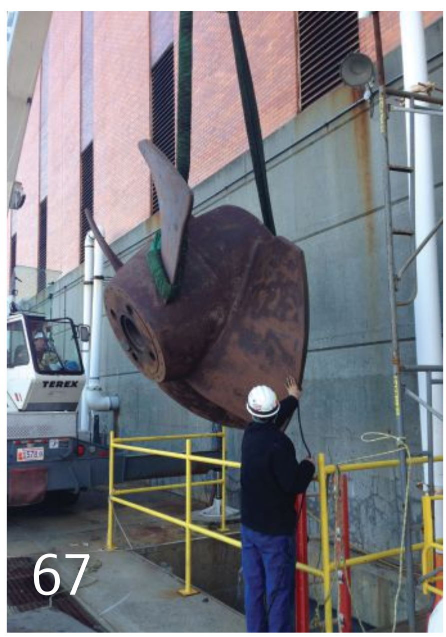
COVER SERIES SMART PUMPING



COLUMNS

PUMPS & SYSTEMS SPECIAL SECTION — HYDRAULIC INSTITUTE 100TH ANNIVERSARY

PRACTICE & OPERATIONS



DEPARTMENTS

HYUNDAI CROWN TRITON™ MOTORS

THREE CRITICAL FACTORS THAT MAKE THIS THE BEST MOTOR IN THE MARKET ...

1 CONSERVATIVE DESIGN PHILOSOPHY

Hyundai has very **conservative** engineering and **design philosophies**, they do not accept the 'Nominal Approach' of making motors. Every motor, not just the average of a group of motors, must meet or exceed the target requirements such as temperature rise, efficiency, noise and vibration.

The Nominal Approach: NEMA or other specifications may require that a motor have a max temperature rise of 80°C at the rated load. The Nominal Approach allows that the average of the entire lot not exceed 80°C, meaning that some motors may exceed the requirement. All that matters is that the average of all motors does not exceed the required value.

Summary - The Hyundai Approach: Hyundai requires that every single motor produced does not exceed 80°C so they set their internal target at 7-8% less. This assures that **every motor** produced meets the requirement. Hyundai uses this same philosophy for many other critical attributes such as efficiency, noise level, vibration, full load speed, locked rotor and breakdown torques.

2 LOW OPERATING TEMPERATURES COUPLED WITH A PREMIER INSULATION SYSTEM

Heat is the largest factor leading to premature insulation failure - the larger the buffer between the actual motor temperature and the temperature rating of the insulation system is, the longer the insulation life will be.

Hyundai's approach for a reliable insulation system is to use **Class N varnish**, which is **rated for 200°C** and limits the temperature rise to ~74°C. This results in a larger buffer between the actual temperature and what the insulation system can handle without breaking down. With a 40°C ambient and a motor running at the nameplate load this buffer for an HHI motor is a whopping 86°C (200-74-40 = 86). Compare this to a typical motor with an 80°C rise and Class F insulation, the buffer is only 35°C (155-80-40=35). Remember the old adage, for every 10°C cooler electrical products run, the life expectancy of the insulation system doubles. An 86°C buffer is a big deal if you want a motor that will last a long time.

Summary - Hyundai motors run cooler and provide a larger buffer of protection for the insulation system which results in long life. An additional benefit of this design allows you to apply a stock motor in higher ambient conditions and still provide a good buffer.

3 LOW VIBRATION

Vibration leads to premature bearing failure and can damage the coupled equipment.

Hyundai's approach to a low vibration motor ... Shoot for less than half of the NEMA requirement, don't cut cost with lighter weight end bells, machine all motors with a precise foot flatness and use only the best bearings.

NEMA requires a finished motor to have a vibration level that does not exceed **.15 inch/second peak**. **Hyundai's conservative approach** sets the target at **~.07 inch/second peak**. All motors are precision balanced, feet are machined to a flatness of ~0.005", end bells are heavily ribbed and only premium bearings such as NSK, SKF or FAG are used.

Summary - heavy cast iron frames, precision balance rotors and precise foot flatness leads to lower vibration and thus longer bearing life and less damage to other equipment.

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NEW HIRES, PROMOTIONS & RECOGNITIONS

RODNEY VAN, **ASAHI/AMERICA INC.**

Rodney Van

LAWRENCE, Mass. – Asahi/America Inc. announced the promotion of Rodney Van to industrial business development manager for the eastern and central regions effective Jan. 1. Van will lead Asahi/America's sales efforts of industrial single-wall and double-wall piping systems for chemical service. Van has been with Asahi/America for 27 years in various roles, most recently as district sales manager in Tennessee, North Carolina, South Carolina and Virginia. A statement from the company said he has a deep technical knowledge of Asahi/America products and has successfully managed large piping installations in his previous sales territory. Van is based out of North Carolina and can be reached via email at rvan@asahi-america.com or by phone at 617-686-0976. ■ *asahi-america.com*

DENNIS SADLOWSKI, **CECO ENVIRONMENTAL CORP.**

CINCINNATI, Ohio – CECO Environmental Corp. announced that Jeffrey Lang, the company's chief executive officer, president and a director, has decided to step down as CEO, president and a member of the Board of Directors as of Feb. 1, 2017. The board has appointed Dennis Sadlowski, currently a member of the board, to serve as interim CEO while a search process is conducted to identify a permanent CEO, the company said in a statement. Lang has agreed to be available to the company through a transition process. Sadlowski, 55, previously held a number of senior leadership roles including CEO of Siemens Energy and Automation, COO of LSG Sky Chefs and CEO of International Battery. Sadlowski also previously worked at General Electric and Thomas & Betts. Sadlowski continues to serve on the board of directors and audit committee of Trojan Battery, a privately held global leader in deep cycle lead-acid batteries. He earned a bachelor's degree in chemical and nuclear engineering from the University of California at Berkeley, and his master's degree in business administration from Seattle University. ■ *cecoenviro.com*

JONATHAN SAMUEL, **GIW INDUSTRIES INC.**

Jonathan Samuel

GROVETOWN, Ga. – GIW Industries Inc. has named Jonathan Samuel as vice president of sales and marketing, according to a statement from the company. With more than 22 years of hands-on expertise in the pumping industry, Samuel brings a wealth of experience and knowledge to the position, the company said. He earned his bachelor's degree in mechanical engineering in India before beginning his first career opportunity as a sales and application engineer with Nerelge Corporation in India in 1991. In January 1994, he joined KSB Pumps Ltd. in India as a sales engineer, which led to his first position with GIW as an application and project manager in 1999. Samuel then held various roles with larger scopes of responsibility, including Region Manager, Asia, Brazil and Australia; Commercial Manager - Project Management; Region Manager, Europe, Asia and Global Dredge; and, most recently, Region Manager, Global Dredge, Europe, Asia, Australia and Africa. ■ *ksb.com*

RALPH ROSA, **LENZE AMERICAS**

Ralph Rosa

UXBRIDGE, Mass. – Lenze SE announced the appointment of Ralph Rosa as president of Lenze Americas. Rosa has more than 25 years of experience at Eaton Corporation in the controls, automation, power electronics and services businesses. At Eaton, he achieved leadership positions running business units and large sales, marketing and engineering organizations in the U.S. and Switzerland. Most recently, Rosa served as president of Schaffner North America. While under Rosa's leadership, his businesses recognized significant market share growth and improved operational efficiencies. ■ *lenze.com*

DAVID PARADIS, **WEIR GROUP PLC**

David Paradis

GLASGOW, Scotland – The Weir Group PLC appointed David Paradis to its group executive as president of the Weir Flow Control Division, effective Jan. 23, 2017, according to a statement from the company. Paradis succeeds John Heasley, who was appointed Weir Group chief financial officer in October 2016. Paradis was president of Weir Oil & Gas' Pressure Pumping business, which is the world's leading supplier of solutions to the hydraulic fracturing industry, the company said. Before joining Weir, he spent 22 years working in the flow control industry including 14 years with Tyco Flow Control, where his experience included API standards and serving as global director of sales, marketing and strategy of the company's Pressure Management Group. Prior to Tyco, he spent eight years with Keystone International. ■ *global.weir*

LUCA SAVI, **ITT INC.**

Luca Savi

WHITE PLAINS, N.Y. – ITT Inc. announced that Luca Savi has been named chief operating officer. In this new role, he will focus on driving business performance by expanding and strengthening ITT's comprehensive management system and processes, while continuing to grow operational capabilities across the company, according to a statement from ITT. In addition, unrelated to the structural change, Industrial Process President Aris Chicles has announced he is leaving the company. ■ *itt.com*

JAMES C. KERR, **THE GORMAN-RUPP COMPANY**

MANSFIELD, Ohio – The Board of Directors of The Gorman-Rupp Company elected James C. Kerr to the position of chief financial officer effective January 1, 2017, in accordance with the company's succession planning announcement of July 6, 2016, according to a statement from the company. Kerr joined the company in July 2016 as vice president of finance. Previously, he served as executive vice president and chief financial officer of Jo-Ann Stores Inc., a formerly publicly held retail chain of residential consumer products with sales in excess of $2 billion. Kerr was with Jo-Ann Stores Inc. for 17 years. ■ *gormanrupp.com*

AROUND THE INDUSTRY

Sulzer Breaks Ground on Pump Facility in Texas

LA PORTE, Texas – As part of the Sulzer's continued investment program, the company is building a state-of-the-art pump services facility in Pasadena, Texas, to expand its increasing network in North America, according to a statement.

Located adjacent to the existing service center for electro-mechanical services, the service center will be the company's new regional headquarters for pump services in the Americas and will provide increased pump maintenance capacity as well as additional technical support, the statement said.

Construction began with a groundbreaking ceremony on Jan. 13, and the facility is due to open in late fall of 2017. Sulzer said the project's aim is to expand the network of service centers that provide cutting-edge services to customers in order to help minimize lead times for pump services, maintenance, repair and refurbishment. ■ *sulzer.com*

SPX FLOW Opens Manufacturing Plant in Europe

BYDGOSZCZ, Poland – SPX FLOW has expanded production capabilities by opening a new manufacturing campus in Bydgoszcz, Poland.

The facility is fitted with advanced manufacturing equipment and a highly trained workforce to ensure components are made to the highest quality standards with streamlined inventory processes that keep them readily available at competitive prices, the company said. This enables SPX FLOW to offer its customers rapid delivery of precision engineered products that are designed for long life and dependable performance, according to the statement.

The plant manufactures hygienic valves and SPX FLOW's homogenizer machinery with a selection of materials and homogenization valve types to ensure an even dispersion characteristic across a range of applications and processing conditions, including abrasive, sterile and highly viscous fluids.

The new 28,000-square-meter facility represents a multimillion-dollar investment for SPX FLOW and is part of its commitment and strategy to ensure an outstanding customer experience, the company said. ■ *spxflow.com*

MERGERS & ACQUISITIONS

Interpump Group Acquires Inoxpa Group.	**Feb. 3, 2017**
Sulzer Completes Acquisition of Ensival Moret.	**Feb. 1, 2017**
Pentair Acquires Union Engineering.	**Jan. 31, 2017**
Mueller Water Products to Acquire Singer Valve.	**Jan. 30, 2017**
EKKI Group Completes Acquisition of Deccan Pumps Private Limited.	**Jan. 25, 2017**
JWC Environmental Acquiring FRC Systems International.	**Jan. 6, 2017**

AROUND THE INDUSTRY

Weir Group Relocating Delta Industrial Valves Facility

GLASGOW, Scotland – The Weir Group PLC has decided to relocate its Michigan-based Delta Industrial valves manufacturing operations to an existing manufacturing facility in St. Louis, Missouri, according to a statement from the company. The move will commence in June 2017.

The decision to move was necessitated by the substantial expansion plans of Delta Industrial valves over the next two years, the company said. The relocation of the Delta Industrial valves manufacturing facility will enable the development and enhancement of the product line to better serve the industries in which it operates.

The state-of-the-art manufacturing facility in St. Louis has designed and manufactured the Weir Group's Lewis pumps and valves for the sulfuric acid industry for more than 125 years, according to the statement. ■ *global.weir*

Energy Recovery Signs Desal Deal with Düchting Pumpen

SAN LEANDRO, Calif. – Energy Recovery Inc. announced the signing of a master agreement with German-based pump manufacturer Düchting Pumpen.

The agreement will launch a collaborative partnership between the two companies, and will package Energy Recovery's latest Pressure Exchanger technology with Düchting Pumpen's pumping solutions to provide an all-encompassing energy recovery solution for customers in desalination, according to a statement from Energy Recovery.

The partnership's packaged solution will be provided through an Energy Services Agreement (ESA), specifically the Prime Performance ESA, which includes the launch of the next generation of Pressure Exchanger, the PX Prime.

The Prime Performance ESA will work by packaging the desalination industry's energy recovery technology, namely the PX Prime, with installation, service and maintenance for the energy recovery solution, according to the company. The agreement allows customers to use this technology without requiring substantial upfront costs. ■ *energyrecovery.com, duechting.com*

Eaton Launching 'Industrial Controls in Motion' Trailer Tour

CLEVELAND, Ohio – Eaton is debuting its "Industrial Controls in Motion" trailer tour this year that showcases its HVAC/R solutions in a fully functional, real-world environment, according to a statement.

Visitors will be able to walk through the trailer and see Eaton innovations and understand how the company can help customers work smarter, cut costs, and increase energy efficiency and safety, according to the company.

The trailer has more than 200 planned stops in 2017 in the U.S. Visit Eaton.com/ControlTour for more details. ■ *eaton.com*

Dean Pump Enters International Deal with Dorian Drake

CINCINNATI, Ohio – CECO Environmental announced that effective Dec. 21, 2016, its Dean Pump brand has entered into an international distribution agreement with Dorian Drake International Inc.

Under the terms of the agreement, Dorian Drake will be responsible for sales in specific international markets, including all of Europe, Middle East, Africa, Asia and South America, according to a statement from CECO.

CECO said the agreement is the first step in a major initiative for the Dean Pump brand to globalize its business with local sales and support. ■ *cecoenviro.com*

AMETEK Creates Advanced Motion Solutions Division

KENT, Ohio – AMETEK Inc. has consolidated its motors, blowers, fans, pumps and motion control businesses into a new Advanced Motion Solutions (AMS) division that combines its former Floorcare and Specialty Motors and Precision Motion Control divisions.

The new division leverages the resources of four existing AMETEK business units (Dunkermotoren, Dynamic Fluid Solutions, Floorcare and Specialty Motors, and Motion Control Solutions) in a single global business platform.

"The new AMS division allows us to better serve our expanding customer base worldwide and to provide them with a growing range of innovative products and motion control solutions," Matt French, AMETEK Senior Vice President, Advanced Motion Solutions, said. ■ *ametek.com*

To have a news item considered, please send the information to Martin Reed, mreed@cahabamedia.com.

EVENTS

Pump School (Basics Session)
March 7 – 8, 2017
Grainger Marietta Branch #036
Marietta, Georgia
770-310-0866
pumpingmachinery.com/pump_school/course_description/course_description.htm

CONEXPO-CON/AGG 2017
March 7 – 11, 2017
Las Vegas Convention Center
Las Vegas, Nevada
800-867-6060
conexpoconagg.com

Hydraulic Institute 2017 Annual Conference & Centennial Celebration
March 8 – 12, 2017
JW Marriott Orlando Grande Lakes
Orlando, Florida
973-267-9700
pumps.org/conferences/2017_annual_conference.aspx

WQA Convention & Exposition
March 28 – 31, 2017
Orange County Convention Center
Orlando, Florida
630-505-0160
wqa.org/convention

Offshore Technology Conference (OTC)
May 1 – 4, 2017
NRG Park
Houston, Texas
972-952-9494
2017.otcnet.org

NFPA Conference & Expo
June 4 – 7, 2017
Boston Convention and Exhibition Center
Boston, Massachusetts
800-344-3555
nfpa.org/training-and-events/by-type/conferences/conference

2017 AWWA Annual Conference & Exhibition
June 11 – 14, 2017
Philadelphia, Pennsylvania
303-794-7711
awwa.org

Preview: WQA Convention & Exposition

March 28-31, 2017
Orange County Convention Center
Orlando, Fla.

Exhibition Hours

Wednesday, March 29
10:30 a.m. - 5 p.m.

Thursday, March 30
10 a.m. - 5 p.m.

Organized by the Water Quality Association, the WQA Convention & Exposition targets professionals in the drinking water treatment industry by presenting an array of technologies, education, training and networking.

The gathering at the Orange County Convention Center in Orlando, Florida, is open to anyone, but WQA members are eligible for discounted registration fees. The event attracts an international crowd that represented 58 countries at the 2015 convention, according to organizers.

Industry representatives are encouraged to attend to learn solutions and cost-effective strategies from experts, while discovering new technologies, products and distributors. Additionally, the event provides a networking opportunity to connect with colleagues and discuss common issues.

The WQA Convention & Exposition offers numerous educational sessions on each day of the event. Topics include Legionella issues, ultraviolet systems, water additives on ion exchange resin, Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) compliance, and more. In addition to dozens of exhibitors, the event features the New Product Showcase that focuses on technologies and services that have been introduced within the past year.

For details about the registration, the full schedule of events and a list of exhibitors, visit the show's website at wqa.org/convention. ■

Troubleshooting & repair challenges

By **Lev Nelik, Ph.D., P.E.**
Pumping Machinery LLC, *P&S* Editorial Advisory Board

Troubleshooting Mechanical Seals in Vertically Mounted Pumps

Editor's Note: *Lawrence Leising, maintenance supervisor for the Town of Amherst, New York, Engineering Department's Wastewater Treatment Division, contributed to this column.*

Mechanical seals operating under the correct conditions can provide years of trouble-free service. Most mechanical seals are designed to be surrounded by liquid to provide cooling and to avoid running dry. In pumps used for liquids, it is a common requirement that they must not run dry.

It is often assumed that if the pump is pumping liquid, then the seal must be surrounded by liquid. In a horizontal pump, this is almost always the case. In a vertical shaft pump, it should not be taken for granted. A simple way to illustrate this is to push an empty cup with the open end down into a container filled with water. Air is trapped in the cup because it has nowhere to go, and if a sealed shaft passed through the cup the air would remain trapped.

If we turn the cup horizontally, the air escapes from the cup's open end like it would in a horizontal pump. In a vertical pump with a mechanical seal, this principle must be considered: If air is trapped in the seal chamber, the seal is running dry.

A wastewater plant in Amherst, New York, uses several vertical shaft end suction pumps to return activated sludge and raw sewage. These pumps were originally braided packing sealed pumps. They had a history of requiring frequent gland adjustments and shaft sleeve wear that required rebuilding the pumps.

The plant decided that the energy savings and reduced downtime of split mechanical seals were worth the investment. The seals were installed with a restrictor bushing in the stuffing box to reduce flush water usage and limit solids entering the seal. The seals were flushed with process water and vented at startup. Pressure in the seal housing is maintained as recommended by manufacturers and industrial practice. The seals were vented by releasing the air through a vent before startup.

But there was a problem: The seals were prematurely failing on a regular basis, despite being built to high quality standards.

One day a plant manager noticed the air release valves on the plant's hot water heating system were called "high vents"—they release air from the heating lines, and they are located at the high points in the system. Even though the seals were vented before starting the pump, the flush water carries entrained air that is probably collecting in the seals. Because the seal is the highest point and is working properly, over time enough air collects to create a dry pocket around the seal faces. The flush water is going through the air pocket but not displacing it. (The faces were getting splashed but not surrounded with water.)

In order for this valve to work, the seal chamber or housing pressure must be high enough to push water up into the valve. The manager looked into the specifications of the air release valve used on the heating system, a float and needle valve type similar to a carburetor float—only air passes through the needle valve, so it is unlikely to clog.

Plant personnel attached the valve to the pump frame above the seal and placed a shutoff valve below it so it could be closed in the event the valve requires repair. Plastic tubing connected it to the vent port on the seal housing (opposite the flush port). The seal is now constantly vented, and the seals operate as they should. The plant modified all similar pumps.

In a pump with double mechanical seals (horizontal or vertical), the flush water is deadheaded between the seals. Venting at start-up should be adequate. In any case the vent should be the higher port and the flush the lower; this removes the most air possible from the seal.

In the situation described in this article, a pump designed to be operated horizontally was installed vertically. The seal chambers may or may not have flush and vent ports installed. Even though it is equipped with two single seals, they are naturally vented and flushed by the pumped liquid when used horizontally.

Once the pump is installed vertically, the upper seal chamber acts like the cup with the open end down. The upper seal runs dry. In this case, the pump is pumping clear cooling water. The suction pressure is probably lower than in the seal chamber. If no port is provided, the plant operator recommends drilling and tapping a hole in the seal chamber as high as possible.

The operator also would vent the seal and check the seal chamber pressure with a gauge, and confirm it is higher than that in the suction line.

If this is the case, connect the seal chamber vent that was just made with a similarly drilled and tapped hole in the suction line. Connecting them creates flow from seal to suction line, commonly called a suction recirculation system. The clear cooling water is unlikely to plug the line. The higher the pressure differential, the greater the flow. By doing so, it is drawing air and water from the seal chamber continuously and automatically.

If the pump were in a flooded suction condition with the suction line pressure higher than the seal chamber, the air release valve may be an option. This does not address every possible cause of seal failure, but it eliminates an environmental problem created by operating a pump designed for horizontal use in a vertical orientation. Proper venting of the seal chamber is critical, particularly in a vertical shaft pump. ■

Dr. Nelik (aka "Dr. Pump") is president of Pumping Machinery LLC, an Atlanta-based firm specializing in pump consulting, training, equipment troubleshooting and pump repairs. Dr. Nelik has 30 years of experience in pumps and pumping equipment. He may be reached at pump-magazine.com. For more information, visit pumpingmachinery.com/pump_school/pump_school.htm.

A better understanding of complete system operation

By **Ray Hardee**
Engineered Software Inc.

Designing & Operating a Smart Pumping System

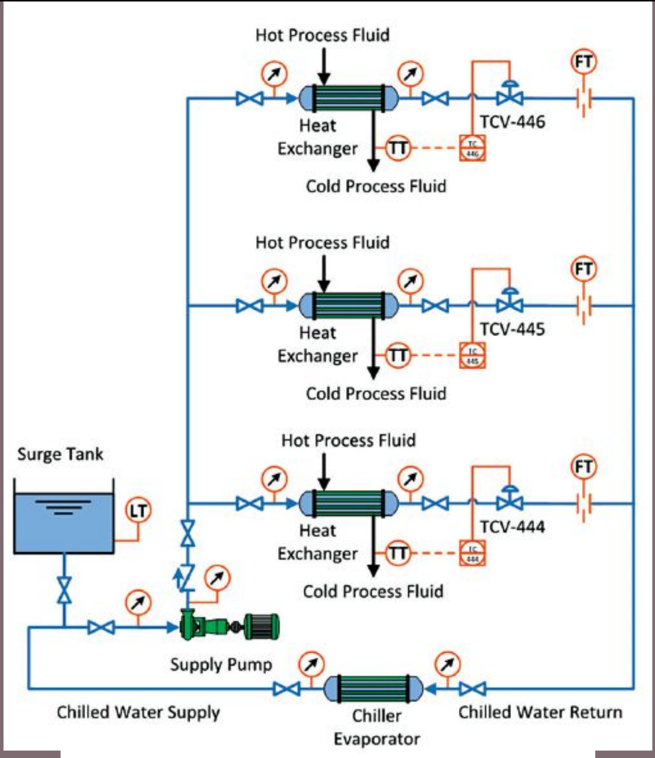
Smart pumping is not just about buying a pump for your system that has a high best efficiency point or installing a variable frequency drive to reduce power consumption and energy costs. Successfully designing a smart pumping system allows the plant to operate in steady state conditions with minimal downtime for long periods of time—the key to reliability and profitability in any facility. Operating in steady state improves product quality, reduces maintenance downtime, maintains environmental compliance and impacts the bottom line.

Designing and operating a smart pumping system requires an understanding of the overall system requirements, the hydraulic performance of the system equipment and the expected range of operations. Steady state is achieved when the fluid properties (including the flow rate, pressure, temperature, pH and other critical quality parameters) at any given point remain constant with time.

Because the pump, process and control elements all work together to achieve the design requirements of the system, it is critical that the engineering design team knows how much flow is required, what temperature must be achieved or what pressure must be provided to a given piece of equipment. The configuration of the system, the number of loops or end users, and the location of the critical path load (or most hydraulically remote loop) will come into the calculations. The presence and effect of a siphon must also be evaluated whenever there is a change in elevation from a high point to a lower elevation.

Considering the closed loop chilled water system shown in Figure 1, one of the heat exchanger loops will be the most hydraulically remote, or the critical path load, depending on the flow rates to each, the elevation differences, and the size and length of the pipelines. Sizing and selecting a pump to make this a smart pumping system will ensure that all users will have their required flow rates without excessive pressure drop across the control valves, regardless of which one is the critical path load. There may be a siphon present due to an elevation difference in the system. This siphon effect must be evaluated to ensure that cavitation or choked flow conditions do not occur in the control valve or flow meter at the high point in the system.

Figure 1. Closed loop chilled water system *(Courtesy of the author)*



When a system is initially designed, there may be many unknowns that must be estimated so that long lead equipment can be ordered and delivered in time for construction. The pipe routing, number of valves and fittings, or the hydraulic performance of key equipment may not be known by the time the pump must be ordered. Sizing and selecting the pump then often results in adding design margins and over-sizing the pump to ensure that the required flow rate or pressure can be achieved.

Installing a larger pump than needed not only adds capital costs, but may result in higher maintenance costs to repair cavitation damage in control valves, more downtime due to broken welds or leaking gaskets caused by high vibration, or reduced product quality due to poor process control.

Failure to achieve smart pumping may be because of the unknowns during the system's initial design phase, but also changing the system requirements over time. This may be because a higher or lower production rate is needed, the temperature set points must be adjusted or new environmental regulations must be met. This may move a pump operating close to its best efficiency point to one that is operating near its minimum or maximum flow rate at an extremely low efficiency. To achieve smart pumping, the pump must match its system requirements at all times.

After the system is built and the true system requirements are determined, the system may need to be optimized to achieve smart pumping. Trimming the pump impeller or installing a variable frequency drive are two common options for ensuring that the pump matches the system requirements and saves energy costs. For grossly over-sized pumps, replacing the pump with one that is better sized to meet the actual system requirements may be a better option than living with years of downtime, high energy and maintenance costs, poor product quality, or environmental non-compliance.

Smart pumping begins in the plant's design phase by understanding what the pumping system is required to do, configuring the system to achieve those design requirements, and sizing and selecting the equipment to operate at their best efficiency in steady state conditions. When the plant is running smoothly in steady state, hazardous work conditions are avoided, environmental emissions are kept under control, and prime product output is increased.

Modeling and analyzing the design in a steady state hydraulic simulation software package is key to achieving a smart pumping system. A system model can facilitate clear communication between the various engineering design teams, owners and operators, and equipment manufacturers to minimize the impact of the unknowns in the design phase and more accurately size critical equipment. A model also helps the various working groups understand how the system should operate in steady state, how to troubleshoot the system when it is not operating properly and how to modify the system as requirements change or optimization is needed over time. ■

Ray Hardee is a principal founder of Engineered Software, creators of PIPE-FLO and PUMP-FLO software. At Engineered Software, he helped develop two training courses and teaches these courses internationally. He may be reached at ray.hardee@eng-software.com.

Simple solutions for end users

By **Jim Elsey**
Summit Pump Inc.

7 Steps to Grouting a Pump Base

Some common goals clients report to me include having a pump that operates reliably for a long time combined with an inexpensive installation. I would argue that it is rare to accomplish both on the same job. Manufacturers often encourage their customers to have a foundation with a mass three to five times the mass of the pump, driver and baseplate combined—even more if the pump is a positive displacement design, especially reciprocating pumps. Additionally, recommendations and specifications focus on ensuring that the baseplate is properly grouted (grouting bonds the base to the foundation).

The purpose of any baseplate is to provide level, coplanar surfaces to mount the pump and driver, allowing for a proper and precise alignment between the two. More importantly, the base provides a path for the transmission of vibrations, nozzle loads and piping forces to the foundation and into the ground. If the base is not designed or installed properly, the investment in the alignment process will be lost in the first moments the pump operates. A proper baseplate installation will maintain that crucial alignment—and pay off for decades with reduced maintenance costs.

I acquiesce that the smaller the pump and consequential horsepower, the need for the expensive installation (foundation, baseplate and grouting) is diminished.

Some companies will buy the least expensive baseplate and then lay it on the floor/ground with no further action other than to pipe up the pump and connect the electricity to the motor. Anyone with pumps that operate in this manner for more than three years with no downtime for bearings, mechanical seals or couplings also has luck on their side. Chances are the pump is lower horsepower, and the service is ambient temperature and at low-duty hours.

Many end users shy away from pre-grouted bases or poly bases because of their higher initial cost, but anyone wanting a proper installation at an overall and long-term value should consider these alternative choices, especially in the National Electrical Manufacturers Association (NEMA) motor size ranges of 250 horsepower (hp) and below.

This article does not address stilted bases.

As an example, a 100-hp pump/driver set is purchased and the next step is installation. A cast iron, Process Industry Practices (PIP) or structural steel base also has been purchased. A good foundation has been designed and it is time to grout the base to the foundation. Here are some tips for the grouting process.

To start, do not assume the mechanical contractor may be the best at the pump installation process. Effectively communicating the specifications and procedures to the contractor increases the chance for success.

1 Prepare the Underside

With no other actions or specifications, almost no pump or base manufacturer will have the baseplate's underside properly prepared for the grouting procedure. They will have prepared the surface solely to prevent corrosion in the transit and storage stages. Consider these questions: When was the last time you turned the baseplate over and prepared the surface to be grouted? Did you remove the pump and driver?

You can sandblast the underside and then install the base immediately before corrosion occurs (less than eight hours in an ideal ambient). Another approach is applying the proper epoxy paint to the underside as a surface to which the grout can bond. Grout manufacturers will advise the proper surface preparations and paint for their grout.

Many people do not properly prepare the base's underside surface or they apply too much epoxy paint. Check with the manufacturer, but in most cases 4 mils (dry) is the proper amount. If the paint is too thick, the epoxy grout will pull the paint off of the metal, a process known as delamination. It may be necessary to remove the protective paint supplied by the manufacturer.

In the past, many installations used cementatious grout, but most companies in the last 20 to 30 years have elected to use epoxy grouts. Epoxy grouts yield superior results in most cases, while cementatious grout is less expensive.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2 Remove Equipment from the Baseplate

The equipment (pump and driver) should be removed from the baseplate during the grouting process. Before removing the equipment, make sure it can be aligned and the base is flat and coplanar.

Field machining of the base after completing the critical grouting process is difficult and expensive.

The concrete foundation must be adequately cured before installing and grouting the base. In the case of a new foundation, this depends on ambient conditions and on the concrete mix that was used (a five-bag mix can take as long as 28 days while a seven-bag mix may cure in a week).

Test for moisture by using duct tape to secure a 2- or 3-foot-square piece of plastic over the foundation overnight. Wait longer if moisture is visible on the underside of the plastic the next day.

If installing a base on a new or existing concrete foundation, be sure to chip away the laitance at least one-half inch or, in the case of working an old foundation, until reaching stable concrete or aggregate.

Laitance refers to the thin, flaky layer of hardened yet weak hydrated cement and fine sand on the top surface of concrete, usually from too much water or overworking the surface (for example, resulting from excess trowel work).

When removing the laitance, do not use a jackhammer, which may crack the concrete. Instead, use a small, light-duty pneumatic hammer with a sharp point tip, sometimes referred to as "bush hammering."

3 Allow Cure Time

Curing time for grout, especially epoxy grout, depends on the ambient temperature. If the site is too hot or cold, steps must be taken to change or control the situation, such as temporary insulated shelters or shade from the sun and heat. Never let rain fall on equipment during this process.

Be aware that during the curing process, the grout can actually pull the base out of level as it shrinks. Continue to check for level during the curing process.

4 Secure Bolts

Most designs require the installation of anchor bolts in the foundation that will run up and through penetrations on the baseplate. This is a highly recommended step. Many believe it is to hold the base to the foundation, but the purpose is to pull the foundation, the grout and baseplate together to form one monolithic mass. Place some tension on the anchor bolts relative to the base when grouting to keep the base from floating.

Do not allow the grout to come in contact with the anchor bolts. Use a protective sleeve/tube with some clearance to allow for tolerances and ease of handling. A common tip is to fill the sleeves with dry sand to prevent the grout from entering that area. The sand can be topped off with caulking or tape.

5 Use Shims & Jack Screws

When I started in the business, we would use sets of wood or metal shims to level the base prior to grouting, leaving the shims in place. Experience has taught me it is prudent to remove the shims after the process because as the shims corrode or rot they will create other issues with the foundation-to-grout joint. If using shims, be sure to apply a coating (such as light grease) of some sort to ease removal.

After some time in the field, I learned to use leveling jack screws in lieu of shims. This technique allowed for more precise results. It was easy if the base manufacturer designed for the use of jack screws, but even when that was not the case, they were easy to adapt and install in the field. If using leveling jack screws, coat them with something (grease) to facilitate their removal. Also, put a piece of metal under the jack screw to prevent digging into the concrete because this makes the leveling procedure very tedious. Small metal plates, preferably stainless steel, can be placed under the jack screw's nose. These plates are commonly referred to as "pucks."

Once the jack screws are removed, fill the resultant voids with grout or liquid epoxy.

6 Choose Pour Method

Prior to the grouting process, decide whether to use the two-pour or one-pour method. I prefer the one-pour process, especially if using epoxy grout; it takes a little more preparation time because of the more sophisticated forms, but it will yield excellent results if done correctly.

Keep in mind that when pouring the grout into the forms, the displaced air needs somewhere to go, and that transverse base members and braces can sometimes prevent the proper installation and venting.

I have added (drilled) plenty of vent holes in the base to allow for the venting process.

Typically it is best to pour from one side to let the air escape from the other.

7 Pour Grout

The grout forms need to be strong and liquid tight (do not hesitate to caulk the joints). By comparison, the forms used to pour a patio or driveway are probably not strong enough for this application. Coat forms with something that will not adhere to the grout. A common practice is to use two to three layers of paste wax. Do not use oil because it can react with the grout substrate.

You will not have enough grout if you simply allow for the volume of the form. Prudence suggests you have 10 percent more grout than the form volume—and I guarantee there will be spillage.

Pour the grout from a head box that is positioned at an elevation higher than the baseplate to provide a static head for the grout to flow.

Try to avoid pushing or rodding the grout into place because it creates air entrainment and voids. It is acceptable to pump the grout in place with different and specific appliances for that purpose. Never use a vibratory device unless specifically directed by the grout manufacturer.

For epoxy grouts, mix the liquid first (resin and catalyst) and then add the aggregate to the liquid mix—not the other way around.

This tip reminds me of my submarine days when the specific instructions were to shut the hatch and then dive the boat. The specific sequence is paramount. ■

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History of the

HYDRAULIC INSTITUTE

In 1917, representatives from 16 pump companies met to establish the Hydraulic Institute, which not only led to standards for the manufacture and supply of pumps, but opened the door to growth and a robust industry. HI's 100th birthday will be marked by celebrations, learning opportunities and a commemorative coffee table book. Looking back over the last 100 years, HI has set the standard for operational excellence not just in the United States, but also with a growing global reach. For information about anniversary events, visit pumps.org.

While the official beginning of the Hydraulic Institute is listed as 1917, the history of the organization precedes that date, as groups of pump industry professionals would gather in various ways to promote and improve their industry. Early records show that on July 9, 1873, the Pump Manufacturer's Association of the United States met at Saratoga Springs at Congress Hall.

According to Noble Dean Jr. of Dean Brothers Pumps, in a 1974 letter to Lawrence Spence of Allis-Chalmers Industrial Pump Division, the "antecedent of the present Institute was the Hydraulic Club formed on January 18, 1905."

Spence was the HI historian in the mid-1970s, when he reached out to members asking for information about the organization's past. "Exhibit B is a copy of the minutes of the first Hydraulic Society meeting, held the 18th and 19th of April 1917, in Chicago. This document is interesting because of its candor and the expressed concern of the Federal Government through the newly established F.T.C. (Federal Trade Commission) in the organization of the industry for war," Dean writes of an attachment to his letter that included minutes from that meeting.

Those minutes recorded that "the members of the Hydraulic Society present partook of a banquet in the parlors of the La Salle Hotel and exchanged experiences in business as well as social matters to the edification of all those present. The banquet was most pleasant as well as most profitable meetings of this character that has ever been held."

At that meeting in 1917, the first HI committees were created by those present. The committees included the following: plan and scope, commercial, technical, cost, membership, nominating and publicity. These early committees established much of the structure that still guides today's Institute.

Sixteen independent pump manufacturers were part of the first HI meeting. While they competed, they had assembled that day largely to lend support to World War I production efforts and to coordinate those efforts while following new governmental requirements.

A 1921 meeting includes 44 pump industry representatives in South Philadelphia

At this meeting, the following companies were represented: Advance Pump & Compressor, American Steam Pump, Blakeslee Manufacturing, Buffalo Steam Pump, A.S. Cameron Steam Pump, Deming Pump, DeLaval Steam Turbine, Epping Carpenter, Fairbanks Morse, Gardner Governor, Gould Manufacturing, National Steam Pump, National Transit, Platt Iron Works, Worthington Steam Pump and Wagener Steam Pump.

From the beginning, the group grew.

A photo from a meeting in 1921 (seen on page 20) shows a gathering of 44 industry leaders, from companies that included—in addition to the 16 founding businesses—Ingersoll Rand Company, Alberger Pump, Dean Brothers Steam Pump Company, Lea Courtney Company, Dayton Dowd Company and Midwest Pump & Engine Company. Also counted in attendance were representatives from the Hydraulic Society of New York.

Members of this event in 1921 met at Westinghouse Electric & Manufacturing Company in South Philadelphia.

Annual Meetings

In the early days, HI members were a lively bunch. While they met to address the serious business of the day, they also took time to enjoy fellowship with each other.

"When I came aboard some of the 'old timers' had mellowed, but they enjoyed reminiscing about the various places they'd been thrown out of … They were a tough, hard-working crew," Dean said in his letter to Spence. "All of us who have been associated in any way in the Hydraulic Institute can remember similar instances. There are lots of stories to tell. But we're a pretty conservative bunch. Our industry is somewhat fragmented but very fundamental, and the roll of the Institute representatives is made up of many strong individuals. This is good, and I hope it stays that way."

Following World War I, the Hydraulic Society sought to keep pace with a changing world. In the early part of the Depression, in 1933, a new constitution and bylaws were adopted to keep pace with these changes, according to HI archives. This is the year that the name of the organization was changed to the Hydraulic Institute.

In 1967, on HI's 50th anniversary, the annual meeting was held at the Pittsburgh Hilton. During the dinner event, members dined on fruit supreme princess, roast prime ribs of beef au jus, vegetables and bisquit glace with strawberry sauce.

The program pointed out that "modern pump designs and applications are legion." It said:

"In the U.S. alone, there are several hundred manufacturers, which produce millions of pumps every year. There followed much important work, which formed the foundation for what is today the principal trade association of American industrial pump manufacturers.

"The Institute developed standard, authoritative definitions for everyday terms used in pump work and published these in a manual known as the 'Standards of the Hydraulic Institute.' Broadened in scope over the years, these standards have attained such wide circulation and acceptance that the phrase 'Pump to be furnished in accordance with the latest edition of the Standards of the Hydraulic Institute' is used almost universally today."

Expanding HI's Membership

As the Hydraulic Institute's focus continued to grow, so did the need to expand HI's membership outside of the pump manufacturing community.

In 1997 an "Associate Member Whitepaper" emerged from a committee led by then-HI President Pat Thomas (Sunstrand Corp.) that highlighted the merits of expanding the membership in this direction.

HI members voted to approve the Associate Member Program and in 1998, HI began recruiting associate members from suppliers to the pump industry. Companies manufacturing motors, seals, bearings and component parts such as couplings, gauges, controls, instruments and pump-specific software were targeted.

HYDRAULIC INSTITUTE TIMELINE

1873
Pump Manufacturer's Association of the United States meets at Saratoga Springs at Congress Hall

1905
The formation of the Hydraulic Club

1917
Official beginning of the Hydraulic Society (later the Hydraulic Institute)

1933
A new constitution and bylaws adopted, enlarging the scope of the group's activities and changing the name to the Hydraulic Institute

1967
50th Anniversary Celebration in Pittsburgh, Pennsylvania, with guest speaker W.P. Gullander, president of the National Association of Manufacturers

1991
Robert Asdal hired as executive director; previously, HI managed by a national association management company

1992
75th Anniversary Celebration in Washington, D.C., with keynote speaker Dr. Bruce Merrifield, former assistant Secretary of Commerce

1996
HI and Europump Sign a Mutual Cooperation Agreement to begin collaborative work on standards and guidelines

1998
Supplier manufacturers become eligible for associate membership in HI

2005
HI Standards Partner program introduced, allowing engineering consulting and pump user organizations to affiliate and engage with HI

2006
Pump Systems Matter incorporates as an educational subsidiary of HI

2012
HI membership opens to global companies that sell pumps, systems or supplies in North America

2015
HI Industry Partner and Academic Partner programs introduces to allow individual engineers, pump users, academics and retirees to participate in HI

2015
Asdal retires; Michael Michaud hired as executive director

Preview:

Hydraulic Institute 2017 Annual Conference & Centennial Celebration

March 8-13, 2017

JW Marriott Grande Lakes Orlando, Florida

The Hydraulic Institute will celebrate its centennial at the 2017 Annual Conference in Orlando, Florida, on March 8-13.

"This momentous event will recognize the critical role pumps play in society and honor pioneers, innovations, organizations, and technical achievements that have propelled the industry for the past century," according to the leading association representing the pump and related industries in North America.

This year's event features a variety of panel discussions and presentations by experts covering topics including policy trends, behavioral economics from the Gallup Organization, technology, global risk-management issues and more.

Featured speakers include Ross Eisenberg, VP of Energy & Resources Policy at the National Association of Manufacturers; W. Todd Johnson, Global Channel Leader of Entrepreneurship & Job Creation at Gallup; Alan Beaulieu, president of ITR Economics; and Erik R. Peterson, director of A.T. Kearney's Global Business Policy Council.

This year's event will mark a momentous occasion for the Hydraulic Institute, which is celebrating its centennial. The black-tie-optional Centennial Gala & Commemorative Program on March 10 will include the HI Pump Industry Excellence Awards. The conference also features a pump museum display and tabletop exhibition.

For a full list of events and registration options, visit pumps.org/Conferences/2017_Annual_Conference.aspx.

Past presidents (left to right) J.R. Vidmar-1973, J.B. Freed-1976, J.C. Meyers-1970, G.W. Jensen-1974, W.D. Staley-1958, T.E. Bennett-1975, C.B. Bason-1959, R.A. Prosser-1972, J.T. Culleton-1977

At the time, these companies were required to manufacture in North America.

In 2005 expansion continued with the creation of the Standards Partner program. Realizing that expertise from some of the leading engineering design, construction and procurement firms was absent from many technical committees, the Standards Partner category was an ideal solution.

To be a Standards Partner, organizations or individuals must establish that they provide pump and pumping system engineering, process or facility design, procurement, project management, construction services, hydraulic or mechanical modeling, analytical methods, or laboratory or field-testing to a facility owner, government, or vendor, or that they are an end-user of pumps.

In 2012, HI members overwhelmingly voted to further expand by approving a bylaw change to broaden membership eligibility to include "pump and supplier companies that manufacture wholly outside the North American market, but sell into the North American market."

Former longtime HI Executive Director Robert Asdal

According to former Executive Director Robert Asdal, "The expansion of HI's membership footprint is a natural response to current conditions in the global marketplace. It is in direct alignment with the Institute's stated vision to be a global authority on pumps and pumping systems. The active involvement of global companies will strengthen and add vitality to HI and the volunteer committees that drive the standards, guidelines, education programs and other initiatives of the Institute. We expect both our current and new international members, as well as the North America pump industry as a whole, to benefit from the change," Asdal said at the time.

By 2015, the Standards Partner concept was a great success, and was expanded even more to ensure that individual experts could also share their perspective of design, construction, scoping, end users, maintenance, operations and research and could be easily integrated into the HI community.

Encouraging a greater diversity of pump manufacturers, suppliers, system designers, users, etc., ensures that HI technical and educational resources will stay current with the ever-evolving needs of the extended pump community.

Lastly, a Media Partner category was also created so that the work of HI and its members could be shared beyond HI. As this important work continues to grow in scope and volume, it will now also gain more prominence in the trade press and the marketplace, thanks to this new affiliate group.

This opening of the HI community has changed the composition of committees and the overall look and feel of meetings.

Indeed, of HI's membership today, close to one-third are associate members, representing various pump system components. Standards and other partners are fully integrated into HI, bringing much-valued perspective to the technical discussions and the overall programs of the Institute.

Membership spans the globe, representing manufacturers from Europe, Asia, Latin America and Indian subcontinent. Through all these changes, and perhaps because of them, HI has maintained its position as the global authority on pumps and pumping systems.

Educational Focus

One major change for the Hydraulic Institute through the years has been the increasing focus on training and education. In an open letter to the pump industry in 1988, Igor Karassik advised HI members to further address the needs of end users. Part of the letter read: "Pump manufacturers should exert greater efforts in the education of users in several important areas such as:

- pumps and energy conservation
- adequacy of suction piping
- monitoring pump performance
- proper lubrication procedures"

HI took Karassik's advice and began collecting materials to develop a training curriculum to address these topics. Working alone or with partners such as the U.S. Department of Energy (DOE), the Fluid Sealing Association (FSA), or Europump, HI has made strides in global training. This effort was formalized in 2006 when Pump Systems Matter (PSM), HI's education subsidiary, was formed.

Now a cornerstone of HI, PSM courses teach everything from how to understand and apply HI standards to the fundamental principles of centrifugal or positive displacement pumps, to courses on related components.

As the focus shifted over time from pumps to pumping systems, HI's courses also evolved into courses titled: Pump System Optimization and Pump System Assessment.

Along with the change in course topics came improvements to delivery, as training courses are now offered live, via webinar, through e-learning and as part of certificate programs.

HI's focus on education and training will continue into the next 100 years. The group has, and will, impact the industry it represents in numerous positive ways. ■

Enhanced Monitoring Improves Performance

IoT information allows end users to provide corrective action that serves a proactive purpose, rather than reactive.

BY **TODD LOUDIN**
FLOWROX INC.

It is estimated that by 2020 there will be as many as 50 billion devices connected to the Internet of Things (IoT) operating in the consumer and industrial world. Additionally, there may be as much as 44 trillion gigabytes of information transferred, utilized and analyzed.

In today's major technological advances in plant assets, there is a significant increase in data that can be captured and transferred using the IoT.

Modern sensors can be used for vibration monitoring; non-invasive motor testing; ultrasonic, electrical capacitance tomography; infrared thermography; oil analysis; and much more.

Many of these sensors can be attached to equipment by magnets, screws or adhesives to provide feedback on the health of those assets.

The goal of using these sensors is to monitor asset condition and take corrective action when anomalies are detected. Preventing equipment failure can provide tremendous bottom-line savings.

With this information available, it is important to ensure that corrective action serves a proactive purpose rather than reactive.

As organizations further develop Industrial Internet of Things (IIoT) strategies for their operations, they will be increasingly analyzing tremendous amounts of data. This has forced some organizations to create the role of chief data officer (CDO) to help decipher this immense amount of information, as well as develop proactive plans and key performance indicators (KPIs) to improve their operations.

For example, a plant with annual revenues of $700 million may spend as much as 5 percent of revenues on maintenance, repair and operations (MRO) to keep vital assets running. Reducing these costs by 2 percent by incorporating advanced asset monitoring and proactive strategies can reduce overall expenditures by $14 million a year.

Some suppliers provide systems that improve data management to help put necessary information into the hands of maintenance personnel immediately.

In large chemical plants, a maintenance professional may spend half a day or more researching to perform work on an asset. That person may need to access a dozen systems to capture data required to perform the work. In some cases, that half a day could mean the failure of the asset.

Proper maintenance is not just about monitoring but also about data and document management that allows personnel to be more productive and proactive. One system that often has a gatekeeper or a professional well-trained in the software is an enterprise resource planning (ERP) system. There are numerous manufacturers of ERP systems, and all of them require firsthand training and knowledge to navigate within these systems.

The maintenance professional needs to know if the replacement parts for an asset are available and where they are located in the plant. If the parts are not in the plant, then getting them on order as quickly as possible is critical to prevent an asset failure or process downtime. These new systems are capable of tying into various ERP systems and extracting data that the maintenance

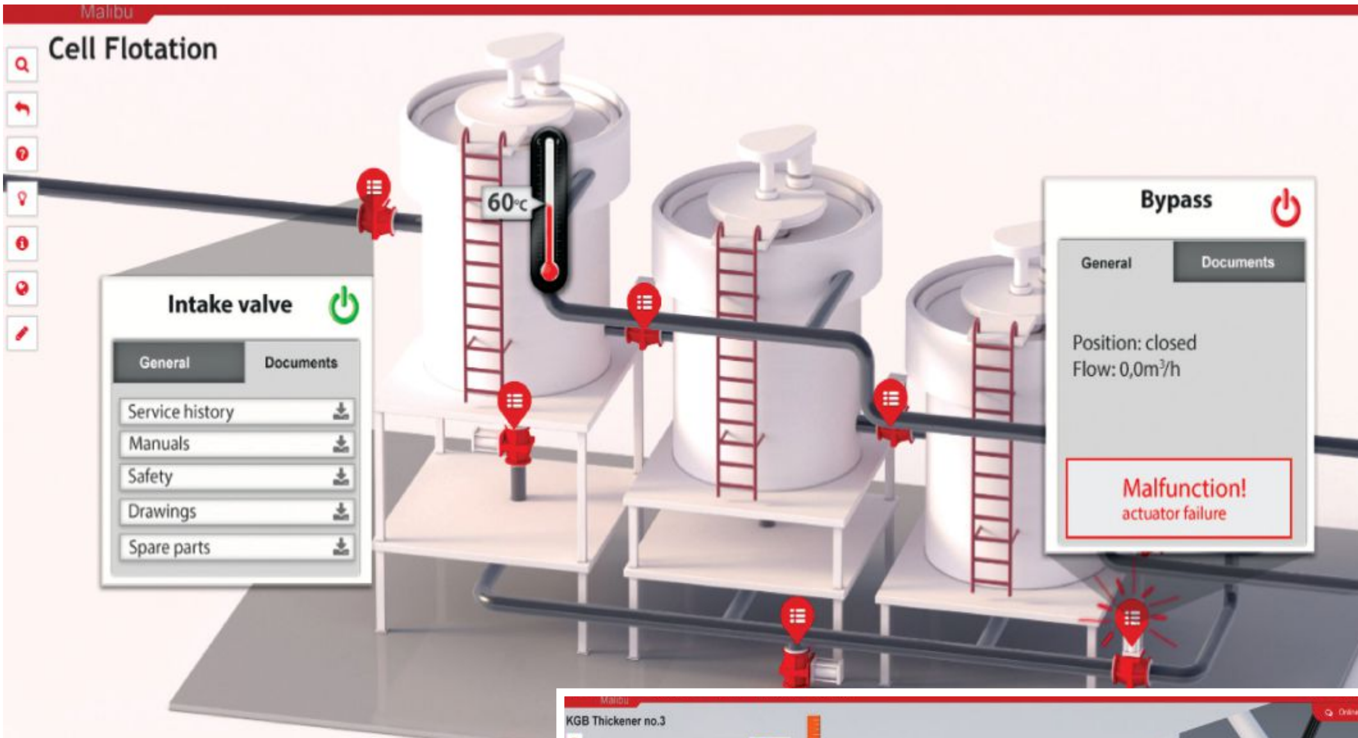

Figure 1 (top). IIoT-equipped flotation loop depicting a smart valve failure. All service history of the valve, manuals, safety documents, drawings and spare parts can be viewed from any smartphone, tablet or PC.
Figure 2 (bottom). This IIoT-equipped pumping loop incorporates operation performance measures, future maintenance requirements and overall process measures. (*Graphics courtesy of Flowrox*)

professional can access on a mobile device or computer. As a result, this maintenance professional will not have to wait for an answer from the ERP master to determine if parts are available.

As new data-processing systems are deployed, a culture change may be necessary in the organization. For instance, maintenance personnel may receive a default signal from the system. The maintenance people visit the asset in trouble and find no elevated temperatures or noise from the asset and assume it was a false alarm. Then the asset becomes fully disabled at a later date. With new IIoT-capable sensors, default detection can be highly sensitive and accurate for detecting anomalies that can be fixed, eliminating downtime in many cases.

A large facility could have many different operating systems. Because of a lack of standardization in industrial control systems, these systems may not communicate with each other. As a result, a process upset in one portion of the plant can have significant downstream effects in another system of the plant. Technology has been developed that offers the capability to bridge the communication gap by capturing data from all systems and reporting a greater overall picture to stakeholders than stand-alone systems.

3-D Virtual Environments

Certain software can incorporate a 3-D virtual environment of an entire chemical plant, subprocess, or individual asset or system. The information can be set up in layers so the plant manager can view production matrixes and failure points or bottlenecks.

The safety manager may view hazardous areas or key areas of concern. For instance, a chemical release can be monitored with gas sensors and tracked so that only the plant's affected portion needs to be evacuated. The plant's unaffected area can continue to work normally.

Using the software, the maintenance team can navigate down to specific portions of the plant to individual assets. The maintenance professional can view previous failure reports of a given asset and learn possible remedies for the affected asset.

The team can collect all data such as drawings and installation and maintenance manuals, as well as check on the availability and location of spare parts. The maintenance professional can access both augmented reality and educational videos that demonstrate the necessary maintenance from his or her smartphone, tablet or PC.

Bottom-Line Results

Some software offering 3-D visualization can help users by simply clicking through visual parts of the process so they can capture all needed documents, training, required spare parts, past failures and resolutions directly to the users' smartphone, tablet or PC.

The information is immediate and delivered directly to the user regardless of where the information is stored in the plant's IT infrastructure.

There are tremendous savings that can be achieved by intelligent and user-friendly software that offers point-and-click convenience. Many systems that offer similar IIoT capabilities with intelligent monitoring do not use a 3-D environment that is point and click. It is possible to increase overall production availability by 5 to 10 percent compared to plants not using such technologies.

The result or additional process uptime can be as significant as one full month of production more when compared with peers. In addition, energy, chemical consumption and emissions can be halved.

Downtime can be reduced by 3 percent, and profitability can increase by 5 to 10 percent. Companies deploying IIoT strategies and smart systems are typically in the top 25 percent of their peers. ■

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7 Technological Advancements Shaping Water Operations

New technologies and challenges are pushing utilities to create smart networks.

BY **ADRIAN NEWCOMBE**
TRIMBLE

The water industry is on the cusp of a major transformation driven by a combination of industry needs and emerging technology. Challenges associated with aging infrastructure, budgetary constraints, weather and more are driving utilities to do more with less.

A key element in enabling a water utility to become more efficient is building an understanding of how the network is performing and the network assets' condition. Situational awareness through network monitoring is key to understanding how the network is operating, including problems and possible remedies.

Utilities have deployed supervisory control and data acquisition (SCADA) systems to monitor and remotely control network assets. However, SCADA systems are complex, expensive and require continuous power. Their deployment often has been limited to key plant locations such as treatment works, pump stations and reservoirs. This leaves a blind spot for utilities throughout the distribution and collection networks that can be filled with battery-powered remote monitoring for pressure, flow, level, pump runtimes and other parameters.

These can be cost-effective solutions; however, with current remote monitoring data loggers, there is a trade-off between battery life and reporting interval. The power requirements of current cellular technology means shorter interval reporting, causing more regular battery changes and, in turn, increasing the monitors' operating cost.

IoT Networks

The enabling technology for the emerging Internet of Things (IoT) is Low Power Wide Area Networks (LPWAN), which is a family of new communications technologies that allow devices to communicate small volumes of data over a long distance with low power. For this reason, they are perfect for battery-operated sensors because they facilitate small bursts of measurements sent frequently, while the low power profile ensures that sensors can retain a long battery life. This is a significant advantage over current cellular network technology for machine-to-machine communications.

Network technologies that fall under the LPWAN umbrella include LoRa and SigFox, both of which operate in unlicensed radio spectrum, and NB-IOT, which is a cellular technology that uses a small part of the current cellular spectrum.

Long Range Wide Area Network (LoRaWAN) is an LPWAN specification from the nonprofit IoT group LoRa Alliance for battery-operated devices that provides secure, bidirectional communications between remote sensors and centralized network servers.

LoRa has gained significant acceptance in the industry with multiple network providers offering public networks across North America, Europe and Asia. Availability of these public networks means that utilities do not need to operate their own networks and can use existing networks in a similar manner to current cellular service.

DEVELOPMENTS IN MONITORING TECHNOLOGY

Advancements in technology will enable a rapid change in how water utilities conduct their operations. These technology drivers include:

1. **IoT:** LPWAN technologies such as LoRa, SIGFOX and NB-IOT are being adopted with smart sensor solutions available for the water industry. These new smart sensors are much lower cost to deploy than sensors using cellular technology. Their battery life is much greater than cellular-based sensors and recorders, even with shorter reporting intervals, meaning that utilities can get near-real-time data while having much lower maintenance costs. With the lower cost to deploy and operate these sensors, utilities will deploy them on an unprecedented scale and gain a near-real-time view of network performance.
2. **Sensor technology:** Another key technology driver is in the area of sensors, where the cost is dropping and new types of sensors are being brought to market that enable monitoring of parameters such as water quality at line pressure. These new sensors enable a visibility of the network's state and quality not previously possible and ensures that the number of monitoring points and parameters at each point will increase dramatically.
3. **Network protocols:** New sensors and network technologies will introduce new protocols for integration of sensors to master stations. These protocols will reflect the needs of the emerging sensors, which will send very small bursts of data in short intervals and integrate data from third parties such as weather agencies. This does not mean that supervisory control and data acquisition (SCADA) will be replaced because current SCADA technology will remain and evolve, particularly for control of critical plant assets.
4. **Big data:** The scale of future water telemetry networks and volume of data captured will raise a challenge for the systems that must store, process and analyze this data in order to extract meaningful, actionable information. Storage and analysis tools collectively referred to as big data will be critical to distill the information from the sea of data. Elastic cloud-computing techniques will allow rapid execution of analysis functions on this data that would not be possible with current on-premise server technology.
5. **Real-time modeling:** Utilities have relied on hydraulic models to aid in planning and operational decisions. Availability of both near-real-time data from the network and powerful cloud-computing resources will allow near-real-time execution of such models to aid operations staff to predict and respond to unfolding events and take preventive actions.
6. **Domain-focused applications:** The degree to which the future water network will be monitored means that all stakeholders in the utility will need access to that information to aid them in their work. Information derived from telemetry will no longer be the preserve of an individual department, but rather each department (e.g. operations, engineering, customer service) will have focused, near-real-time decision support applications that allow them to take optimal and informed actions.
7. **Self-healing systems:** These mentioned trends will enable utilities to deploy systems that move from reactive monitoring to adding more real-time control and optimization at key points in the network. This will be similar to "self-healing" concepts in electric and communications networks, whereby the system can automatically predict events and take preemptive action—for example, automatic pumping to storage tanks during extreme rainfall.

In some regions, cellular operators are rolling out LoRa networks as an IoT specific complement to their cellular offering. Other cellular operators are pursuing NB-IOT, which has completed standardization and is intended to be the cellular solution for LPWAN requirements. These LPWAN networks will be the driver for more economic, near-real-time monitoring solutions, which will enable water utilities to execute on smart water strategies.

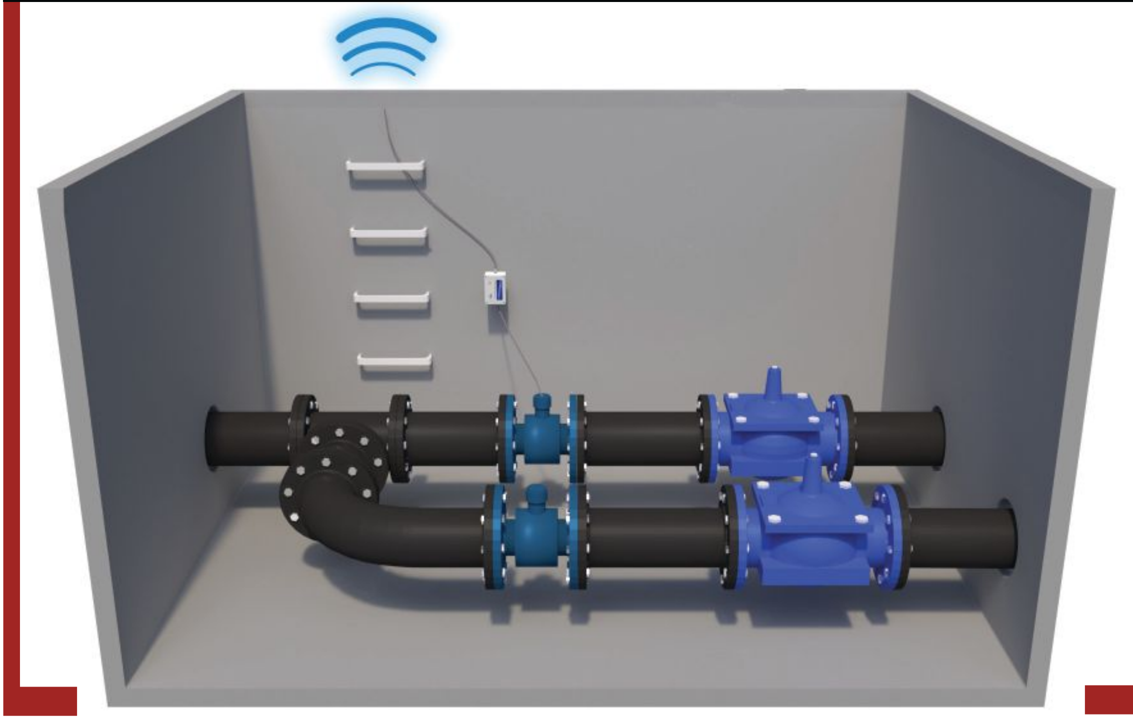
Adopting Technology

While the IoT's technology advancements may be revolutionary, its adoption in the water industry will be evolutionary and iterative.

Water utilities will initially focus on key assets in their distribution and collection systems such as pumping and lift stations. This allows visibility into the performance of these assets with a modest capital investment that can be retrofitted to existing equipment such as pumps, valves and meters, turning these into smart assets.

Near-real-time information on asset performance allows operational staff to make informed decisions about the current network state. For example, when a pump is deviating from its expected duty cycle, an alarm can be raised to a dispatcher. Adding other sensors such as a level monitor in the wet well can provide the dispatcher with more information to determine the best response.

Figure 1. Wireless remote monitoring of a pump station with an IoT sensor *(Graphics courtesy of Trimble)*



As the work progresses to address the issue, near-real-time information allows both dispatch and field staff to understand the impact of the work and ensure that issues are resolved before staff leaves the remote site.

With the new generation of battery-operated IoT sensors, water utilities can readily incorporate monitoring throughout the network. The sensors' lower capital costs, coupled with the long battery life and low maintenance requirements, mean that the total cost of ownership (TCO) is much lower than previous solutions and enables utilities to roll out monitoring throughout their distribution and collection systems as part of a smart network strategy.

Cloud-based analytics operating on this monitored data can extract key information and performance indicators, turning raw data into actionable events. Sophisticated graphical and spatial visualizations ensure that personnel can quickly assess the situation and field staff have access to key performance data in the field.

Creating Smart Networks

Remote monitoring systems are a foundational element on a journey that many water utilities will undertake in the next decade. This journey starts with getting sufficient data to make optimal decisions. Making all machine data and other pertinent telemetry data available within a single platform is critical to the eventual realization of an optimized network.

This journey will follow a number of stages:

- Rolling out instrumentation through the network and gathering the data back to the cloud, where it can be stored and managed.
- Organizing data into reports, dashboards and visualizations, thereby understanding what is happening on the network and responding to alarms and other events.
- Optimizing operations that integrate network data into systems for better decision making.
- Adding analytics to understand correlations in data and develop models to predict what will happen on the network and react before it happens to optimize operations and significantly reduce operation cost.
- With the addition of machine learning and artificial intelligence, the operational decisions and changes required for the network's optimal operation at minimal cost will be advised by the system.

These developments represent an exciting time for the industry as it works to find creative and effective ways to implement new technologies to achieve much-needed changes and growth. ■

Adrian Newcombe is business area director for Trimble Water, with responsibility for Smart Network solutions, including the Telog portfolio.

More End Users Embracing Smart Pumping Applications

These systems can increase efficiency and add unique insight.

BY **SIVA KANESVARAN** & **JACK CREAMER**
SCHNEIDER ELECTRIC

Image 1. Tracking pump output levels through a browser-based monitoring application for variable frequency drives using a handheld device (*Image and graphics courtesy of Schneider Electric*)

The Industrial Internet of Things (IIoT) is a business buzzword. But asking 10 people for a definition of IIoT will likely result in 10 different answers. Additionally, many may think IIoT refers to connecting people with machines, instead of a connected process. This concept goes beyond basic process management to informing and educating people on what is happening in a process.

Further, some people who mention machines often think of industrial applications, such as packaging or conveying equipment. Pumping systems and pumping applications are often left out of the discussion.

Pumping needs to not only be included in the discussion, but it also has the opportunity to lead it given the potential upsides of a fully connected pumping system. This connected system offers the opportunity to increase efficiency, reduce energy consumption and provide unique insight into a process. This also helps with maintenance scheduling and identifying possible issues before they become problems resulting in downtime.

Evolution, Not Revolution

The IIoT is an "evolution" and not a "revolution." As with most evolving technologies, adoption curves are impacted by both the technology and operators' willingness to change. The concept of personal connectivity is widespread—an example being the increasing social networking—but it will be dwarfed short term by connected devices (the Internet of Things), as shown in Figure 1 (see page 34). When the "Industrial" is added to the Internet of Things, it takes that same concept and applies it to an industrial process.

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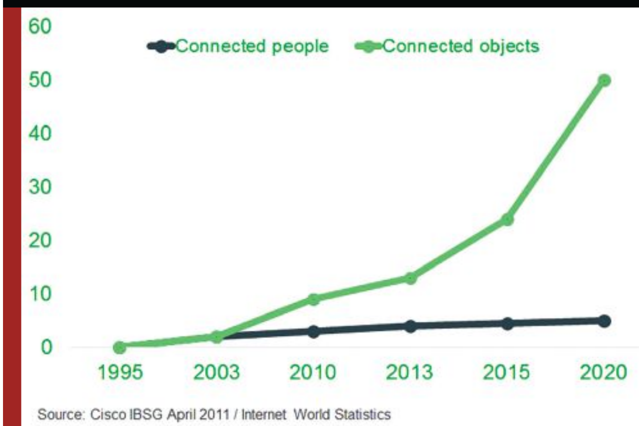
Figure 1. This chart shows that IIoT covers machines and people, with significant growth on the connected-objects front.



Over the years, pumping equipment has been getting "smarter," but now there is the opportunity to connect each piece into a single process view. The benefit of this technology spans the entire design, implementation and ongoing monitoring of the pump system.

The concept of "smart pumping," also referred to as an "intelligent pumping system," combines the technology of each component—a sensor, variable frequency drive (VFD), programmable logic controller (PLC), human machine interface (HMI), etc.—into one smart system (see Figure 2).

Direct connectivity to sensors improves insight into the system's pressure and flow in real time. By connecting those to the software that oversees the system, greater efficiency is possible through adjustments based on the readings.

In addition, this can monitor equipment output within a system to identify possible maintenance concerns. This allows users to better manage the equipment lifetime, schedule maintenance and reduce costly downtime. Increasing efficiency and managing equipment performance mean savings to the bottom line.

Remote Connectivity

The IIoT benefits previously mentioned can be seen in many industries. One that is often unique to pumping, however, is connectivity to remote locations.

Pumping systems are frequently located in remote locations, which have made monitoring and managing a challenge and expensive. Whether in water/wastewater facilities, oil and gas upstream locations, or commercial buildings, the practicality of local monitoring has been limited.

By connecting remote pump stations and systems with a single monitoring system, multiple locations can be monitored from one location.

If those stations are part of a larger process, adjustments can be made from that single station that benefit the process as a whole—for example, increasing flow from one pump station to compensate for another, less productive station and ensure even supply.

Additionally, remote monitoring in some cases can be done wirelessly through a secure web server. By enabling this capability, a process status can be viewed on an iPad or a mobile phone should the process manager be on the road or unable to make it to a facility because of inclement weather or another reason.

Figure 2. The concept of "smart pumping" combines the technology of each component such as a sensor, variable frequency drive (VFD), programmable logic controller (PLC), human machine interface (HMI), etc., into one smart system.

System Efficiency

Two upsides of connected solutions involve energy consumption and maintenance. Energy is a crucial consideration because pumps are the primary source of energy savings among motor-driven loads.

Maintenance, operations and downtime can account for close to 40 percent of the equipment's total operation costs.

Along with energy consumption, there are several other pump system factors that can be measured or monitored in a smart system.

These other factors include the level, flow, pressure, temperature and vibration, among many others.

By having insight into these aspects of a pumping system, even greater efficiency can be gained.

The standardization of data and its availability reduce the complexity for system planning purposes, as well as providing cost benefits.

Practical Benefits

A smart, connected pumping system—the IIoT in pumping—enables a significantly more efficient system by:

- Providing insight into individual aspects of a pumping system as well as into how those systems work together for greater overall process knowledge.
- Establishing preventive maintenance plans for systematic inspection to detect potential failures.
- Enabling condition-based maintenance by monitoring pumping system data for an accurate status and risk assessment.
- Deploying corrective maintenance measures as needed in response to an unanticipated problem or emergency.

Data availability and data visualization are two specific features in the current IIoT device evolution. With data availability, application data such as motor current or operating status of a control system can be collected and made available to a higher level system. Many devices in the industrial control environment, such as VFDs and PLCs, include data availability features standard.

On a recent lift station application, the pump packager's approach involved a set of data points such as pressure and flow values made available on the standard package. The goal was to reduce customization requirements from project to project, while providing a set of data points that can be utilized by a supervisory control and data acquisition (SCADA) or supervisory system. For projects deployed, this would allow the end user to tap into these data points if and when a SCADA or higher level data collection system is implemented.

The alternate to this would be for each control package to be modified to feed data points as required, a task that would increase the cost of integration in the system. The standardization of data and its availability reduce the complexity for system planning purposes, as well as providing cost benefits.

Visualizing Data

Data visualization is equally important for realizing the benefits of data availability and IIoT. VFDs and PLCs are increasingly embedding visualization editors in their software configuration tools. In some cases, this allows for vital figures and statistics of the device to be readily viewable. In many cases, some level of customizability is included to make that visualization suit the context of the application.

Figure 3. Application data from multiple devices is transmitted and collected for higher system level monitoring.

For example, if a system only requires tracking of VFD speed and current, all other data points can be left out of the visualization screen. This reduces clutter and improves the effectiveness of the data points to the operator.

VFD installers are usually not expected to be savvy programmers. With this in mind, customizing the browser-based dashboard of these newer VFD systems as a task performed with drag-and-drop function can be more convenient than developing Java script or HTML code.

The needs of an industrial control system user can be met by a simpler, graphical, front-end application to develop visualization screens as opposed to another type of programming environment.

This helps when an installer or end user has to be able to customize and pull up a browser-based application within minutes and with minimal programming knowledge. A visualization configuration environment can reduce the complexity and nuances of programming, graphics and data handling.

This drop-and-drag configuration style is much easier than that of previous low-level, exhaustive programming requirements. This means reduced engineering and configuration times, and therefore reduced cost for the customer.

The IIoT's evolution has brought great benefits including new levels of connectivity, data availability and information sharing that allow industry professionals to better manage pumping systems. By implementing newer IIoT-enabled devices into current pumping systems, industry has the opportunity to increase efficiency by reducing costs and unscheduled downtime. ■

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Optimize Pumps with Digital Data

The pump sector is well-positioned to reap the rewards of what many are calling the Fourth Industrial Revolution.

BY **DAVID DRAKE,** AMI GLOBAL

The Industrial Internet of Things (IIoT) is a wave of innovation that turns machinery into intelligent equipment through cloud-networked sensors and software. IIoT has the potential to become one of the biggest drivers of global productivity in the next decade as machines, technology and humans further integrate and unleash an unprecedented level of efficiency.

Such sweeping change is not difficult to imagine now that billions of previously inert pieces of equipment can be digitized. The pump sector, with complex machines throughout all major industries, is well-positioned to reap the rewards of the Fourth Industrial Revolution.

At its most basic, IIoT connects industrial machines using a network of remote servers hosted on the internet to store, manage and process data. IIoT makes this information and automation available 24/7 from anywhere in the world.

Field-based assets and information can be accessed securely from any web-enabled device, which makes remote programming, troubleshooting, alerting and reporting available in a simple and affordable format for end users.

Users have access to the latest software stacks, multiservice gateways and sensors to bring actionable data from the field into business operations. IIoT's technological versatility allows the base technology to be easily adapted to a wide array of industries.

IIoT's core customers are industrial equipment manufacturers and end users seeking reliable, secure and cost-effective connectivity solutions for their product lines. Many of the largest multinational companies have recognized the transformative value of IIoT, notably in the development of more service-based business models. Companies such as GE, Schneider Electric, Siemens and Rio Tinto have positioned substantial portions of their business models around IIoT.

The ability to generate outsized productivity gains, competitive advantage and additional revenue streams is driving this shift. In a 2015 Accenture survey, 84 percent of C-Suite business leaders stated they could generate new income streams from the integration of IIoT.

The widespread integration of IIoT products and services into the global economy is estimated to generate up to $14 trillion of additional output over the next 15 years.

Pump equipment manufacturers and their end users are equally poised to derive connectivity and pump efficiencies from IIoT. By providing automated alerts based on system optimization, IIoT allows manufacturers and end users to benefit from full-time monitoring and control that reduce downtime, wear and tear, and water and energy consumption. This kind of automated and predictive control produces considerable savings and productivity gains that offer competitive advantage.

IIoT connectivity also allows for the creation of valuable new databases that manufacturers can use to enhance products and establish closer customer relationships.

Since their inception, industrial manufacturers have struggled to shrink the distance between themselves and their customers. Connectivity allows pump manufacturers to know who their customers are, where their machines are installed and how those machines are being used. IIoT provides an unprecedented level of market intelligence and relationship building in a currently fragmented marketplace between vendors and clients in the pump industry.

IIoT's value proposition for pump manufacturers and end users is commoditization from IIoT. IIoT can enable pumps with connectivity and build vast associated services and data accumulation. As manufacturers and contractors struggle in a price-sensitive market, it is imperative for them to differentiate themselves on a service level. By leveraging the power of IIoT, both manufacturers and contractors can open up new revenue streams based on service models while at the same time reducing their associated service costs. ■

David Drake is CEO of AMI Global. AMI provides IIoT and Internet of Agriculture (IoA) solutions, systems and strategies for remote assets. For more information, visit amiglobal.com.

5 Barriers to IoT Adoption & How to Overcome Them

Even with all necessary systems and processes in place, a strategy can be crushed by old visions of what a company is or aspires to be.

BY **DAN YARMOLUK**
ATEK ACCESS TECHNOLOGIES

The Internet of Things (IoT) is changing the future of industry. Cloud-connected "things," including all manner of equipment and devices, are becoming pervasive among consumers and business alike.

Many of these concepts are not new. Some were known by different labels in the past: supervisory control and data acquisition (SCADA) systems, telematics, machine-to-machine (M2M) communications. Another term has been coined: "Industry 4.0," representing the Fourth Industrial Revolution.

There are many concrete examples of the IoT in action. In oil and gas, industrial equipment is being remotely monitored across vast distances and often in harsh environments. In agriculture, moisture sensors are used to minimize water usage while maximizing crop yields. Commercial buildings are being retrofitted with next-generation, connected heating, ventilation and air conditioning (HVAC) systems that can factor in weather to maintain comfort and save energy.

Pumps and systems can be retrofitted with accelerometers to analyze vibration and temperature as ongoing condition monitoring. The learning and trends, or normative data, can be analyzed to have a true sense of degradation over time and feed into a data-driven preventive maintenance schedule.

Business Drivers for IoT

Along with vision, IoT projects need funding justification with a business case. There are principally four main business drivers for commercial IoT projects.

- *Comply with new regulations*: An example is the U.S. Department of Transportation's new rules for commercial drivers around e-logs and hours of service. Electronic compliance is a straightforward way to document these new regulations digitally.
- *Reduce or avoid costs*: Examples include field service, logistics and supply chain optimization. Industry is moving from scheduled maintenance to a predictive maintenance model. Also, companies are using IoT to prevent inventory losses among valuable, perishable assets like food and pharmaceuticals.
- *Differentiate product*: Industrial companies are offering connected product features as adjunct offerings to differentiate themselves from competitors, increase revenue, avoid commoditization, enable better reliability and improve uptime. Additionally, manufacturers are using connected product customer usage data to gain insights and improve road maps.
- *Generate new revenue streams*: Monitoring a product sold to a customer can enable premium service levels, as well as entirely new managed services revenue streams for manufacturers. IoT is also reinventing


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the concept of equipment leasing: IoT enables managed hardware-as-a-service monitoring—or subscription-type offerings—that bundle the device with connectivity and the application. This is opening up recurring revenue-based business models for traditional manufacturers. Traditionally, original equipment manufacturers (OEM) have created a product and sell direct or through distribution. The service element is handled by OSM or outside service and maintenance organizations. As sensors can be connected, the OEM itself can guarantee uptime as opposed to a standard warranty.

But why is there not faster adoption of IoT technology? Here are the top five barriers to IoT adoption:

1 Too much media attention is on informational technology

For the mid-tier industrial world, it is hard to decipher the big picture on how and where to start. As a result, the IoT industry appears heavily focused on gadgets and not making them relevant to the particular business verticals themselves—so the IoT can appear expensive and intimidating. While one must understand the pieces and costs, focus on the desired outcome and peel back the onion one layer at a time. As a manager, use data and information to influence human behavior. For example, a maintenance technician can preempt a costly pump failure through use of data alerts and trending analysis.

2 Conservative technology culture or too much focus on operational technology

A second major barrier has to do with the expertise and culture of industrial organizations, which focus on operational technology (OT). Industrial organizations as OT companies are at direct odds philosophically with informational technology (IT) organizations. While IT is defined by constant change and innovation, OT is change- and risk-averse. That is why it is not unusual to see industrial automation systems in service for decades with little or no change. In a world where production downtime can devastate revenue, stability is the top priority.

Kodak was a market leader until digital disruption eclipsed film photography with digital photos. Some referred to those who do not innovate during these rapidly changing times as being “Kodaked.” One has to commit through a series of small experiments to learn from these organizational changes. Companies can mitigate risk by having reasonable expectations in small, coordinated “digital test beds” to determine the value and return on investment (ROI).

3 Lack of industrial technologists to lead the IoT program

There is the question of who in a company can lead the digital charge. Companies need a person or team that can bridge the gap between the IT and OT cultures so competing priorities are met. The program needs a combined IT/OT perspective for the organization, all within the confines of achieving IoT goals with increasing operational complexity or burdens that may be already short-staffed.

An organization must consider how lean manufacturers are running, and think of innovative ways to automate insights, but have human “touchpoints” that force change from those insights such as alerts, schedule maintenance to save on costs.

There are several certifications in data science, online courses and conferences nationwide to introduce middle management to these concepts. Look to team with universities and vendors that can assist with this function and educational need. The thirst and quest for knowledge must be an ongoing mandate of the executive team.

4 Misunderstanding the ROI

Industrial technology investments are highly ROI-driven. IoT should be seen as a process improvement over time that yields significant savings and efficiencies, not as a typical 12-month payback cycle type of investment. ROI must be looked at holistically with the bottom line organization-wide and from a cost-savings and efficiency-improvement standpoint.

Data should be considered an asset not only for SCADA or monitoring, but as condition monitoring that leads to predictive/preventative maintenance. Sensors that monitor vibration, temperature, humidity and more can provide a wealth of new insights.

Measuring and seeing trends from various sensors can help predict failures before they occur, minimizing unplanned and costly downtime. This also improves maintenance schedules, replacing the calendar or manual guides as leading indicators of planned downtime.

5 Security concerns

With all the news regarding cyber security and hacking, it is easy to worry about the potential problems that occur. But there are safeguards to protect sensitive industrial information.

Data can be verified and encrypted with a myriad of one-way communications depending on the level of sensitivity. SCADA systems do not need to integrate sensor data and action it—they can be separated digitally.

In addition, the cloud infrastructure could be networked internally as a "private" or corporate cloud with no access to the outside world.

How to Begin

A straightforward and practical approach should be used when embarking on an IoT project. This should not be viewed as a massive, company-changing effort, but rather a series of small projects or digital test beds that have the potential to increase revenue, improve the bottom line or boost customer retention.

Realize that not all IoT initiatives will succeed—some say that about half will fail.

A reasonable approach is to pick a few products and services to which adding sensors and connecting them could result in substantial improvement to the organization's bottom line.

In addition, identify products and services that could possibly lead to additional sources of revenue. Research has shown from a portfolio of six projects, one will be a big success, two will be average hits and three will fail.

This approach is manageable and if the pilots are successful, they can be part of the company's offerings. If they do not succeed, they can be considered learning experiments.

This process should be repeated. In addition, one should consider the organizational culture when implementing IoT: ensure buy-in from the top management, identify digital directors, transform the company culture, etc. Even with all necessary systems and processes in place, a strategy can be crushed by old visions of what the company is or aspires to be. ■

Dan Yarmoluk is the business and market development lead for ATEK's IoT products, which include TankScan and AssetScan. He has been involved in analytics, embedded design and components of mobile products for more than a decade. He has an MBA from Loyola University Chicago and a Master's of Data Science from the University of St. Thomas. He can be reached at dyarmoluk@atekcompanies.com.

Improve Flow Rate by Understanding Control Valves

A nearly fully opened valve allows increasing flow—hence higher production—while eliminating a bottleneck or pinch in the system is possible.

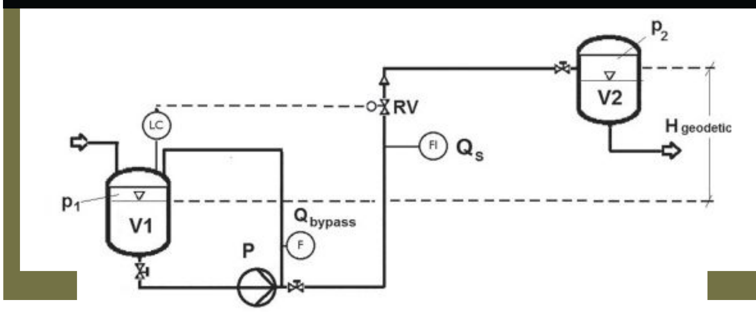
By **Walter P. Schicketanz**
Pumpenfachingenieur GmbH

It is common for process plants to contain many centrifugal pumps. In continuous processes, the conventional method for continuously controlling a pump is to throttle a control valve. The purpose is to defend the controlled variable against disturbances by adjusting the manipulated variable. In pump systems, the manipulated variable is usually the flow of liquid.

When designing a pump system, process engineers typically calculate the static and dynamic pressure drop of the pipework, fittings, in-line equipment and in-line instrumentation at a fixed design flow rate. They then add the control valve's pressure loss, which often is derived from experience. This is traditionally a fixed value of between 0.2 and 0.5 bar. Another way is to allocate a certain percentage, for example, 25 to 50 percent of the dynamic pressure loss of the system-head curve's to the control valve's pressure drop.[1]

Any absolute or relative control valve pressure loss must refer to a certain opening, or travel, typically 60 to 80 percent of full travel. Instead of choosing a certain travel, a percentage of the valve sizing coefficient or rated Cv (Cv at full opening) may be fixed, for example, about 60 to 75 percent.[2]

Figure 1. Schematic of a simple pump system (Pump P) with Control Valve RV, adjusted by a level controller in Vessel V1. Design flow rate is Q. *(Graphics courtesy of Pumpenfachingenieur GmbH)*



$$A = \frac{\Delta p_{RV,S}}{(\Delta p_{dyn,S} + \Delta p_{static})}$$

Equation 1

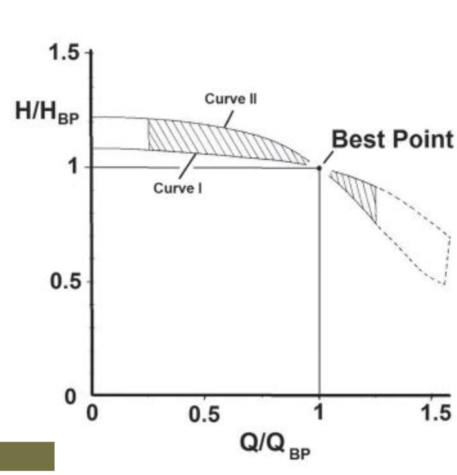
Where:
$\Delta p_{RV,S}$ = the pressure drop of the control valve at design flow rate
$\Delta p_{dyn,S}$ = the sum of the dynamic pressure loss at design flow rate
Δp_{static} = static pressure difference

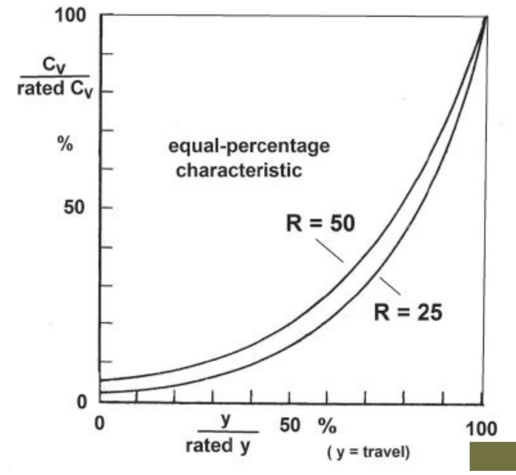
Depending on a valve's parameter, the flow rate will increase when the valve is opened to 100 percent travel. However, an operating controller will respond to disturbances by oscillating so the maximum flow rate at 100 percent travel cannot be reached in reality and constitute a limit. Nevertheless, a nearly fully opened valve allows increasing flow, hence higher production, and eliminating a bottleneck or pinch is possible.

Figure 1 shows a system in which a centrifugal pump (P) moves liquid from a suction side vessel (V1) to another vessel (V2). Immediately after the pressure nozzle of the pump, a bypass line forks off; this recycles part of the liquid through a resistance device to V1. The main flow passes an actuated control valve (RV) on its path to V2.

The control valve's opening, or travel, is determined by a controller, in this case, the level controller (LC) in vessel V1. The controller could also be located somewhere else in the process, for example, a temperature controller in the bottom of a distillation column.

Figure 2 (left). Field of radial centrifugal pumps' dimensionless characteristics limited by Curves I and II
Figure 3 (right). Characteristics of equal-percentage control valves of different rangeability R





The pipework with all of its members exerts a dynamic pressure loss; so does the control valve RV. In addition, there is a total static pressure difference that consists of the difference in pressure between V1 and V2, plus pressure from the geodetic height.

A generalized example can demonstrate the influence of the control valve parameter on the maximum flow rate. Pump characteristics are described using the best efficiency point (BEP) as reference. Most radial centrifugal pumps, usually small pumps featuring a low specific speed, cover the characteristics in Figure 2. Actual characteristics are scattered over a wide range with a clear tendency toward steeper characteristics similar to Curve II with increasing specific speed.[3]

The pump system can be characterized by three parameters. The first describes the relationship between pressure loss of the control valve and that of the system (see Equation 1). The second allocates a certain dimensionless travel Y_s (see Equation 2) to the pressure loss of control valve $\Delta p_{RV,S}$ at design conditions.

The dynamic pressure loss at design flow rate $\Delta p_{dyn,S}$ is divided also by the sum of the dynamic pressure loss plus static pressure difference Δp_{static}. For example, $\Delta p_{static} = 0$ reflects a closed loop system, B = 1. Changing the travel of a control valve will change flow rate. The relationship between the capacity or flow rate versus travel follows a specific curve. Equation 4 demonstrates the equal-percentage characteristic, which is found in the majority of valves.

Figure 3 reflects this in dimensionless terms, for example, Cv divided by rated Cv over the travel/rated travel, with the parameter being the rangeability R = 25 and R = 50, respectively.

$$Y_S = \frac{ys}{(\text{rated } y)}$$

Equation 2

$$B = \frac{\Delta p_{dyn,S}}{(\Delta p_{dyn,S} + \Delta p_{static})}$$

Equation 3

$$Cv(y) = (\text{rated } Cv) \exp[(y/\text{rated } y - 1)\ln R]$$

Equation 4

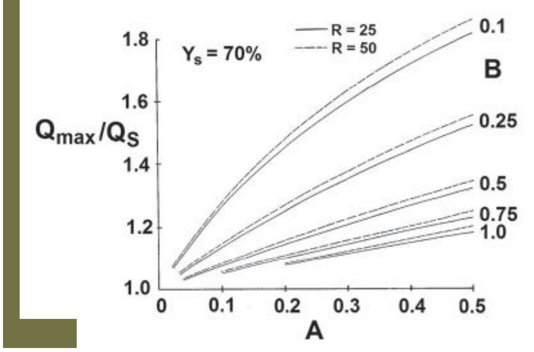
Where:
Cv = the valve sizing coefficient
y = travel
R = rangeability (ratio of flow rate of fully open to flow rate of closed valve[4])

Influence of the System's Parameter

A calculation of the system in Figure 1 was performed with some simplifications (for example, a negligible pressure drop on the suction side and also from the pressure side of the pump to the fork-off point of the bypass).

The calculation assumed a fixed bypass flow of 10 percent of flow at BEP, and the pressure drop of the control valve at design was fixed to a travel of 70 percent. The control valve featured an ideal equal-percentage characteristic and a rangeability of 25 and 50, respectively.

Calculation results are shown in Figure 4 and are based on pump characteristic Curve I. The relative maximum flow rate is plotted versus A, the relative pressure drop of the control valve at design.



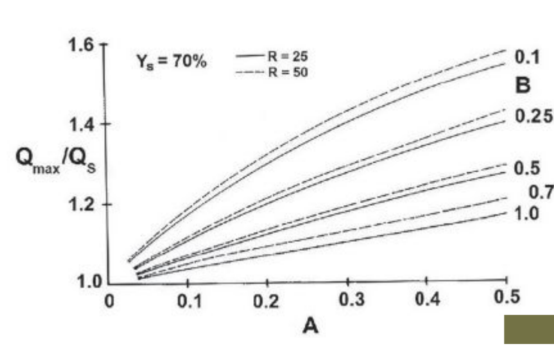


Figure 4 (left). Maximum flow dependent on relative pressure loss of control valve, variable A, based on Curve I of Figure 2. Parameter B represents the relative dynamic pressure loss of system.
Figure 5 (right). Maximum flow dependent on relative pressure loss of control valve, variable A, based on Curve II of Figure 2. Parameter B represents the relative dynamic pressure loss of system.

Parameter B constitutes the system's relative dynamic pressure loss. The same calculation was performed based on the pump's characteristic, as demonstrated by Curve II (see Figure 5).

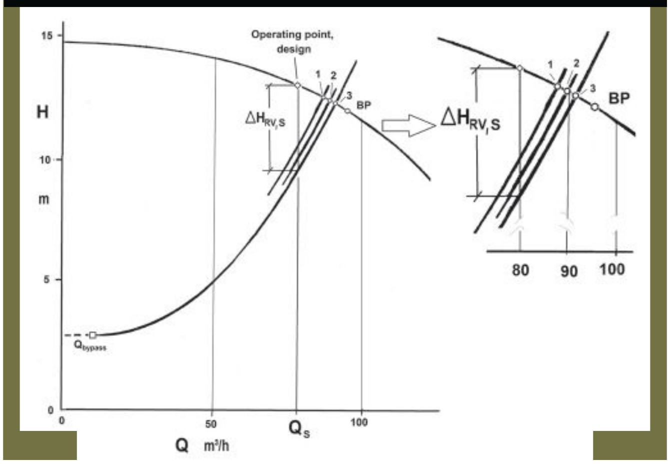
A comparison of those figures demonstrates the great influence of the pump's characteristic on the maximum flow rate: The flatter the pump curve, the larger the maximum flow rate at a given relative pressure drop of the control valve.

Doubling the rangeability of the control valve increases the maximum flow rate to a small amount.

The previous scenario may be highlighted by another example having a configuration like the system in Figure 1 and where a control valve of low rangeability (base case) is replaced by valves with higher ones.

The H-Q diagram in Figure 6 contains the pump's characteristic and the system's pressure drop curve without the loss of the control valve.

Figure 6. Example of the influence of a control valve's rangeability on maximum flow rate.



Adding the control valve's pressure loss, which had been fixed to ΔH_{RV} = 3 m at a dimensionless travel of Y_S = 70 percent, results in an operating point 1 (base case) that matches the design flow rate and a bypass of 10 m³/h.

The plot in Figure 6 shows several scenarios, with duty points at various maximum flow rates due to different control valves' rangeabilities. The maximum flow rate Q_S is determined by a travel of 100 percent—a totally open control valve.

The pressure loss curve of the system with different rangeabilities of the control valves was calculated using the appropriate rated Cv, converting it into the frictional loss factor, which is subsequently used in the Bernoulli equation.

The friction loss factor decreases with increasing rangeability; in an extreme case, it becomes more or less equivalent to that of a full bore pipe having the length of the valve.

Based on the design flow rate Q_S, the relation Q_{max}/Q_S may be taken from Figure 6:

- Point 1 (base case): R = 25; Q_{max}/Q_S ≈ 109 percent with linear characteristic of control valve
- Point 2: R = 25; Q_{max}/Q_S ≈ 113 percent for equal-percentage characteristic

- Point 3: R = 150; $Q_{max}/Q_S \approx 114$ percent for equal-percentage characteristic—a straight pipe replacing the control valve resulting in $Q_{max}/Q_S \approx 115$ percent

This example illustrates that a high rangeability typically does not have a great effect, but this result depends on the individual system and the parameter chosen.

Additionally, at the same design pressure loss and design travel of the control valve, an equal-percentage valve characteristic allows a higher maximum flow rate because of a steeply increasing Cv.

Nevertheless, whenever the travel approaches 100 percent, controllability may deteriorate because a small change of travel causes a relatively large change in flow rate.

Conclusion

Qualitatively, the steeper a pump's characteristic falls, the smaller the maximum flow rate, and the higher the relative dynamic pressure loss of the system, the smaller the maximum flow rate.

The parameter "design flow rate" and "design pressure loss and travel" of the control valve establish the reference values. As a result, increasing a specified design flow rate by 10 percent, for example, without also increasing the pressure the pump delivers does not mean that the system will necessarily achieve this flow rate. ■

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Meter Biocides for Cleaner Cooling Tower Systems

Cut down on microorganism growth to overcome fouling and potentially hazardous conditions.

By **Jeff Shaffer**
Graco Inc.

Cooling towers are used all over the world to cool processes in commercial and residential establishments. The towers can be found in hospitals and hotels, petrochemical refineries, power generation facilities, general manufacturing plants, and food and beverage production facilities. In each, these systems are responsible for cooling processes to keep production running smoothly and efficiently.

The system works by circulating water through the process to absorb excess heat. The heated water then flows back to the cooling tower where it is reverted back to the ambient temperature through open air environments and evaporation.

In order to continuously cool these processes, a significant amount of water is stored within the cooling tower and auxiliary system. If the location of the system is close to a cool water source, such as an ocean or river, it is possible to use a continuous source of fresh water. In most instances, continuous water sources are not available, and water must be cooled and reused multiple times.

Potential Problems

A few issues can arise when circulating and reusing large amounts of water. First, the hardness, or pH, of the water can cause fouling and scaling within the piping and valve system where the cooling system supplies water.

Image 1. The introduction of biocides or growth inhibitors can manage microorganisms. *(Courtesy of Graco Inc.)*

This is often noticed in boiler systems where prevention of fouling is critical for optimal performance. To overcome fouling, most systems employ a chemical pump to dose anti-fouling and anti-corrosion agents into the water. The amount of anti-fouling agents and the size of the pump required to supply the chemicals are determined by the size of the system in place.

The second issue is the growth of algae and microorganisms within the water system of open-air cooling towers. Algae and bacterial growth decrease efficiency, increase the cost of operation and potentially harm the people in the facility and surrounding neighborhood.

Legionnaires' disease, which has symptoms similar to severe forms of pneumonia, has often been traced back to cooling towers with excessive algae and bacterial growth. When bacteria is allowed to grow uninhibited, the disease is often released into the air during the evaporation process or released into the facility through the air or water supply. The airborne disease can travel through the air up to three miles.

The severity of bacteria and microorganism growth depends on a combination of several factors: the quality of the water source, the amount of sunlight and exposed air in the system, the temperature of the system, and the amount of moisture in the surrounding environment. Bacteria are typically dormant below 20 C, but they can multiply rapidly when temperatures are between 20 and 45 C.

Algae & Bacteria Control

One effective approach plant managers can take to properly control the growth of disease-harboring microorganisms is to introduce a biocide or growth inhibitor into the system. Out of three types of growth inhibitors—oxidizing, non-oxidizing and bio-dispersant—the most common is an oxidizing inhibitor, such as sodium hypochlorite, also known as bleach, which can be introduced into the system in liquid form to effectively kill microorganisms and prevent further growth.

Sodium hypochlorite can be a difficult liquid to handle due to off-gassing, which occurs during pumping. Due to the introduction of gas into the fluid stream, peristaltic pumps are the preferred technology because of their lack of check-valves, allowing them to pump fluids with gas entrapped inside. Single diaphragm style pumps have issues handling gas and can become vapor locked without the installation of an off-gas valve.

In addition to selecting a peristaltic design with wetted materials that are chemically compatible, several other factors must be considered for handling sodium hypochlorite.

First, the system operator should ask if the pump is rated for outdoor use, since most cooling towers are outside and may not allow for the pump to be placed inside a building or facility.

Perhaps a more pressing factor to consider is the climate and temperature where the cooling tower is located.

In the northern U.S., in states like Minnesota, algae and organism growth is minimal to non-existent during the cold winter months but becomes a problem during the warm, humid summer months.

In this case, the pump must have a high range of flow rates, or turndown ratio, to cover the various requirements throughout the year.

This is contrary to the requirements of cooling towers in southern states such as Florida, where the climate is warm and humid all year, which makes algae control a consistent battle.

This application would require a higher volume of bleach and larger pump to achieve desired flow rates, but the consistency of the warm weather would eliminate the need for high turndown ratio.

In the Field

Minnesota Power, a utility company based in Grand Rapids, Minnesota, has previously used single diaphragm metering pumps to transfer a mixture of 17 percent sodium hypochlorite to combat bacteria growth in its cooling tower and condenser cooling systems. The utility found that the single diaphragm metering pumps were costly to maintain and did not handle the off-gassing of bleach as well as peristaltic hose pumps. Minnesota Power added some pumps, including a new model peristaltic pump with a CSM hose and Hastelloy barbs to handle sodium hypochlorite.

Since the switch to peristaltic pumps, Minnesota Power has been pleased with their performance. Jason Vickerman, maintenance planner for Minnesota Power, said it operates efficiently for the application. “It requires very little maintenance. The hose lasts about six months before needing to be replaced,” Vickerman said.

Minnesota Power’s internal water lab can easily test for bacterial growth and adjust bleach requirements by using a supervisory control and data acquisition (SCADA) control to speed up or slow down the pump to adapt to Minnesota’s changing climate.

“We operate a rigorous inspection procedure on our systems,” Vickerman said. “Because of the reliability of the pumps, our system has not had any issues with bacterial outbreaks or large system downtime.”

Companies such as Minnesota Power realize that properly controlling bacterial growth is a vital concern for the health and safety of employees and the greater community. To effectively combat bacteria in cooling towers, it is important to conduct a comprehensive study of algae, bacteria and their growth rates. This will help determine the optimal direction when considering the appropriate pump. ■

Jeff Shaffer is a product marketing manager at Graco Inc. for the Process Division. His areas of focus include developing products for the fluid-handling applications targeted toward electric-driven pump technologies and sanitary markets. He may be reached at 612-379-3702 or jshaffer@graco.com.

A Beginners' Guide to Flow Meters

Not all meter designs are appropriate for every application.

By **Brian Kettner**
Badger Meter

Flow measurement is a critical aspect of operations involving pumps, valves and other industrial systems. Users choosing flow meters to measure the flow of liquids or gases must consider key factors to make the right decision. There are significant differences between meter designs, with each type of device having its own pros and cons.

Image 1. Coriolis flow meters are designed to directly measure fluid mass over a wide range of temperatures with very high accuracy. *(Images courtesy or Badger Meter)*

Evaluating Meter Technologies

Flow meters are excellent tools to measure, monitor and control the distribution of a host of fluids. There is the question of which technology to use because a wide variety of meter configurations are available and each must be properly deployed to achieve optimal performance.

Coriolis: Coriolis flow meters directly measure fluid mass over a wide range of temperatures with very high accuracy. Their unobstructed, open flow design is suitable for viscous, non-conductive fluids. With no internal moving parts, Coriolis meters require minimal attention once installed (see Image 1).

Differential pressure: Differential pressure (DP) meters employ a proven, well-understood measuring technology that does not require moving parts in the flow stream. DP meters are not greatly affected by viscosity changes.

Electromagnetic: Electromagnetic meters measure virtually any conductive fluid or slurry. They provide low pressure drop, high accuracy, high turndown ratio and excellent repeatability. The meters have no moving parts or flow obstructions, and are relatively unaffected by viscosity, temperature and pressure when correctly specified.

Positive displacement: Positive displacement meters are highly accurate (especially at low flows) and have large turndown ratios. These devices have only one or two moving parts, making them easy to maintain. There is no need for straight pipe lengths as with other metering approaches.

Thermal mass: Thermal mass meters carry a relatively low purchase price. They are designed to work with clean gases of known heat capacity, as well as some low-pressure gases not dense enough for Coriolis meters to measure.

Turbine: Turbine meters are known for high accuracy, wide turndown and repeatable measurements. They produce a high-resolution pulse rate output signal proportional to fluid velocity and, hence, to volumetric flow rate. Turbine meters are limited to use with only clean fluids, and they require periodic recalibration and service.

Impeller: Impeller meters are frequently used in large diameter water distribution systems. Their attributes include direct volumetric flow measurement (often with visual indication); universal mounting; fast response with good repeatability; and relatively low cost. Their performance suffers in applications with low fluid velocity.

Ultrasonic: Ultrasonic flow meters have no moving or wetted parts, suffer no pressure loss, offer a large turndown ratio, and provide maintenance-free operation. Clamp-on ultrasonic meters can be used for troubleshooting a wide range of flow issues (see Image 2).

Variable area: Simple, inexpensive and reliable, variable area meters provide practical flow measurement solutions for many applications. Be advised most of these meters must be mounted perfectly vertical. They also need to be calibrated for viscous liquids and compressed gases.

Vortex: Vortex meters have no moving parts that are subject to wear, so regular maintenance is not necessary. They can only measure clean liquids. Vortex meters may introduce pressure drop due to obstructions in the flow path.

Oval gear: The latest breed of oval gear meters directly measures actual volume. It features a wide flow range, minimal pressure drop and extended viscosity range. This design offers easy installation and high accuracy, and measures high temperature, viscous and caustic liquids with simple calibration.

Nutating disc: Nutating disc meters have a reputation for high accuracy and repeatability, but viscosities below their designated threshold adversely affect performance. Meters made with aluminum or bronze discs can meter hot oil and chemicals.

Identifying Selection Criteria

In a typical industrial facility, fluid characteristics, flow profile, flow range and accuracy requirements are important for determining the best flow meter for a particular measurement task. Additional considerations such as mechanical restrictions and output-connectivity options impact the user's choice.

For plant operations, the key factors in meter selection include:

Image 2. Clamp-on ultrasonic flow meters can be used for troubleshooting a wide range of flow issues, from verifying the reading of another meter to monitoring flow systems over an extended time period.

Process media: Fluids are conventionally classified as either liquids or gases. The most important difference between these two types of fluid lies in their relative compressibility (i.e., gases can be compressed much more easily than liquids). Consequently, any change that involves significant pressure variations is generally accompanied by much larger changes in mass density in the case of a gas than a liquid.

Type of measurement: Industrial flow measurements fall under one of two categories: mass or volumetric. Volumetric flow rate is the volume of fluid passing through a given volume per unit time. Mass flow rate is the movement of mass per time. It can be calculated from the density of the liquid (or gas), its velocity and the cross-sectional area of flow.

Flow rate information: A crucial aspect of flow meter selection is determining whether flow rate data should be continuous or totalized. A flow rate has to do with the quantity of a gas or liquid moving through a pipe or channel within a given or standard period of time.

Desired accuracy: Flow meter accuracy is specified in percentage of actual reading (AR), percentage of calibrated span (CS) or percentage of full-scale (FS) units. It is normally stated at minimum, normal and maximum flow rates. A clear understanding of these requirements is needed for a meter's performance to be acceptable over its full range.

Application environment: Users must decide whether the low- or high-flow range is most important. This information will help in sizing the correct instrument for the job. Pressure, temperature, density and viscosity conditions are equally important parameters.

Fluid characteristics: Users should be cautious that the selected flow meter is compatible with the applicable fluid and conditions. Thick and coarse materials can clog or damage internal meter components, hindering accuracy and resulting in frequent downtime and repair.

Installation requirements: Planning a flow meter installation starts with knowing the line size, pipe direction, material of construction and flange-pressure rating. Complications due to equipment accessibility, valves, regulators and available straight-pipe run lengths should also be identified.

Power availability: Today's installations normally call for intrinsically safe instruments, which are "current limited" by safety barriers to eliminate a potential spark. Another option is to employ fiber optics.

Necessary approvals: Approvals for the use of flow measurement equipment in hazardous plant locations include FM Class 1 Division 1, Groups A, B, C and D; and FM Class 1, Zone 1 AEx d (ia) ia/IIC/T3-T6. Standards such as the Measuring Instruments Directive (MID) in the European Union (EU) apply to fiscal and custody transfer metering for liquids and gases.

Output/indication: Flow meter users must decide whether measurement data is needed locally or remotely. For remote indication, the transmission can be analog, digital, or shared. The choice of a digital communications protocol such as HART, FOUNDATION Fieldbus or Modbus also figures into this decision.

Choosing the right flow measurement solution can have a major impact on operational and business performance. Companies anticipating a flow meter purchase should consult with a knowledgeable instrumentation supplier in the early stages of a project. This will ensure a successful application once the equipment is installed. ■

Brian Kettner is a product manager for Badger Meter. Badger Meter serves the global flow measurement market. For more information, visit badgermeter.com.

Motor Control Centers Enhance Smart Pumping Systems

These advanced components connect with a networked automation system and provide more control and safety for protecting pump systems.

By **Glynn Newby**
Eaton

Modern motor control technologies have surfaced that address evolving smart pumping system requirements. They protect pumping systems by simultaneously providing a new level of diagnostics, energy awareness and control, as well as by enhancing operator safety.

System management has moved away from the equipment itself and into the control room. The components in motor control centers (MCC) offer advanced protection, efficiency and information, so that operators can provide more effective predictive maintenance.

Among the variety of solutions essential to the distribution of power, low-voltage MCCs are unique because they can be used for power distribution, as well as for the control and protection of motors. MCCs are traditionally the most effective way to group motor control, associated control, distribution and industrial communications equipment.

A typical MCC is designed to meet National Electrical Code (NEC) and Underwriters Laboratories (UL) standards for safety. They are designed to be used in a range of environments—from standard commercial to harsh and hazardous—and are built to withstand a variety of environmental conditions covered by National Electrical Manufacturers Association (NEMA) 1, 2, 12 and 3R ratings.

MCCs range in complexity of application from basic mechanical motor control to advanced communicating solid-state motor control.

These advanced components can communicate to the rest of a networked automation system and provide more control and safety for protecting pump systems.

Also, because MCCs can remain in service for decades, there has been increased demand in recent years for solutions that help customers update and replace legacy componentry to modern communicating motor controls components.

Motor Management Relays

Many new options are available when it comes to protecting pumps from various issues associated with motor overloads.

Motor management relays are one example of an emerging technology that enables improved diagnostics and intelligence of pumping systems without requiring a complete overhaul of the distribution and control system.

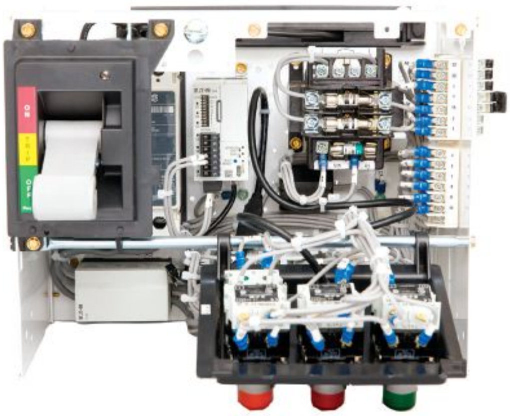

Image 1. A motor management relay can provide monitoring accuracy and protection for the entire power system from the incoming power source feeding the motor all the way to the individual pump or load. *(Images courtesy of Eaton)*

These motor management relays increase energy awareness, improve diagnostic capability and enhance uptime through excellent monitoring and protection.

These devices communicate on all standard industrial protocols and provide performance data on entire pumping systems.

Unlike legacy overload relays, motor management relays contain features such as real-time clocks, non-volatile memory backup, motor temperature protection, efficiency monitoring, fault queues, trip snapshots and optional algorithms that provide automatic restart after an outage.

These relays are also capable of remote configuration and monitoring, which contribute to operator safety.

Image 2. This motor control center design combines arc-containment and arc-preventative technologies to establish new levels of protection.

Another example of product evolution in the smart pumping space is in drives technologies. Drives can support communications and save energy costs in the process. The general-purpose drive incorporates an energy-control algorithm, extensive onboard industrial communication protocols and built-in harmonic reduction to help reduce the cost of using a drive for pump control.

The modular design, using the latest generation of semiconductor technology, can provide greater reliability and reduce maintenance time and costs. With embedded communications capabilities and an enhanced graphical display, drives can provide detailed system data to simplify installation, commissioning and maintenance.

Some software tools make it easier to connect low-voltage motor control solutions, including drives, directly with the automation system.

Algorithms that enable active energy control can dynamically adjust the voltage and help optimize motor performance while minimizing power usage. Compared to standard drives' out-of-the-box linear volts per hertz (V/Hz) curve performance, active energy control has been shown to yield a 2 to 10 percent cost savings—and that is for applications already using adjustable frequency drives.

Energy savings calculators are available to provide energy cost savings metrics against a standard across-the-line motor starter. This feature enables users to see cost savings in real time.

The data can be customized to reflect local energy costs, currency and the format that energy savings are displayed. The data can be accessed daily, cumulatively and over time.

Enhancing Safety

Two of the most common requests in MCC technology are for product longevity and safety during maintenance. MCCs require regular maintenance and have higher instances of user interaction than most other electrical equipment. When there is an issue and personnel must perform maintenance, some MCC product features can help protect workers.

Arc flash safety is one of many requirements that continues to evolve in power distribution and controls. For example, arc-resistant designs engineered to contain arc blast energy are no longer limited to switchgear. MCCs are available with a Type 2 accessibility rating, which means that arc-resistant designs are present on the front, back and sides of the assembly. This rating translates to enhanced safety around the entire perimeter of the MCC if an arc flash event occurs.

Arc flash safety solutions found in today's MCCs are specifically designed to help reduce personnel risk during maintenance. Industrial circuit breakers address this in MCCs through technologies that reduce the energy available during an arc flash event. Safety remote racking mechanisms can be found within modern MCCs, providing bus isolation, stab indication and lockout features that proactively prevent the initiation of an arc flash event during maintenance operations.

Global manufacturers have the expertise to design and build components that assimilate well into smart, communicating pumping systems. Because of networked devices such as drives and motor management relays, end users can be sure that they have the information they need to run a safe and energy-efficient remote pumping installation. In the case that maintenance is required, they can be sure that their personnel will be safe as they interface with modern MCCs. ■

Glynn Newby is a product manager at Eaton for its motor control center solutions. Newby has more than a decade of engineering experience.

Improper Gasketed Joints Can Be Deadly

By **Jim Drago,** FSA Member, Garlock Sealing Technologies &
Ron Frisard, FSA Member, A.W. Chesterton

Safety is a concern at any industrial site. An Occupational Safety and Health Administration compliance specialist has stated that safety should be more than a priority: "Priorities in an organization can and usually do change. Safety and health need to be a core value of the organization."[1]

Safety can be a case of values versus priorities. When it comes to sealing devices, perceived dangers sometimes are overlooked. The case of an explosion at a refinery in Anacortes, Washington, shows how deadly accidents can occur when safety risks are distorted.

Image 1. Ruptured heat exchanger *(Courtesy of the U.S. Chemical Safety Board)*

A heat exchanger, known as E-6600E, catastrophically ruptured at the Tesoro refinery in Anacortes on April 2, 2010 (see Image 1). Highly flammable hydrogen and naphtha at more than 500 F were released from the ruptured heat exchanger and ignited, causing an explosion and an intense fire that burned for more than three hours. The rupture fatally injured seven Tesoro employees (one shift supervisor and six operators) working near the heat exchanger.

The Anacortes incident has been reviewed by many organizations, including the Chemical Safety Board (CSB), which released a 160-page report.[2] Acceptance of a non-safety-focused culture is one of the major points made in the CSB report. This accident and the CSB report illuminate many lessons regarding how engineers and maintenance personnel should look at flange leakage and use sealing technology correctly. The Fluid Sealing Association's focus is to assist in educating the industry in sealing technology to create a safer working environment.

E-6600E's flanges had been leaking for many years before the accident. As stated in the CSB report, "The NHT heat exchangers frequently leaked flammable hydrocarbons during startup, sometimes resulting in fires … management had been complacent about these hazardous leaks and did not always investigate the cause of the leaks."

The report discusses how the corrective action process failed to resolve these problems. Actions included the use of steam lances to spray on the leaking flanges during startup to mitigate fires. This required additional personnel near the NHT heat exchanger. Another action was to increase the heat to lessen the heat-up time of the heat exchanger—a contributing factor to the rupture. The use of clamps and active leak repair can mask the underlying sealing problem.

The leakage of these flanges was a technical issue of engineering design, maintenance and sealing devices. The plant sporadically attempted to prevent leaking of the NHT heat exchangers. These attempts included: gasket modifications; changes to torque and bolting practices; resurfacing of flange surfaces; and the installation of warm-up piping to smooth the equipment's transition from cold to hot during heat exchanger startup.

After several severe leaks from the heat exchangers during a March 2009 startup, the plant installed a different type of gasket in August. During the startup that followed, records indicate that no leaks from the heat exchangers occurred. The problem reappeared during the next cycle, and one possible reason was the reuse of the gasket.

Despite published industry best practices that require use of new heat exchanger gaskets after change out, documents indicate that the new heat exchanger gaskets could be reused after flange disassembly at subsequent cleaning cycles. This exemplifies lack of knowledge in sealing devices by not following gasket manufacturer and industry best practice guidance that gaskets should never be reused.

The information may have come from the gasket distributor, which might have had a lack of knowledge. (The Fluid Sealing Association has a gasket manual available at fluidsealing.com.)

Avoid Gasket Reuse

Why should a gasket not be reused? First, when gaskets are installed they are compressed and take a permanent set. The gasket's whole design is to conform to the flange face and seal. If the gasket were 100 percent elastic—such as with homogeneous rubber sheet and molded parts used at ambient temperature and not exposed to elevated temperature—reuse would not be such an issue.

When a sheet gasket made of compressed fibers, inert fillers with rubber binders or polytetrafluoroethylene (PTFE), or metal with flexible graphite filler/laminate is compressed, it is irreversibly densified. When the compressive load is released, it does not return to its original shape. It will not seal under the same assembly conditions as it did when first installed.

Second, heat changes the gasket material's form and properties. Heat will cure and harden gasket materials that contain rubber. At elevated temperatures, the metal used in 100 percent metal and composite metal gaskets can be subject to the reduction of their yield point. Elevated temperature will alter stress versus strain characteristics, taking the material out of the elastic region—causing permanent deformation and a reduction or elimination of resilience.

Understand Thermal Growth

Besides reuse of the gasket, another problem that occurred in this accident is a loss of seating stress caused by thermal growth. When process equipment goes from ambient to elevated temperature, a flange connection's components are subject to thermal growth and movement. Axial and radial growth of heat exchanger flanges is substantial.

Thermal growth rate differences of head flanges, tube-sheets, bolts and gaskets create an upset of the gasket-flange interface and a loss of seating stress on the gasket that can cause flanges to leak. As the equipment heats, the exchanger flanges' faces grow axially and radially. Axial growth causes compressive stresses on the gasket beyond what was provided by the bolt pre-load. Because the flanges and gasket are made of different material, the rates of thermal expansion are different.

Radial growth causes the flange surfaces to wipe across the gasket, upsetting the gasket-flange interface and potentially causing leak paths. Some gaskets, such as corrugated metal with flexible graphite laminates, handle this service better than others. A test developed by the now-defunct Tightness Testing and Research Laboratory of the Polytechnique Montréal included an evaluation to address this called the Radial Shear Test (RAST). Another technology (flange springs) could have been used to give more travel during this time that could have kept a larger seating stress on the gasket.

The 2010 explosion at Anacortes was not directly caused by poor gasket application. The NHT heat exchanger vessel ruptured and caused the fire because of the vessel material's high temperature hydrogen attack, which is metal deterioration from high temperature hydrogen contact. Because of safety complacency that accepted heat exchanger leaks during startup, additional personnel were required to manage those leaks, which led to the tragic loss of life. Technology and know-how are available to assure safe sealing that can make sure everyone safely ends the work day. ■

References

1. "OSHA Update," presentation given to the Monroe Professional Engineers Society on Sept. 27, 2016, by Gordon DeLeys, OSHA Compliance Assistance Specialist
2. Report can be downloaded at the U.S. Chemical Safety Board website: http://www.csb.gov/tesoro-refinery-fatal-explosion-and-fire/

Next Month: Valve Sealing as a System

FLUID SEALING ASSOCIATION FSA

We invite your suggestions for article topics as well as questions on sealing issues so we can better respond to the needs of the industry. Please direct your suggestions and questions to sealingsensequestions@fluidsealing.com.

Jim Drago is the principal applications engineer at Garlock Sealing Technologies. He has worked with sealing technology since 1983. He has a B.S. in mechanical engineering from Clarkson University and is a registered professional engineer in the state of New York.

Ron Frisard graduated from Northeastern University in Boston with a degree in mechanical engineering technology in 1989. He has worked for the A.W. Chesterton Company for the last 26 years in all facets of the mechanical packing. He is currently focused on global product line management for both rotating and stationary sealing.

IIoT Impacts on the Pump Industry & Implementing Vibration Monitoring in a System

By **Hydraulic Institute**

Q How has the Industrial Internet of Things (IIoT) impacted the pump industry?

A The pump industry has seen a growing trend to implement new technologies, based on the Industrial Internet of Things (IIoT) trend. They provide the original equipment manufacturers (OEMs) the opportunity to offer more to the purchasers and users. The Hydraulic Institute recently addressed wireless data transmission technology innovations in the latest revision of the ANSI/HI 9.6.5 *Rotodynamic Pumps for Condition Monitoring* standard.

Condition-based maintenance (CBM) is the monitoring of the output of various sensors and/or indicators. Machinery condition may be assessed by monitoring many indications, but vibration analysis has taken the forefront of implementing wireless data transmission. The level and pattern of vibration can indicate the health and condition of rotating components.

For specific markets, such as industrial sensors, wireless technology is evolving rapidly while standards are significantly lagging.

Proprietary wireless protocols that are specific to CBM sensors are expected to fulfill an important role in enabling wireless online monitoring at a comparable level to a wired solution.

The development of IIoT is expected to increase operational efficiency by up to 45 percent and provide a fairly quick return on investment (ROI) for manufacturers as a result of readily available diagnostic data capabilities.

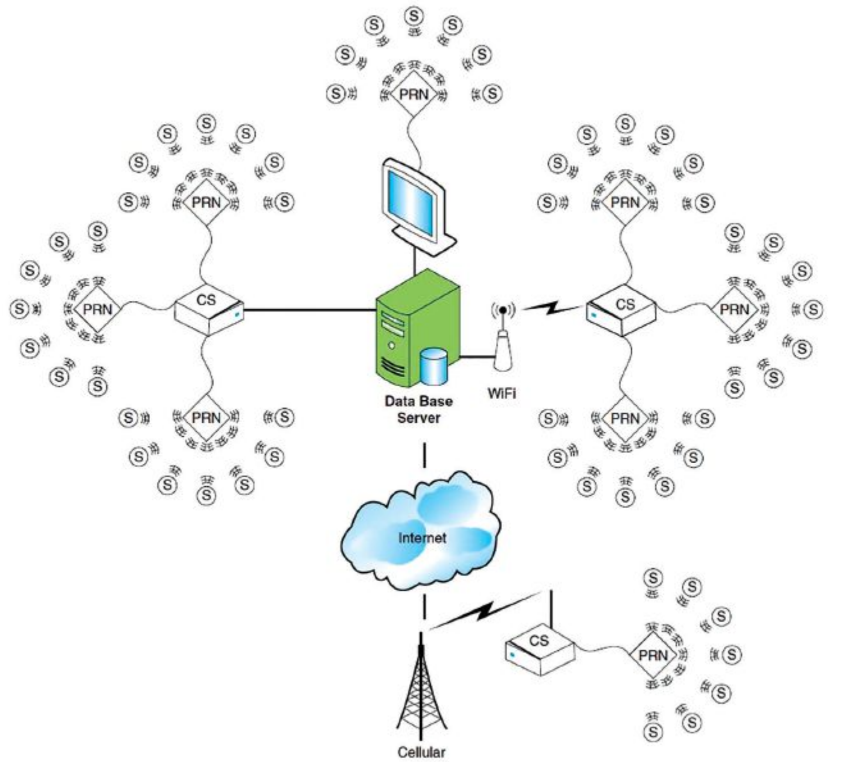

Figure 9.6.5.16.1. Example of a vibration diagnostic system network (star topology) *(Courtesy of Hydraulic Institute)*

Q How can you implement the IIoT to monitor vibration in a pumping system?

A Wireless vibration transmitters provide early indication of potential problems. Various problems in pumps can be detected using vibration monitoring, including bearing problems, imbalance or misalignment of rotating elements, gear tooth damage, loose connections of pump and motor components, and drive belt and coupling problems.

Vibration monitoring sensors are mounted on the bearing housing to detect these changes in vibration. These sensors can be mounted permanently and monitored continuously or mounted temporarily as part of a route-based periodic monitoring system.

Data can be collected in multiple locations and directions (horizontally, vertically and axially) on the equipment. Vibration data is recorded and can be analyzed remotely or by program to identify faults.

There are several topologies for connecting a wireless sensor to a receiving station for data processing. Figure 9.6.5.16.1 shows the star topology network. The star topology is a network that consists of one central node, typically a switch or hub, which acts as a conduit to transmit messages.

In this network for CBM, the primary receiver nodes (PRNs) communicate with multiple vibration sensor nodes simultaneously to collect vibration time data.

In turn, the PRNs connect directly to a database server computer or to a company's network backbone via a collection server.

In effect, a sensor network is a two-level star with a database server computer at the center connected directly to the sensor network scales from a very simple two- to three-sensor network. This can monitor anything from the health of a single machine to a very large network with sensors on hundreds of machines.

Figure 9.6.5.16.1 shows how the collection server may be connected to a plant's or facility's network.

These include Ethernet connected directly to the company's backbone intranet, a Wi-Fi or Bluetooth connection to a company's existing wireless network, and cellular network data connection to the Internet via a cellular telephone carrier. This network infrastructure example highlights the benefits of wireless, online CBM strategies in terms of ease of installation and expandability/scalability.

Radio frequency (RF) wireless communication capability, including transmission range, reliability, and data throughput, pressure important trade-offs in performance and capability that are negotiated when applying wireless solutions to specific applications. For this reason, different wireless communication solutions have emerged to serve markets with different requirements. For example, Bluetooth is suited for pairs of devices that can communicate over short ranges, while WirelessHART enables large networks with low data rates. Wi-Fi supports high data rates but it is not suited for battery-powered operation.

For more information on vibration monitoring for pumping systems, refer to ANSI/HI 9.6.5 *Rotodynamic Pumps for Condition Monitoring*. ■

HI Pump FAQs® is produced by the Hydraulic Institute as a service to pump users, contractors, distributors, reps and OEMs. For more information, visit pumps.org.

HYDRAULIC INSTITUTE

Slow Operation Allows Ball Valves to Prevent Valve Slam

Technological advances related to pump control valves also help pumping system performance and energy savings.

By **John V. Ballun**
Val-Matic Valve & Mfg. Corp.

Three 20-inch high service water pumps at the Huntsville Southeast Water Treatment Plant in Alabama are protected with hydraulically operated American Water Works Association (AWWA) C507 ball valves instead of typical swing check valves. Ball valves were selected by the engineer as a way to save energy. Also, the ball valve is equipped with features to monitor system operation and help prevent damage from equipment variations.

As a result, the pump discharge flow can be carefully controlled to prevent check valve slam and surges in the downstream 48-inch water pipeline (see Image 1). Because ball valves are slow-closing, quarter-turn valves, they are not subject to check valve slam. Also, when pipelines are several miles long, it is important for pump control valves to operate very slowly, over several minutes. The slow operation protects the pipeline from rapid changes in fluid velocity when the pumps are started.

Image 1. Smart ball valve pump control system (*Images courtesy of Val-Matic Valve & Mfg. Corp.*)

On long pipelines, every 1 foot per second (ft/sec) of velocity change can create a 50 pounds per square inch gauge (psig) surge on top of the system pressure. Starting just one of the three pumps could boost the velocity in the 48-inch pipeline several feet per second, potentially causing a 200 psig surge. The solution is to control the opening and closing of the pump control ball valves slowly over 60 to 300 seconds using a hydraulic control panel powered by an oil accumulator supply system. The oil accumulator system provides 80 psig oil pressure for smooth and reliable valve operation, even after a power failure.

Ball valves not only prevent surges by closing slowly, but they also have equal-percentage inherent flow characteristics that help prevent surges on long pipelines. The equal-percentage characteristic states that for

$$A = \frac{(1.65\ Q\ \Delta H\ S_g\ C\ U)}{E}$$

Equation 1

Where:

- A = annual energy cost, dollars per year
- Q = flow rate, gallons per minute (gpm)
- ΔH = head loss, feet of water
- S_g = specific gravity, dimensionless (water = 1.0)
- C = cost of electricity, dollars per kilowatt-hour ($/kW-hr)
- U = usage, percent x 100 (1.0 equals 24 hours per day)
- E = efficiency of pump and motor set (0.80 typical)

every percent change in valve position, there is an equal percentage change in the valve's flow coefficient (Cv). This characteristic allows the valve to effectively control flow through a wide range of its operation. Looking at the geometry of ball valves, they have a seat on each end of the valve, resembling two valves in series, hence their wide operating range.

Energy Calculations

The ball valve is used for pump discharge applications because it can provide energy savings over the plant's life. Most of the energy used at water plants is consumed for high service pumping costs to overcome the static head and friction losses of distribution systems. Head loss can be converted into an energy cost related to the pumping electricity needed to overcome the additional head loss from the valve using Equation 1.[1]

The energy consumption difference between two valve selections can be calculated by using the head loss difference between the two valves for the variable ΔH in the equation. For example, the difference in head loss between a 20-inch ball valve and 20-inch swing check valve operating at 10 ft/sec is approximately 2.5 feet of head.[2] Therefore, assuming the pumps run 50 percent of the time with an efficiency of 80 percent and an electrical cost of 8 cents per kW-hr for 40 years, the following calculation can be made:

40 [(1.65 x 9,792 x 2.50 x 1.0 x 0.08 x 0.5) / (0.8)]
= $80,800 over 40 years per valve
= Total Cost

The calculation shows that the use of a 20-inch AWWA ball valve in the place of a swing check valve can save $80,800 per valve over the plant's life—showing that valve selection can play an important role in energy savings.

Saving electrical energy also reduces the need for burning fossil fuels and creating greenhouse gases. On a national average, for every kW-hr of electricity used, about 1.14 pounds of CO2 emissions are generated. In the previous example, the use of a ball valve would result in savings of 575 tons of CO2 emissions per valve over the 40-year life of the system.

Valve Operation

The ball valve performs the critical function of an automatic check valve, so it needs to be reliable and tight-closing. The ball valve is powered by an oil-powered cylinder actuator built in accordance to AWWA C541, which requires specific materials of construction and production test to ensure a high level of quality and dependability.

The barrel of the cylinder is constructed of a lined fiberglass tube to prevent corrosion. The cylinder rod

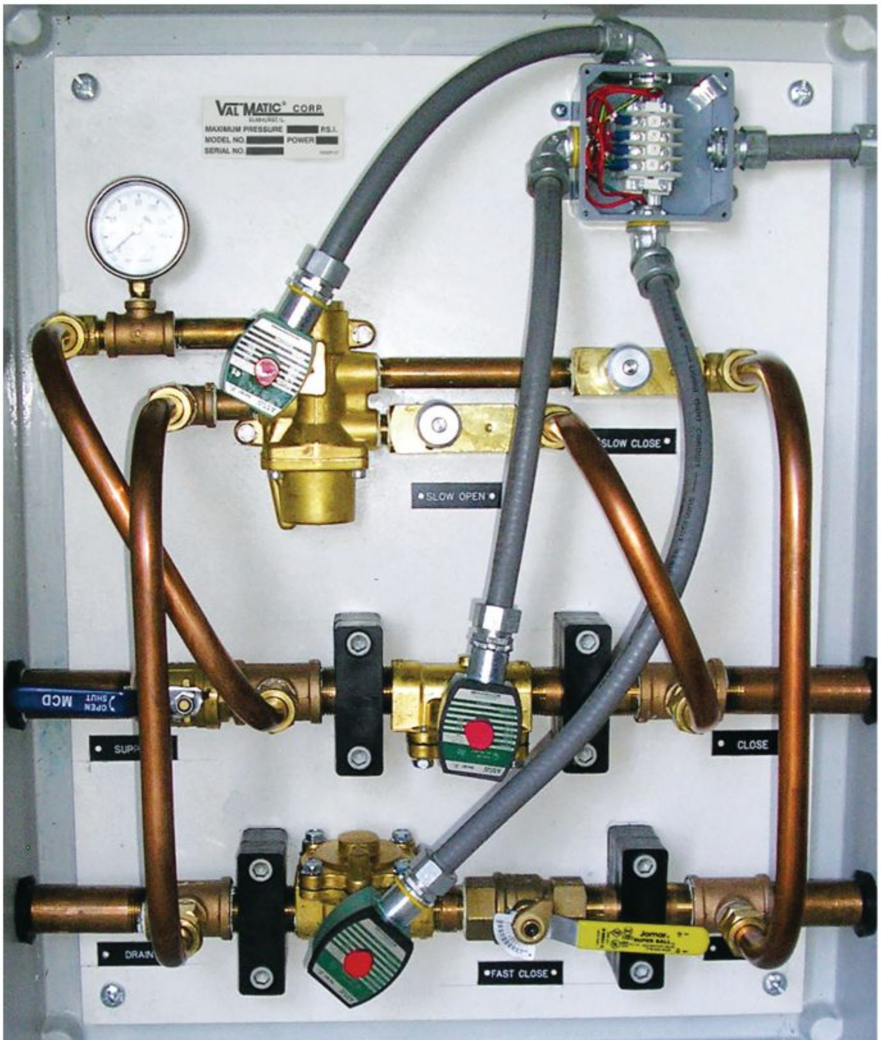

Image 2. Hydraulic control panel

is hard chrome plated stainless steel to prevent wear and corrosion in the cylinder. The hydraulic cylinder is coupled to a quarter-turn, link-lever actuator to provide the required 90-degree rotation to operate the ball valve.

Mounted on the actuator's top is a limit switch control unit that provides a remote signal for valve full-open and full-closed positions. The entire valve assembly was built and tested together in the factory in accordance with AWWA C507.

The valve's hydraulic actuator is controlled by an oil-hydraulic control system consisting of a four-way solenoid valve that opens the ball valve when energized (see Image 2).

Also included are two large two-way solenoid valves that are normally energized. But upon loss of electrical power to the pump station, they allow rapid flow of supply media to the cylinder actuator to rapidly close the ball valve in 10 to 30 seconds to prevent reverse flow through the pump. The hydraulic system also includes flow-control valves to allow field-adjustable operating times.

Smart Electrical Panel

A smart electrical control panel is mounted on top of the hydraulic panel and provides the interface between the hydraulic system and the pump's drive control unit. The electrical panel displays pump system operation, valve position and alarm indications.

The sequence of operation is similar to any check valve, but there is a unique aspect. When a pump is started, its pressure is sensed by a pressure switch, which sends electrical power to the four-way solenoid valve, opening the ball valve. When the "stop" signal is given, the four-way is de-energized, closing the ball valve. However, while the ball valve is closing, the pump continues to run until the ball valve is fully closed, then a limit switch on the valve trips off the pump. In general the ball valve operates like a check valve, but it does so in slow motion and with no slam.

The AWWA ball valve can provide low head loss and equal-percentage flow characteristics to eliminate check valve slam and prevent system pressure surges.

The electrical panel has three independent safety modes to monitor the pumping system. Upon receipt of a pump "start" signal, the pump discharge is monitored by an adjustable pressure switch mounted on the pipe's discharge. If the pump does not reach normal operating pressure of 110 psig within an adjustable time period of 1 to 10 minutes, a safety circuit will close the ball valve and provide an "emergency stop" signal, locking out the system until it is reset. There is a second safety mode that similarly shuts down the system if the pump runs at a high pressure exceeding 140 psig for an extended period, which may be a result of a downstream closed valve.

Finally, if the pump discharge pressure drops below 95 psig for an extended time, a similar safety mode is triggered. The smart panel is wired to the pump control drive for remote monitoring of conditions and helps protect the pumping system from abnormal operating conditions.

Conclusion

Technological advances related to pump control valves can help pumping system performance and energy savings. The AWWA ball valve can provide low head loss and equal-percentage flow characteristics to eliminate check valve slam and prevent system pressure surges. Ball valve hydraulic and electric control panels can deliver reliable operation, field adjustability and smart monitoring of system operation. ■

References

1. AWWA M49. 2012. "Butterfly Valves: Torque, Head Loss, and Cavitation Analysis," 2nd edition, Denver, Colorado
2. Val-Matic Valve's "Energy Cost Calculator," www.valmatic.com/ecalc/calc.php

John V. Ballun is president and CEO of Val-Matic Valve & Mfg. Corp., a valve manufacturer in Elmhurst, Illinois. A mechanical engineer with more than 40 years of valve design experience, Ballun has been a prominent contributor to valve standards development work for ASSE, AWWA and MSS. He is a past president of MSS and is a graduate of Illinois Institute of Technology with a BSE and Northern Illinois University with an MBA.

Engineered Hurricane Barrier Pump Upgrades Help Port City Stay Safe

A 15,000-pound impeller with broken vanes presents an opportunity to improve the original design.

By **Jeff Aliberti** & **Gary Boudreau**
Allen Pump

An ongoing challenge in the industrial world involves aging equipment. Pumps and systems designed a half-century ago are expected to handle today's workload. Too often, dwindling budgets and production pressures force quick turnarounds on repairs, causing operators to miss opportunities to improve reliability and efficiency, as well as reduce the equipment's life-cycle cost.

Pumping systems have numerous variables, requiring time to better understand application details and how each pump operates within the system and its environment. Upon failure or loss of efficiency, an in-depth documented failure analysis should be conducted to identify the failure mode. Oftentimes, simple procedural changes can extend pump life. When catastrophic or recurring failure modes are present, an opportunity exists for engineered upgrades.

A large port city in the Northeast U.S. was scheduled to run a typical functional test on its 650,000-gallon-per-minute (gpm) hurricane barrier pumps. The pumps' function is to protect the city when high seas surge; in an event, gates are closed and water is pumped out of the river bay.

Image 1. The 119-inch impeller undergoing balancing.
(Images courtesy of Allen Pump)

In the test, when Unit 5 started, the entire building that housed the equipment shook violently. Once the shaking stopped and the pump appeared to settle, the team noticed that there was no flow output.

After a quick visual inspection, maintenance personnel determined that the vanes had broken off from the 15,000-pound impeller. The gates were then dropped to isolate the suction pit from the river bay. Two diesel pumps were brought in to dewater the pit.

Running the dewatering pumps for more than 36 hours without emptying the pit revealed an obstruction that blocked the isolation gates.

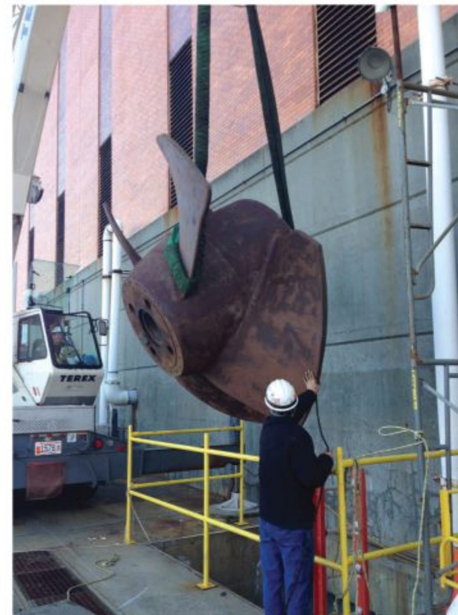

Image 2. The broken 15,000-pound impeller is being removed from the pit.

A diving team was then commissioned to locate and identify the obstruction.

The investigation found that a vane had broken off the rotating element and lodged under the gate. After cranes pulled the gates and removed the impeller vane, the gates dropped again and the suction pit was dewatered. The impeller was detached from the shaft, lowered out of the suction bell, rotated 90 degrees and pulled out of the pit.

After a thorough inspection, the maintenance team attributed the impeller vane cracking to multiple factors. The type of material, Ni-Resist Type 1b cast iron, was used in the early 1960s and specified by the U.S. Army Corps of Engineers to be used on the wetted components of the hurricane barrier pumps. The material contained large graphite flakes and had excellent corrosion resistance in the harsh environment, but it is not recommended today for rotating components because it does not possess enough ductility and is brittle under stress. A modern ductile Ni-Resist conforming to ASTM-A436 and containing 18 to 22 percent nickel has more than twice the tensile strength of the original material and allows the option of weldability.

In addition, a latent defect was found in the casting of the vanes. The leading vane hub root area varied from 0.62 to 0.75 inches thick, while the vanes had an overall thickness of 1.5 to 2.0 inches. This root area was relatively thin with a high stress point and most likely had micro-cracking that resulted from rapid cooling at this section when it was originally poured. It was not known if this was a design problem with the original hand-sketched drawings from the early 1960s before the development of engineering software.

While in service over a long period of time, the numerous micro-cracks in the original casting structure had greatly increased in size because of residual stresses, vibration, operating impacts and other environmental conditions. The original material and poor design contributed to the catastrophic failure.

To reverse engineer this 119-inch impeller, a vane had to first be reattached using a metal stitch process. The broken vane was matched to the original location and locked in position before two additional sets of locks were installed. The impeller was then digitized using two different methods to create a 3-D model. The vane surface profile was acquired by scanning 8-inch-by-8-inch sections with a laser imaging process before layering to produce a point cloud for the actual cast surface contour. The bores and non-vane areas were recorded with a portable laser scanner.

Based on the data acquired, an opportunity existed for an engineered upgrade. The new impeller was designed with a 25 percent increase in service factor, creating a more robust design. The design change equated to an approximate minimum vane thickness of 1.63 inches with a maximum of 2.00 inches. The hub root areas were changed to a 2.5-inch radius on both sides of each vane.

Another design upgrade was the addition of four 8-inch-diameter core holes on the discharge side of the impeller hub. Each hole was machined to accept a blank flange made of the same upgraded metallurgy.

These flanges allow for internal correction balancing weights to be added as needed to achieve optimal impeller balance. These changes did not affect the form, fit or function of the impeller.

The new pattern was made and the impeller cast in the upgraded material. The finish machine work was completed, and the impeller was balanced to 4W/N. The remaining pump components were inspected, repaired and upgraded where possible. All components were delivered on-site, and the impeller was attached to the 12-inch-diameter, 30-foot-long shaft. It was aligned with the 4,500-horsepower electric drive motor that spins at 150 revolutions per minute.

Pump failures can present an opportunity to improve the original design. Engineered pumps require qualified repair and manufacturing partners that understand the intricacies of pump hydraulics. These partners can provide the engineering support and documentation necessary when reverse engineering and upgrading pump components.

In this case, multiple technologies and methods were used to obtain the desired result in a cost-effective and efficient manner. Unit 5 was successfully started prior to Hurricane Irene, which hit the East Coast of the U.S. in 2011. The upgraded pump was used during the storm surge, helping keep the port city safe. ■

Jeff Aliberti is the Southeast regional sales manager for Allen Pump. He and his team service the engineered pump needs of the power and heavy industrial markets for the eastern U.S. He may be reached at jeffaliberti@allenpump.com.
After 25 years working with OEMs as an engineered pump supervisor, service center supervisor and sales engineer, **Gary Boudreau** purchased Chas G Allen Inc. with Chuck Sargent and Dave Krupp in 2006 to form Allen Pump. He started with the Worthington Service Corp.

New & Notable Technology

Products selected by the Pumps & Systems *editors*

1

1 FLOW METERS

BADGER METER announced the introduction of two new vortex flow meters: VN2000 Hot Tap and VN2000 Compact insertion vortex flow meters. VN2000 vortex meters offer a durable and reliable solution for measuring the volumetric or mass flow rate of steam, gas or liquids over a large flow range. The versatile design is capable of measuring water as low as 1.32 feet per second and super-heated steam up to 250 feet per second. It is well suited for applications involving energy flow and heat transfer of saturated steam used for heating commercial buildings, hospitals and multi-building campuses.

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2

2 PACKAGED PUMPING SYSTEMS

FLOWROX packaged pumping systems are engineered units equipped with simple site connections to ensure ease of installation and start-up on site. While the system is designed for ease of use, it can be customized to suit the needs of customers. Flowrox offers a variety of pump models that have IIoT capabilities, which can be integrated into the packaged systems. The systems boast accurate and repeatable flow while reducing maintenance time and cost.

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3

3 VARIABLE FREQUENCY DRIVE

EATON has expanded its line of PowerXL Series DG1 variable frequency drives to include a new, more powerful Frame 6 option. Designed for global commercial, industrial and original equipment manufacturer (OEM) customers, the new Eaton engineered drive increases available power from 150 to 250 horsepower, affording customers greater agility, reliability and safety for their applications. The PowerXL DG1 Frame 6 design utilizes thermal management techniques to provide strong power density and competitive performance.

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4

4 BEARINGS

NSK HPS Series bearings deliver a high-performance standard for load capacities, limiting speeds and operating life across an expanded range of types and sizes. These bearings provide dramatically improved reliability and maintenance cost-efficiency across an array of industrial applications. NSK HPS Series Bearings are designed to outperform and outlast in the toughest conditions.

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5

5 STATOR

NETZSCH PUMPS NORTH AMERICA LLC introduced the iFD-Stator 2.0, which combines efficiency, economy and environmental safety in one system. Featuring a two-part, reusable stator housing and replaceable stator, the iFD-Stator 2.0 is compatible with all NEMO NM series progressing cavity pumps. It delivers reduced pulsation and improved fluid flow compared to conventional stator designs, as well as an increase in efficiency due to reduced starting and running torque. There is no limitation of speed or pressure when measured against the standard stator, and the axial mobility of the elastomer leads to prolonged service life.

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6

6 MIDI DRIVE

DANFOSS has released its VLT Midi Drive FC 280, the evolution of the VLT 2800 drive. The drive is available for applications requiring a compact product, and as a migration path from the VLT 2800. It offers software features including sleep mode with boost, integrated proportional–integral–derivative, flying start, broken belt, compressor start and positioning ability. The VLT Midi Drive is ideal for precise and efficient motor control for users in the food and beverage, material handling, processing industries, water/wastewater and industrial applications.

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To have a product considered for this section, please send the information to Martin Reed, mreed@cahabamedia.com.

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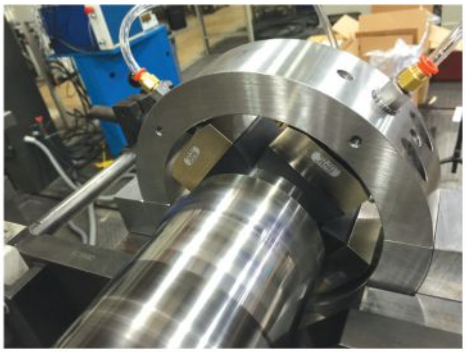

9

7 PROCESS PUMP

WATSON-MARLOW FLUID TECHNOLOGY GROUP is offering its new MasoSine Certa Sine pump for high-viscosity food product handling with low shear and zero pulsation. The Certa pump can decrease cleaning time, reduce chemical and water use, as well as wastewater requiring disposal. Unlike traditional pumps with rotors that cut through the fluid, Certa's sinusoidal rotor gently carries fluid through the pump to dramatically reduce shear while cutting power consumption by up to 50 percent with high-viscosity fluids. The Certa product range offers users a fully clean-in-place (CIP) capable pump at flow rates up to 436 gallons per minute.

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8 AIR BEARINGS

NEW WAY AIR BEARINGS offers externally pressurized air bearings for non-contact support of rotors during balancing operations. The non-contact air bearings eliminate damage issues to the rotor and the mess of oil film bearings in vacuum chambers. The air bearings provide a more precise axis of rotation with a cleaner signal for higher resolution in balancing. The air bearings replace hard and soft bearings in balance machines. When replacing hard rollers in low-speed applications, the rotor can be supported on its bearing journals without damage to the bearing surface from point contact with a crowned roller or from contamination between the rolling surfaces.

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9 PORTABLE DATA LOGGER

The OM-DAQXL Series is a new **OMEGA** exclusive portable handheld data logger that delivers high performance and functionality. This series offers eight or 16 universal analog inputs, fast sampling rates, large data storage, and a 7-inch TFT color touch screen display offering advantages such as an intuitive user interface, easy channel configuration, data logging and playback. This series is ideal for a wide range of applications including research and development, industrial labs, chemical, water treatment or HVAC process monitoring and strain measurement during physical testing of materials.

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10 SOLENOID VALVE

HANTEMP CONTROLS is now offering its model S4At stainless steel solenoid valve. While ideal for ammonia, these solenoid valves can also control CO2, fluorinated refrigerants, glycols, pure water, light oils and other approved liquids. For ammonia refrigeration systems, they can be used for overfeed/recirculating liquid lines, suction lines over 10 F, hot gas lines, high-pressure liquid lines and discharge gas lines. Functionally and dimensionally, the S4At valve replaces similar models from traditional steel and iron valve manufacturers.

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11 MONITORING SYSTEM

PUMPING MACHINERY LLC is offering its Pumps Reliability and Efficiency Monitoring/Measuring System (PREMS-2A), a data acquisition system specifically designed and custom-made for the online, live-automated construction of the actual performance curve (head, power, efficiency versus flow). It compares the true performance to the expected OEM curves, and also displays the cost associated to operate at the degraded performance. The system also monitors vibrations and temperatures of bearing housings, including a full spectral (FFT) analysis.

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12 DRAIN VALVE

The EZ Drain Valve from **GLOBAL SALES GROUP** is mainly used to drain engine oil, but it can be used to drain other types of fluids, such as gas/diesel fuel, transmission oil, coolant, or even water, from the fuel tank. The company has developed a unique, 90-degree version to fit into tight spaces. The new valve needs less than 40 millimeters of space to install, and the direction of the drain can be fully adjusted. A new lock-nut option on the drain valve provides full adjustment of the final position of the valve. This will allow operators to install the valve in any position they prefer and offers flexible draining options.

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13 PROCESS SIMULATION

SCHNEIDER ELECTRIC released SimSci SimCentral for Process Utilities, a new platform to manage how processes are engineered across their entire life cycle. With this platform, users can streamline process utility design, collaborate for process improvement and simplify modeling complexity. Benefits include reduced time and cost, an appealing user experience and accelerated process simulation and design. As one of the first commercially available platforms designed to take full advantage of current web and cloud technologies, SimCentral delivers a modern user experience that embraces the expectations of the next generation of workers, helping to accelerate adoption, usage and time-to-value.
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14 FLOW METERS

ENDRESS+HAUSER is offering the Proline 300/500 family of Coriolis mass and electromagnetic flow instruments that simplify installation, speed commissioning, and streamline operation and maintenance activities. The Proline Promass Coriolis mass flow meters are available in 11 models ranging in sizes from 1/24 to 14 inches in diameter, for measuring flows up to 100,000 tons per day. Proline Promag flow meters are available in three models in sizes from 1/12 to 78 inches for volume flows up to 634 million gallons per day. Both types are available in models suitable for high temperatures, corrosive fluids, hygienic and sterile process applications.
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15 CALCULATION SOFTWARE

SCHAEFFLER GROUP USA INC. is offering the latest module from the company's popular BEARINX-online calculation software. The Easy Pump is an online calculation tool specifically designed for bearing arrangements in fluid pumps. With Easy Pump, users can quickly and easily select suitable rolling bearings for vertical and horizontally mounted hydraulic pumps. Easy Pump is available online and free of charge.
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16 SLIDING VANE PUMPS

BLACKMER, part of PSG, a Dover company, released its new SGLWD Series sliding vane pumps with double mechanical seals. Available in two sizes—SGLWD3 and SGLWD4—Blackmer SGLWD Series pumps have been specially developed to provide zero leakage thanks to an exclusive cartridge type, double-radial-seal design. SGLWD Series pumps are available with flow capacities from 133 to 270 gpm (503 to 1,022 L/min) at working pressures up to 525 psi (36.2 bar). SGLWD Series pumps can be used with mechanical seal flush plans 53A, 53B and 53C.

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17 PUMP CONTROL PANEL

SEE WATER INC. has introduced the Hydra Transducer Pump Control Panel. The Hydra transducer panels are a complete pre-engineered line of simplex, duplex and triplex control panels that are ideal for sewage, wastewater and dewatering applications. Hydra features a comprehensive HMI touchscreen display that allows for complete monitoring of tank level, pump status and alarm/fault history data logging. Hydra control panels are designed to control single- and three-phase pumps in simplex, duplex or triplex operations.

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18 BALL VALVE

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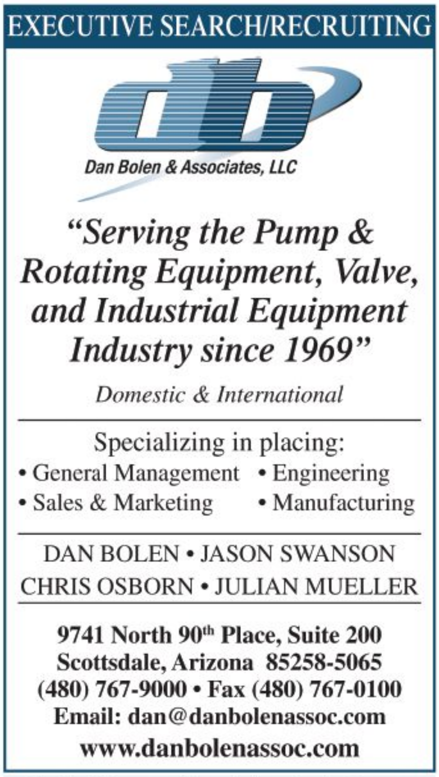

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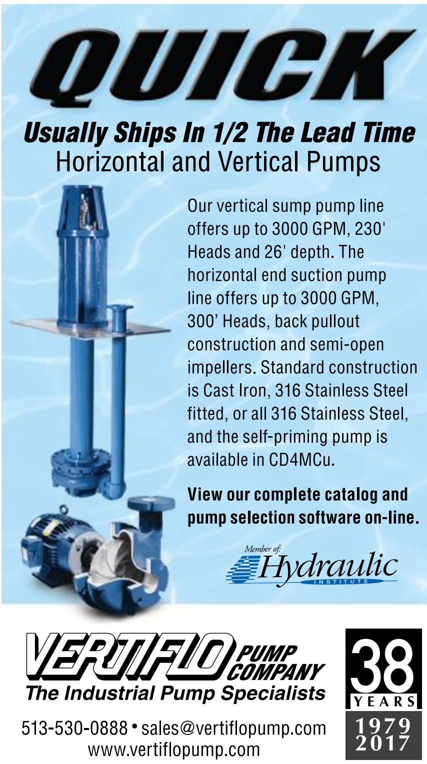

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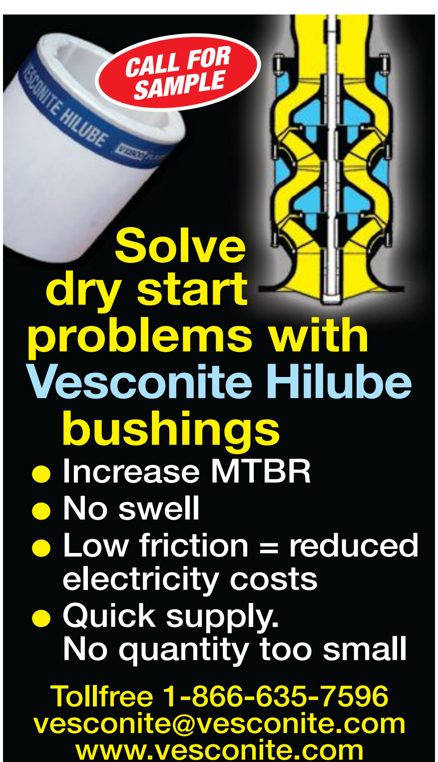

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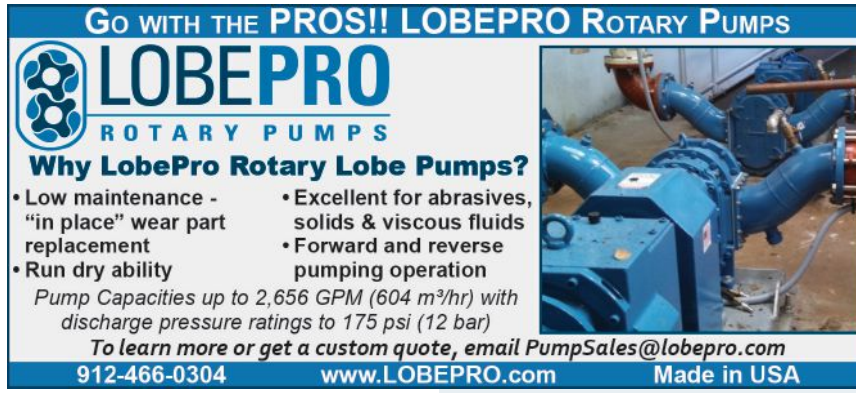

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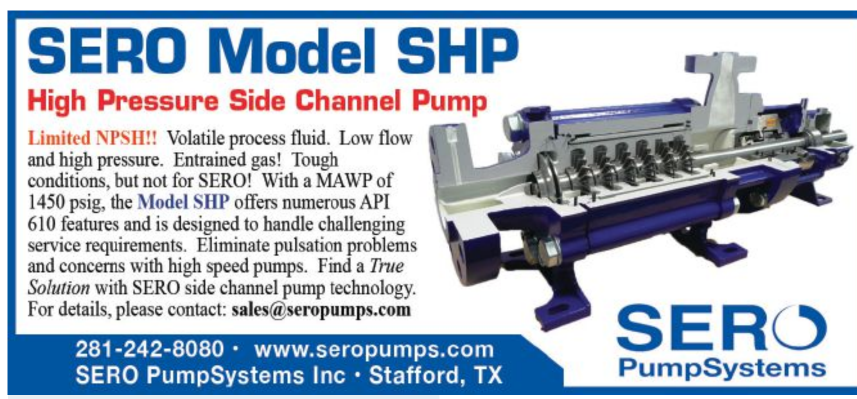

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Wall Street Pump & Valve Industry Watch

By **Jordan, Knauff & Company**

The Jordan, Knauff & Company (JKC) Valve Stock Index was up 32.4 percent over the last 12 months, while the S&P 500 Index was up 17.5 percent. The JKC Pump Stock Index rose 36.2 percent for the same period.[1]

The Institute for Supply Management's Purchasing Managers' Index (PMI) increased 1.5 percentage points to reach 56 percent in January, the highest reading since November 2014 and the fifth consecutive month of increases. The production index rose 2 points to 61.4 percent. The employment index increased the most during the month, rising 3.3 points to 56.1 percent. The overall PMI, new orders and production indices registered their highest levels since November 2014.

The Bureau of Labor Statistics reported that nonfarm employment increased by 227,000 jobs in January, well ahead of December's gain of 157,000 jobs. Retail employment increased by 46,000 jobs over the month, construction added 36,000 and financial services hired 32,000. The manufacturing sector added 5,000 jobs. Average hourly earnings rose 0.1 percent in January, bringing the year-over-year increase to 2.5 percent.

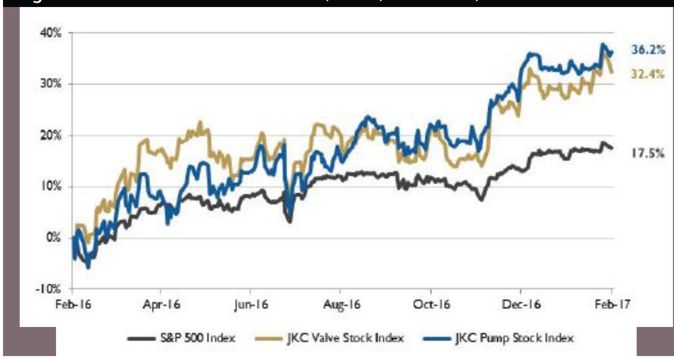
The U.S. Energy Information Administration (EIA) expects U.S. crude oil production to increase from an average of 8.9 million barrels per day in 2016 to an average of 9.3 million barrels per day in 2018 due to gains in the major U.S. tight-oil-producing states of Texas, North Dakota, Oklahoma and New Mexico. Even though U.S. oil production has been declining since mid-2015, production has continued to increase in the Permian region of Texas. Permian production averaged 2 million barrels per day in 2016 and is projected to increase to 2.5 million barrels per day in 2018. Production in the Eagle Ford region in Texas has declined since March 2015 but is expected to begin increasing in the third quarter of this year and continue to increase through 2018. Texas is expected to continue to be the largest oil-producing state through 2018.

Global crude oil production and consumption are projected to increase through 2018, with consumption increasing at a faster rate than production, resulting in a tightening of the global market.

On a quarterly basis, consumption is anticipated to be greater than production in the third quarter of this year and next year. Based on annual inventory builds and a lack of a significant draw on existing inventories, the EIA expects oil prices to remain below $60 per barrel through the end of 2018. Due in part to the responsiveness of U.S. tight oil production to rising oil prices late last year, Brent crude oil prices are projected to remain flat this year, averaging $53 per barrel for the year. Prices should slowly increase in 2018, ending the year at $59 per barrel with an average of $56 per barrel for the year.

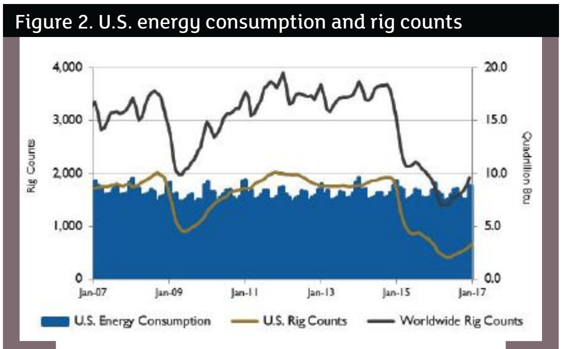
On Wall Street, the major indices advanced for the month of January for the first time since 2013. The Dow Jones Industrial Average was up 0.5 percent, the S&P 500 Index increased 1.8 percent and the NASDAQ Composite rose 4.3 percent for the month. Projections for stronger economic growth based on the new administration's statements regarding infrastructure spending, deregulation and tax cuts boosted the markets. ■

Figure 1. Stock indices from Feb. 1, 2016, to Jan. 31, 2017



Source: Capital IQ and JKC research. Local currency converted to USD using historical spot rates. The JKC Pump and Valve Stock Indices include a select list of publicly traded companies involved in the pump and valve industries weighted by market capitalization.

Figure 2. U.S. energy consumption and rig counts



Source: U.S. Energy Information Administration and Baker Hughes Inc.

Figure 3. U.S. PMI and manufacturing shipments

Source: Institute for Supply Management Manufacturing Report on Business and U.S. Census Bureau

Reference

1. The S&P Return figures are provided by Capital IQ.

Jordan, Knauff & Company is an investment bank based in Chicago, Illinois, that provides merger and acquisition advisory services to the pump, valve and filtration industries. Please visit jordanknauff.com for further information. Jordan, Knauff & Company is a member of FINRA.

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ABOUT THE PRESENTER

Karl Heideck is a graduate of Drexel with a B.S. in Electrical Engineering and MBA graduate of St. Joseph's University. He has worked in the industrial systems business for over 25 years. Karl is an active member of IEEE. He is Principal Business Developmenter for applied engineering and advanced applications for Industrial and Utility Variable Drive Projects for Siemens Industry.

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