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Laying the **GROUNDWORK**

Water infrastructure
investments begin

How PFAS regulations may
affect your water operations

WHAT CAN REMOTE
MONITORING TELL YOU
ABOUT YOUR PUMPS?

PUMP SYSTEM EFFICIENCY
FUNDAMENTALS

PUMP REPAIR SHOP
SELECTION QUIZ



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- White Labeling allows users to re-brand the platform, mobile app and hardware

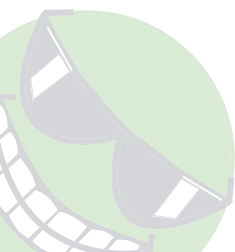
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Check 102 on index.

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I try to keep things professional when researching articles for Pumps & Systems. This is, after all, a resource we know our readers turn to when faced with a pump problem or to learn the basics of installations, operations and upkeep from respected experts in the field.

But once in a while we touch on a subject that is colored with emotions. For me, that's clean drinking water.

As we tried to learn more about how the water infrastructure funds secured in the bipartisan-supported Infrastructure Investment and Jobs Act will be used (read more on page 36) and how per- and polyfluoroalkyl substances (PFAS) regulations will impact water operations (page 38), we came across startling statistics. For example, 10 million homes and 400,000 schools and childcare centers in the United States lack safe drinking water. And 771 million people worldwide don't have clean water access close to home.

I'll admit that when I think of the people faced with this challenge, I think of my own daughter and the privileges we often take for granted—grabbing a glass of filtered water from the door of our refrigerator, filling up a bathtub with water and bubbles, running in the cool droplets of a sprinkler on a hot summer day. I try to teach my daughter not to waste water and how lucky we are. But it is easy to overlook the hardships others face.

Often those problems seem larger than we can comprehend and, thus, we feel lost as to what to do. Thankfully, many around the world—many of you—take on this challenge every day and have made it their personal, and their company's, mission to bring clean water to everyone. See two innovations that are helping accomplish this goal on page 14.

We at Pumps & Systems thank all of you in the pump industry for what you do to make our world run—whether that's providing clean water, treating other types of potable water or the other areas of our arena like power generation, wastewater treatment, oil and gas, chemical processing and more. We don't take you for granted, and neither will the world's children.

As always, thanks for reading.



Jennifer King

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jking@cahabamedia.com



Jennifer's daughter, Penny, enjoying cool water on a hot summer day.

PUMPS & SYSTEMS®

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Check 113 on index.

Detectable Motor Faults

 **Power system**
Asymmetry in motor currents

 **Stator winding**
Stator resistance variation

 **Rotor**
Rotor resistance variation

 **Motor shaft/balance**
Gravity center displacement

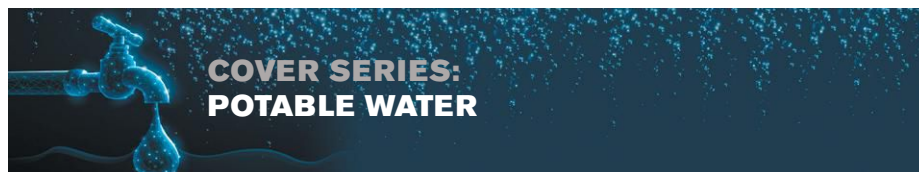
 **Eccentricity**
Stator/rotor concentricity issue

 **Alignment**
Motor/load misaligned

 **Cooling system**
Motor cooling system problem

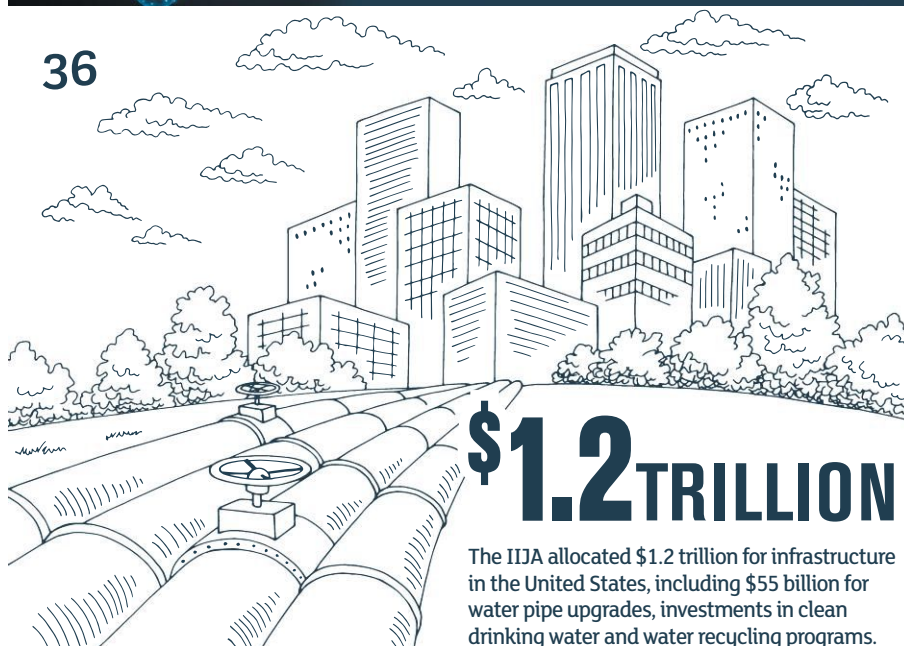
 **Soft/loose foot**
Fixing system problem

 **Bearing**
Failures/defects in bearing



COVER SERIES: POTABLE WATER

36



\$1.2 TRILLION

The IIJA allocated \$1.2 trillion for infrastructure in the United States, including \$55 billion for water pipe upgrades, investments in clean drinking water and water recycling programs.

36 Water Infrastructure Improvement Efforts Begin Following Passage of IIJA

By Evi Arthur,
PUMPS & SYSTEMS

38 'Big Problems Take a Long Time to Solve'

By Drew Champlin,
PUMPS & SYSTEMS

41 Lowering Reverse Osmosis Costs for Small to Midsize Watermakers

By Brian Jacoby,
ITT C'TREAT

44 Potable Reuse as an Alternative Water Supply

By Kevin Flis,
XYLEM

46 Off-Grid Solutions for Providing Potable Water

By Seth Vattilano,
JH PROCESS EQUIPMENT INC.

48 Potable Water Disinfection With Chlorine Gas

By JJ Bekker & Steve Frangione,
GRUNDFOS

SPECIAL SECTION: INSTRUMENTATION, CONTROLS & MONITORING

26 IoT Creates More Reliable Irrigation System for Oregon Farm

By Barbara Padgett,
WIN-911

30 The Advantages of Popular Fieldbus Networks

By Peter Chronis,
WINTERS INSTRUMENTS

32 What Can Remote Monitoring Tell You About Your Pumps?

By Rob Fusco,
SENSAPHONE

COLUMNS

16 COMMON PUMPING MISTAKES

Pump Shaft Failure Redux
By Jim Elsey,
Summit Pump Inc.

22 GUEST COLUMN

Selecting a Pump Repair Shop
By William C. Livoti,
Engineered Software Inc.

EVERY ISSUE

2 FROM THE EDITOR

8 NEWS

14 ON THE CURVE

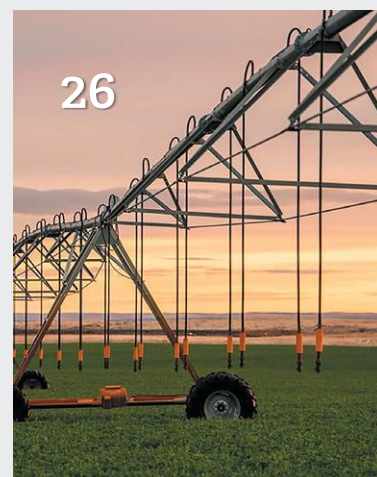
15 FACES OF THE INDUSTRY

67 PRODUCTS

68 ADVERTISERS INDEX

69 PUMP USERS MARKETPLACE

72 PUMP MARKET ANALYSIS





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Check 111 on index.



58

+ PLUS

50 Key Considerations for Selecting a Portable Mixer

By Eulis Ester,
NEPTUNE

54 Deragging Technology Aids Municipal Wastewater Spillage Prevention

By Simon Crompton,
CLEARWATER CONTROLS,
AN INDUSTRIAL FLOW
SOLUTIONS COMPANY



50

DEPARTMENTS

56 HI PUMP FAQs

Bowl Efficiency & System
Curves for Viscous
Applications

58 SUBMERSIBLE SOLUTIONS

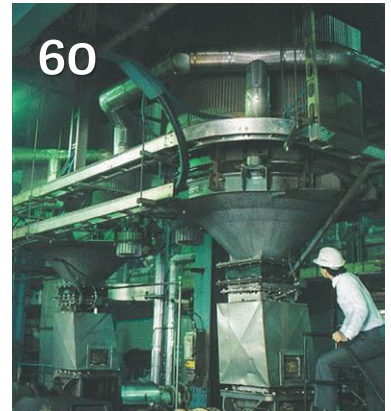
Factors to Consider When
Selecting & Installing a
Submersible Motor
By Jessie Hinthner,
SWPA MEMBER,
FRANKLIN ELECTRIC

64 EFFICIENCY 101

Improving Efficiency in
Pumping Systems
By Pete Gaydon,
HYDRAULIC INSTITUTE

60 SEALING SENSE

Your Guide to Expansion Joints
in Pulp & Paper
By Brandon Phillips,
FSA MEMBER. GARLOCK
SEALING TECHNOLOGIES



60

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Tim Perry, Public Works Director, City of Palestine



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Check 105 on index.



NEW HIRES, PROMOTIONS & RECOGNITIONS

JOSH GOLDBERG

ASAHI/AMERICA

LAWRENCE, Mass. – Asahi/

America announced the addition of Josh Goldberg to its business development team. Goldberg joined Asahi/America on Feb. 18, 2022, as business development manager for industrial and environmental piping systems in the Western U.S.

Goldberg comes to Asahi/America with over 20 years of polymer formulation and product development experience and 10 years in market analysis and technical product sales. He holds a Bachelor of Science in chemistry and a Master of Science in polymer chemistry from the University of Oregon.

He will work closely with the company's sales and engineering teams to further promote Asahi/America's industrial piping product line across a variety of industries in the U.S. ■

asahi-america.com**JOSH NIELS**

BOERGER

MINNEAPOLIS – Boerger

announced the hire of Josh Niels, who joins the Boerger team as the business development manager.

Niels comes to Boerger with over 15 years of experience working in the agricultural, municipal and industrial markets. Niels has a track record that includes working for companies such as Vaughan and Trident Processes. Within his role, Niels will focus on partnering



with the Boerger sales team to identify and develop new opportunities for continued growth. ■

boerger.com**JASON BALCERCZYK**

NETZSCH

SELB, Germany – Jason Balcerczyk has been appointed president of Netzsch Canada, Inc. He has served in many roles from application engineer to regional manager to vice president of sales and has a broad base of experience. ■

pumps.netzsch.com**TREVOR COMBS**

TRELLEBORG

FORT WAYNE, Ind. – Trelleborg

Sealing Solutions appointed Trevor Combs to the role of technical manager for Global Off-Highway and Americas Fluid Power.

In this role, Combs will serve as the primary commercial engineering resource for off-highway globally and fluid power in the Americas. He will be responsible for providing the technical inputs that initiate the strategic development of products, materials and applications that will drive growth in both segments.

Previously, Combs served Trelleborg as an application engineer and technical manager. He has a Master of Science in engineering technology and management from Portland State University and a Bachelor of Science in engineering from George Fox University. ■

trelleborg.com**HECTOR GONZALEZ**

DISCFLO

SAN DIEGO – Discflo Pumps has promoted Hector Gonzalez to operations manager.

Gonzalez came to Discflo as a degreed mechanical engineer from Tijuana, Mexico. His skillset has expanded during his time with Discflo, allowing room for his leadership capabilities to flourish—from engineering manager to research and development (specializing in the low and high head pumps) and now operations manager. ■

discflo.com**BOB GUINEY**

KSB

RICHMOND, Va. – KSB, Inc.

announced the addition of Bob Guiney as director of sales serving the general industry market. In the newly formed position, Guiney will be directing the sales organization focused on increasing KSB's General Industry business in the U.S.

Guiney entered into the pump business 30 years ago as an application engineer after earning a degree in engineering from Penn State University. Prior to joining KSB, Guiney served as regional sales manager and sales director within the pump industry. ■

ksb.com**ABDUL BUTT**

WATSON-MARLOW

FALMOUTH, U.K. – Watson-

Marlow Fluid Technology Group (WMFTG) announced the appointment of Abdul Butt as operations and supply director to drive the company's supply excellence and enable continued growth. Butt joins the company with extensive experience in manufacturing and operational excellence, including 20 years at GKN PLC and then Melrose Industries as CEO of one of their divisions, followed by MPP where he was chief operating officer in his most recent role.

Butt started his career with the Ford Motor Company as a technical apprentice and has had success in increasing roles of responsibility and accountability. He holds a first class engineering degree in manufacturing and management from Loughborough University, England. ■

wmtfg.com**MIKE BRANDT**

AMPCO PUMPS

GLENDALE, Wis. – Ampco Pumps

welcomed Mike Brandt as its new business development manager. Brandt has a 20-year history in the sanitary processing and industrial sectors, coming to Ampco from GEA U.S., where he served as business development manager. Brandt's success at creating growth opportunities stems

Mergers & Acquisitions

SJE Inc. Acquires Horlick Company
April 1, 2022

Atlas Copco to Acquire Lewa & Geveke
March 12, 2022

DXP Enterprises Acquires Drydon Equipment, Inc. & Burglingame Engineers
March 8, 2022

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Check 106 on index.

NEW HIRES, PROMOTIONS & RECOGNITIONS (CONT.)

from his extensive knowledge of pumps, valves, heat exchangers, process systems, mixers/agitators, homogenizers, pasteurizers, HTST/UHT, spray devices and clean-in-place (CIP) systems. He has previous experiences at GEA, Crane Engineering and Sanimatic. ■ ampcopumps.com

GEORGE ARNETT & PETER ROTH

SUNDYNE

ARVADA, Colo. – Sundyne announced that George Arnett has joined the company as vice president of global aftermarket services.



Arnett comes to Sundyne from Chart Industries, where he served as vice president and general manager for parts, repairs, service and leasing. Arnett has a master's degree in engineering from the University of Southern California and is a graduate of the U.S. Navy's Nuclear Propulsion Program.

Sundyne also appointed Peter Roth as new director of PPI products.

Roth comes to Sundyne from Siemens Energy, Inc., where he previously served as North American director of field operations. Roth has extensive experience with small-, medium- and large-scale turbo compressors, reciprocating compressors, steam turbines and gas turbines used for the renewable energy, oil and gas, petrochemical, chemical and power generation markets. ■ sundyne.com

TRADE SHOW PREVIEW

AWWA/ACE

June 12-15

Henry B. Gonzalez Convention Center San Antonio, Texas

Exhibition Hours

Monday, June 13

10 a.m. – 5 p.m.

Tuesday, June 14

9 a.m. – 5 p.m.

Wednesday, June 15

10 a.m. – 2 p.m.



ACE²²

inform.
influence.
impact.



After two years, AWWA is thrilled to be returning to an in-person format where water sector professionals can come together and learn, connect and be inspired to solve today's global water challenges. And for those who are not able to be present, the event will include a hybrid feature where AWWA will stream content from its most essential tracks.

ACE22 provides an opportunity to connect with global water experts in

every segment of the water sector. Whether at the Water Industry Luncheon or pre-conference workshops providing hands-on learning experiences, AWWA cannot wait to welcome back the water sector to San Antonio in June for a highly anticipated ACE22, showcasing smart technologies and new programs that address critical issues to protect the world's most important resource. ■

awwa.org/ace

AROUND THE INDUSTRY

Xylem Moving Global Headquarters

RYE BROOK, N.Y. – Global water technology company Xylem has announced that it will move its headquarters to Washington, D.C., from Rye Brook, New York.

Patrick Decker, president and CEO of Xylem, said, "Washington, D.C., is an important global crossroads for the diverse set of stakeholders who work together toward solving water challenges around the world.

"As a leading global water innovator, we know that the biggest water issues can only be addressed through collaboration. By locating our global headquarters here, we place ourselves right where

the water sector is most engaged."

Decker said he and several senior Xylem leaders will be based in the new headquarters, driving enterprise strategy and execution.

Xylem's new headquarters will be co-located with the recently announced Reservoir Center for Water Solutions, a hub for multiparty, water-focused stakeholder collaboration in the historic Navy Yard district along the Anacostia River. The center is anticipated to open in June. When the move is complete, Xylem headquarters' new address will be 301 Water Street SE, Washington, DC, 20003. ■ xylem.com



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We developed the Byron Jackson H2O+ line of deep well submersible pumps with upgraded materials to provide higher efficiency, extended lifecycles and quick delivery. Byron Jackson H2O+ pumps and water-filled stainless steel motors are stocked in standard sizes of 6, 8 and 10 inches that can be assembled to order from components in inventory and shipped in one to four weeks.

AROUND THE INDUSTRY (CONT.)

Dude Solutions Announces Rebranding

CARY, N.C. – Dude Solutions, an SaaS provider of cloud-based operations management solutions, announced it has rebranded to Brightly Software. Brightly has helped over 12,000 global clients' operations and managed more than \$300 billion of assets over the last 20 years.

"The future will run on intelligent assets that are as smart as the purpose-driven people who care for them. Our new name connects our global employees and clients under one vision, uniting those who seek to improve our world's infrastructure while lessening the environmental impact," said Kevin Kemmerer, chief executive officer at Brightly. "As the industry and world evolve, we're leading the change to meet our clients' developing needs." ■

brightlysoftware.com

Hydraulic Institute Installs New Leadership at Spring Conference

PARSIPPANY, N.J. – The Hydraulic Institute (HI), the largest association of pump manufacturers and suppliers to the pump industry in North America and the global authority on pumps and pumping systems, announced new leadership during the 2022 annual conference. During this conference, the 2022-2023 officers were named:

- DeLancey Davis, president, Headwater Companies; vice president Franklin Electric as chairman of the board
- Brian Sweeney, president, Crane Pumps & Systems as board president
- Scott King, president, Gorman-Rupp Company as treasurer
- Rob Phillips, vice president global engineering, Flowserve Corporation as secretary

Three new members joined the board:

- Ansell Sims, president, Grundfos
- Julian Atchia, vice president of

research and development, SJE-Rhombus

- Randy Bennett, vice president of technology and operations, Leistritz Advanced Technologies

Two vice president positions were confirmed:

- Vice president of education, Scott Tystad, educational leader, Pentair
- Vice president of membership, Mike Ketchum, vice president of sales and business development, Iwaki America Inc.

Outgoing board members Karl Buscher, PSG Dover; Rob Philips, Flowserve; and H.J. Dewes, ABB were recognized during an awards ceremony and thanked for their service on the HI board since 2019. The board of directors will provide organizational oversight to HI and guide the direction of its strategic plan. ■

pumps.org

APWA Board Selects New President-Elect

KANSAS CITY, Mo. – With just a handful of months to go before a new president heads the American Public Works Association (APWA), the association board has selected a new president-elect: long-time active member Keith Pugh. Previous president-elect Dan Hartman had to step down from his role, citing ongoing health issues and his worry that he would not be able to give the role the energy it deserves.

Pugh has been active with APWA for over 20 years, starting with serving on the engineering and technology committee. He has served on other national committees within APWA and has been active in leadership in the North Carolina chapter. He is a client success manager with WithersRavenel in Asheville, North Carolina. He will assume the office of president at the Public Works Expo (PWX) scheduled to be held in Charlotte, North Carolina, Aug. 28-31. ■

apwa.net

WEF Seeks Applications for Utility of the Future Today Recognition Program

ALEXANDRIA, Va. – The application period is open for the Utility of the Future Today recognition program, which seeks to honor water resource recovery facilities for community engagement, watershed stewardship and recovery of resources such as water, energy and nutrients.

This year, the application has been revised to encourage utilities serving as anchor institutions in their communities, with a focus on people both within the utility and within the community and the inclusion of diversity, equity and inclusion in all aspects of the utility's operations.

The Utility of the Future Today concept is being promoted as water systems transform operations through innovation and technology. The Utility of the Future is a model for utilities of all sizes to achieve more efficient operations, enhanced productivity and long-term sustainability. Since the program launched in 2016, almost 200 utilities have been recognized.

The Utility of the Future activity areas focus on recovery and new uses of a range of resources; engagement as a leader in the full water cycle and broader social, economic, and environmental sustainability of the community; engagement in the community and formation of partnerships necessary for success when operating outside of the traditional span of the utility; and transformation of the internal utility culture in support of these innovations.

Public and private water sector utilities of all sizes that can demonstrate achievement of the application requirements are encouraged to apply by May 20 at 11:59 p.m. ET. Applicants must have no major permit violations in the year prior to the submission date of their applications. Honorees will be selected this summer and recognized at WEFTEC this fall in New Orleans. ■

wef.org

Upcoming Events

POWER GEN

May 23-25, 2022

Kay Bailey Hutchison
Convention Center
Dallas, TX
powergen.com

NFPA

June 6-9, 2022

Boston Convention &
Exhibition Center
Boston, MA
nfpa.org/conference

AWWA/ACE

June 12-15, 2022

Henry B. Gonzalez
Convention Center
San Antonio, TX
awwa.org/ace

EASA

June 26-28, 2022

America's Center
St. Louis, MO
easa.com/convention

ACHEMA

Aug. 22-26, 2022

Frankfurt am Main, Germany
Frankfurt, Germany
achema.de/en

Turbomachinery & Pump Symposia

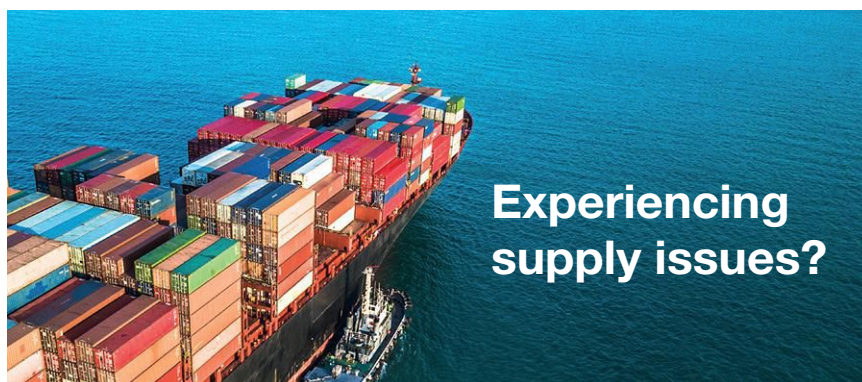
Sept. 13-15, 2022

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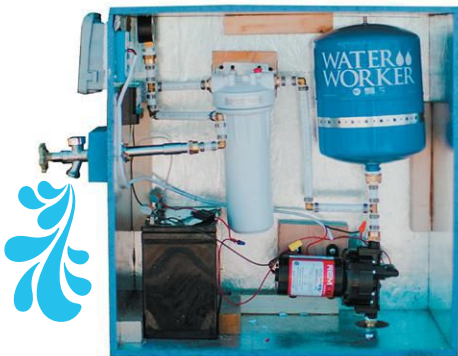
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-Pump Aid, @PumpAid

Mary Zappone

Chief Executive Officer & Board Director
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Mary Zappone, CEO of Sundyne, wants those new to the pumps industry to know that their voice holds more power than they think. She tells the story of being a new engineer leading a turnaround changeout at a refinery and being tasked by her boss to gather opinions from the staff on a specific problem, which she diligently did. After dropping it off on her boss's desk, he asked where in the memo her opinion was. "The funny thing is it never occurred to me to put my opinion in there. It's comical now, as I'm always delighted to share my opinion," Zappone said.

"It takes courage to give an opinion."

This interaction early in her career introduced Zappone to the concept of Completed Staff Work. Originally credited to the military, Completed Staff Work is a management principle where staff submits solutions to higher-ups with enough rationale and detail that all the boss must do is approve or reject the solution.

"This doesn't mean there isn't a place for problem-solving discussions with your boss or team; it means that if the specific request is for a recommendation, then we should be organized, detailed and courageous enough to make that recommendation directly," Zappone said. "My boss modeled the culture the company wanted. He greatly influenced the way I operate, and I always share the concept of Completed Staff Work with all my teams."

As her career continued, Zappone noticed that many teams she spoke to had something in common: there was always more that needed to be done,

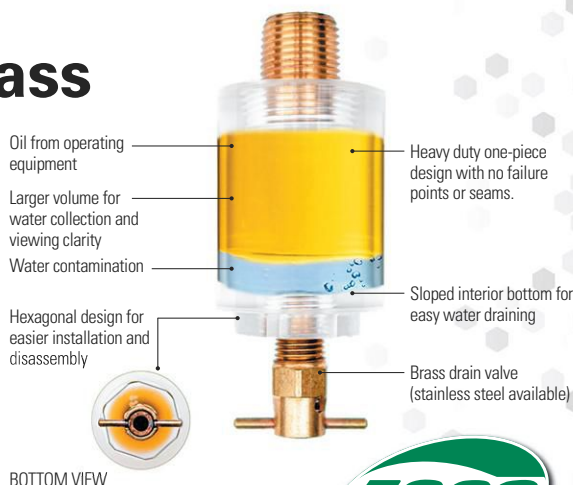
updated, reviewed, fixed, etc. but there was never any consensus on just who should do it.

Zappone said, after asking a few more questions about the requirements for solving that issue, it would become clear that the people in the room could do it themselves. "It was not a lack of intellect or drive—it simply had not occurred to them individually or as a group that they could make their workplace, customer service or safety stronger." So, it eventually turned into a mantra for Zappone: "Be the somebody."

"There are always multiple issues and improvements that 'somebody' in a company needs to fix. My advice is that you have more power to drive change than you may think," Zappone said. "Think about a problem or issue you may see that is not being resolved. You may be able to bring a group together to develop a recommendation and implement a solution. Always ask, 'could I be the somebody' to resolve the issue." ■

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Pump Shaft Failure Redux

JIM ELSEY | Summit Pump Inc.

I frequently talk with pump owners who believe the root cause of shaft failure is solely the strength (or lack thereof) of the material. I offer this column as a counterpoint discussion on the subject.

In my February 2017 column, I discussed the major reasons why shafts on overhung pumps break in service. Normally the shaft will break because the pump is being asked to do something it was not designed for. Root cause failure analysis (RCFA) typically reveals fatigue failure due to excessive shaft deflection. Fatigue failure is also known as failure due to reversed bending fatigue with rotation. Shaft deflection is the preventable result of operating the pump in the wrong area of the curve and/or poor maintenance choices. There are a few exceptions to this common failure mode such as metallurgical defects and/or errors in the manufacturing process.

Mistakes do happen, but for most manufacturers they occur at numbers statistically approaching Six Sigma levels. That is 3.4 defects per 1 million opportunities (DPMO) or think of it as 99.99966% of all the shafts are made without a defect. Reducing shaft deflection will manifest in longer pump life, reduced cost of ownership and higher reliability.

Shaft Design

There is a long list of requirements to consider when designing pump shafts.

All credible pump manufacturers that desire to remain in business will design the shafts for normal startup and operational factors, albeit a smaller number will have higher margins for upset conditions and safety margins in general. Economics will drive the key parameters that the designer must take into consideration, which at a minimum include torque, speed, various stresses such as key-seat geometry and placement, fillet radius, surface finish, hydraulic load, component weight, and bearing placement/span.

As added emphasis, I want to point out that shaft diameter is determined mainly by the amount of torque expected/required. Pump shaft design presents difficult calculations and manufacturing choices due to the various diameters required to accommodate the components for assembly and maintenance.

In addition to the above factors, before you decide on a shaft material for your application, consider the temperature, pH and the percentage of suspended solids in the pumpage. Please refer to my February 2017 column and/or listed references for more specific information.

Materials

Common shaft materials include austenitic 304 and 316 stainless, martensitic 410 and 416 stainless, CD4MCu duplex steel, carbon steels 1040 and 1045, alloy steel 4140 and precipitation hardened martensitic stainless steel 17-4 PH.

Your pump shaft may be of a different material but it will likely have similar mechanical, thermal, electrical and chemical (alloy composition) properties.

Additionally, realize that all materials are elastic to some degree. We can easily understand this concept when considering elastomers such as rubber and plastic, but we rarely think of elasticity when it comes to metals—yet all metals are elastic.

Young's Modulus—What Is a Modulus?

The word modulus has Latin roots and, with sincere apologies to my Latin teacher Mrs. Bruenig, roughly translated it means to measure or gauge. In the field of mathematics, it is another term for absolute value. In physics, modulus is a constant factor or ratio. In computer science it means something else. In metallurgy, we think of it as the ratio of two different curve slopes.

Note: For material science, there are three types of moduli.

1. **Bulk modulus:** The ratio of stress to the fractional decrease in the volume of the body or a measure of how resistant the material is to compression.
2. **Shear modulus:** The ratio of tangential force per unit area to the angular deformation of the body or how resistant a material is to shearing deformation. Shear modulus is the

Reducing shaft deflection will manifest in longer pump life,
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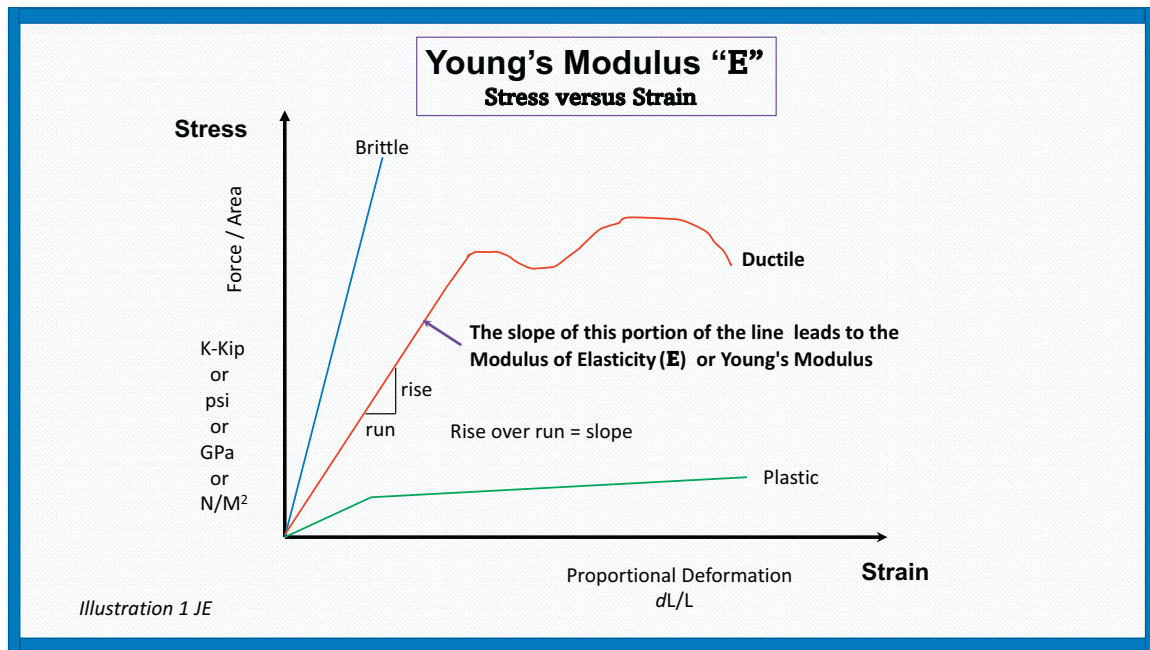


IMAGE 1: Expression of Young's Modulus (Images courtesy of the author)

ratio of shear stress to shear strain.

3. **Very closely related and for this column elastic modulus (aka Young's modulus):** Young's modulus is the ratio of tensile stress to tensile strain or the ratio of longitudinal stress to strain.

For our general purpose and in layman's terms, we can think of Young's modulus simply as a ratio (technically a ratio would not have units), and more importantly, that it tells the pump designer whether the shaft material will bend, deform or break given some amount of stress.

Young's modulus is expressed as E. Where $E = \text{stress} \div \text{strain}$. (Where stress is simply the force per unit area and strain is the amount of differential change [deformation] in the length.) See Image 1.

Young's modulus is a measure of elasticity and should not be confused with strength, toughness or hardness. Since the most common shaft materials all have a similar value of Young's modulus, the decision to change materials due to some deleterious issue is rarely in and of itself the solution to correcting the root cause of shaft failure. The various shaft material choices will have different properties for corrosion resistance, hardness and tensile

strength, and a specific selection may work better for your application—if the shaft is not deflecting excessively.

Young's modulus is, in essence, the elastic property of the material—that is, how many times can you bend it before it breaks? Elasticity is a material property indicating how it will restore it to its original shape after distortion. Technically, and more importantly, is how far can you bend it on each cycle over hundreds of thousands of cycles before you exceed the limits of the material? This is also known as the "endurance limit" and when a shaft does break, we in materials engineering jokingly (nerd humor) refer to this as accidentally exceeding the "Goodman Line."

If you investigate the eight most commonly used pump shaft materials, you will see some differences in the properties of hardness, strength and corrosion resistance. What you will also notice is that the value of Young's modulus for all the materials fits tightly in the same range. The one exception would be titanium, which has a higher value.

Average values for Young's modulus in imperial U.S. customary units (pounds per square inch [psi])

- 316-SS 29.0 x 10⁶ psi
- 17-4 PH 28.0 x 10⁶ psi

- 4140 28.5 x 10⁶ psi
- CD4MCu 29.0 x 10⁶ psi

For SI units (metric international system of units), the value of the psi units would convert to approximately 190 to 195 gigapascal (GPa). Sometimes the units are expressed as Newtons per square meter (N/m²).

Shaft Deflection (Bending)

Shaft deflection in an operating pump is a result of three main factors. The first is that the shaft is bent in the first place. Any shaft with more than 0.0025-inch to 0.003-inch runout should be replaced.

The second reason is rotor imbalance. Imbalance is typically not an issue with the shaft but it will be with the impeller, which is why it is always a smart idea to balance the impeller. Balance to at least International Organization for Standardization (ISO) 1940 grade 6.3 or better. Shaft deflection from an unbalanced impeller is referred to as "whip."

The third reason is unmitigated radial thrust from operating the pump away from the allowable/preferred operating zone (A/POZ). Note that all three of these issues can manifest at the same time.



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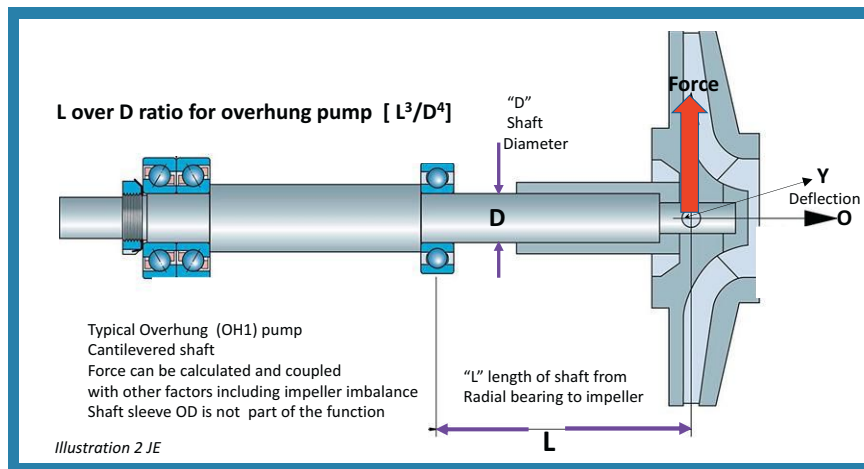


IMAGE 2: L over D ratio for overhung pump

One simple step to reduce deflection would be to use solid shafts in lieu of sleeved shafts. Of course, that requires a shift to cartridge-type mechanical seals and not all operators and applications can accommodate this decision. Additionally, many pump manufacturers offer options for larger diameter shafts to mitigate deflection. Reducing deflection not only saves the shaft from fatigue failure but also prolongs mechanical seal life. Most seal manufacturers require less than 0.002-inch deflection at the seal face to have a successful seal life. See my February 2016 column for more details. An added benefit of reducing deflection is prolonged bearing life.

Realize that shaft deflection occurs two times for every one revolution of the shaft.

Consequently, a pump operating at 3,550 rotations per minute (rpm) will deflect 7,100 times per minute. For details on calculating radial thrust, refer to my column devoted to this subject in January 2021.

Shaft Deflection Factor

One last and most important factor for overhung pumps is the amount of shaft cantilever and corresponding deflection simply known as the "L over D ratio" of the shaft (properly stated as $L^3 \div D^4$ or L^3/D^4). Where L is the axial distance from the impeller centerline to the center of the radial bearing and D is the diameter of the shaft. The ratio is derived and simplified from the cantilevered beam deflection formula used in statics. I am not going to derive the formula in this column, but I will

broadly illustrate the relationship and point out that a major factor in the deflection formula is the modulus of elasticity E (Young's modulus). It is a much more complicated calculation/derivation. See Images 2 and 3.

The L/D ratio is also called the "slenderness ratio" or "shaft stiffness ratio." It is an indication of how much the shaft will deflect (bend) due to radial hydraulic forces when the pump is operating away from the design point (best efficiency point or BEP). The L over D ratio is really only applicable to overhung pumps.

I postulate that shaft failure cannot be prevented simply by material choices but it can be mitigated by geometric decisions.

The most common form of shaft failure is fatigue. The fatigue is due to excessive shaft deflection, which is a function of the radial hydraulic loading, rotor balance and the shaft stiffness. The strength of the shaft has little to no effect on the stiffness. The stiffness is a function of the modulus of elasticity (Young's modulus) and the L over D ratio (geometric dimension).

Common shaft materials all fall into a tight range of values for Young's modulus (29 x 106 psi). Consequently, only changing shaft materials to preclude/mitigate shaft breakage is not necessarily a prudent decision. You will experience higher pump reliability if you address the root cause operational factors. ■

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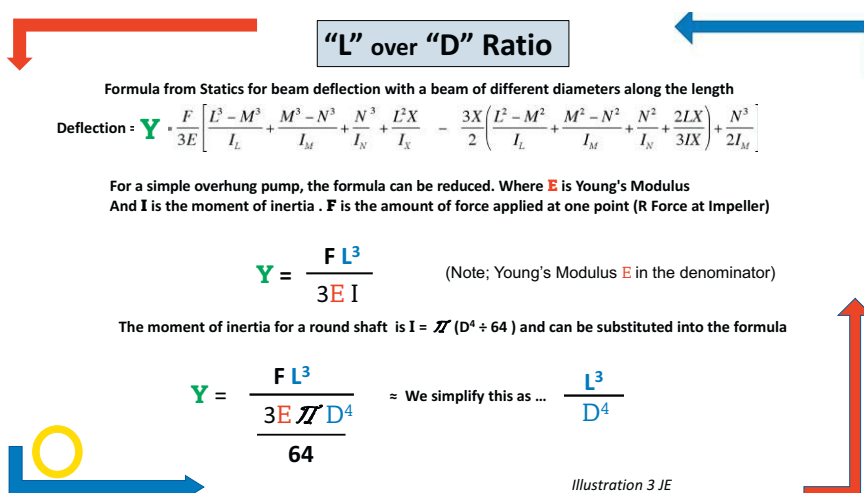


IMAGE 3: Formula from statistics for L over D ratio

Jim Elsey is a mechanical engineer with more than 50 years of experience in rotating equipment for industrial and marine applications around the world. He is an engineering advisor for Summit Pump, Inc., an active member of the American Society of Mechanical Engineers, National Association of Corrosion Engineers and the Naval Submarine League. Elsey is also the principal of MaDDog Pump Consulting LLC. He may be reached at jim@summitpump.com.

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Selecting a Pump Repair Shop

WILLIAM C. LIVOTI | Senior Engineer

Not all pump repair shops are the same. Each shop has specific skill sets and limitations. Selecting the appropriate shop for your repairs depends on several factors. This column will focus on the pump repair facility selection and approval process.

Just as in any profession, you have highly skilled professionals and, shall we say, less than skilled and reputable. Some mean well but do not have the equipment and skill to deliver a quality product.

Wide Range of Pump Repair Facilities

There are many different types of pump repair shops. They range from backyard garages (not be addressed in this article) to factories and all types in between. Each type has pros and cons. Which type is best for your specific needs?

There are several types of pump repair facilities, including electric motor repair shops (stand-alone and multiple locations); multibrand distributors; stand-alone (independent); OEM (service centers); factory (repair performed at factory); and end user repair facility.

Electric motor repair shop

There are quite a few motor shops offering pump repair, and typically these shops perform basic repairs, such as end suction pumps. However, many specialize in submersible pump repair. This makes a lot of sense since the motor is integral to the pump and often the failure mode is moisture ingress. Some stand-alone shops have hired qualified pump engineers as well as mechanics or technicians skilled in pump repair.

There are several motor shops with facilities in multiple locations throughout a specific region or nationwide that have invested heavily in pump repair by hiring qualified pump engineers, mechanics and field service support.

Multibrand distributors

Distributors make up a bulk of pump repair facilities as, over the years, many pump manufacturers have chosen to close their OEM shops and defer repairs and sales in many cases to “authorized” repair facilities. Many of these distributors sell and support brands and products from multiple manufacturers. We will discuss this in more detail later.

Stand-alone (independent)

Stand-alone shops are generally (there are exceptions) owned by former OEM pump engineers and tend to focus on high-end repairs as the owner has the skill set/knowledge to handle the more complex/high-energy pump repairs. There are, however, a few independent shops that hired skilled engineers, mechanics and staff to pursue the more complex pump repairs. Their objective is to minimize the competition since few repair facilities can handle the more complex or high-energy or multistage pump repairs. Given the in-house skill sets, they have the capability of reverse engineering various pumps and manufacturing certain replacement components, as well as running clearances and fits.

OEM (service centers)

Some manufacturers still maintain their own pump repair facilities. It goes without saying that these facilities are staffed with factory-trained engineers, mechanics and technicians. Virtually all OEM shops pursue “non-OEM” repairs. This is necessary to maintain the desired profit margin as dictated by the manufacturer.

Repair performed at factory

Several pump OEMs offer factory repair service (not to be confused with OEM service centers). As stated in the description, the

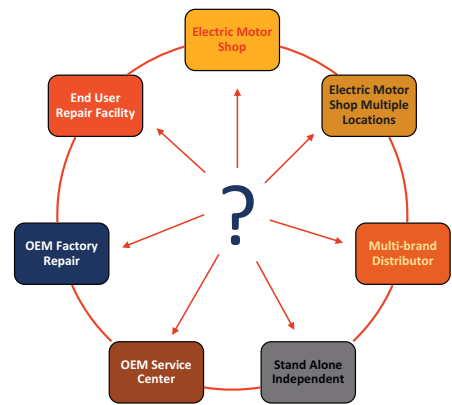


IMAGE 1: Types of pump repair facilities
(Image courtesy of the author)

pump is shipped back to the manufacturer (point of origin) for repair. There is a significant benefit to using this service assuming the pump in question is high energy and/or critical service as the factory typically has a test capability to ensure the unit is returned to OEM specification. It should be understood there is additional cost associated with performance testing.

Pump Repair Shop Selection Process

First and foremost, when selecting a pump repair shop, one must first establish expectation. I ran across the following quote (author unknown) that puts everything into perspective: “You don’t ask, you don’t get.” There is no area of life where this principle does not apply. Pump repair is no exception. I have met with numerous clients regarding pump system-related issues. When I ask for the “as found, as built” reports for past and current repairs, I get the “deer in the headlights look” followed with “we didn’t receive any documentation.”

As the quote states “you don’t ask, you don’t get”—thus, you cannot hold the repair shop accountable for services you didn’t ask for. Would you walk into a car dealership and tell the salesman to sell you a car? I hardly think so. You would most likely have a specific model, features,



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Questionnaire

The following questions were developed by the folks at National Grid. I found the series of questions very comprehensive and could not think of any additional information I would need prior to a site visit.

1. What types of pumps do you repair at your facility?
 - a. Vertical Pumps
 - single casing (open pit intake)
 - double casing (can or suction barrel intake)
 - inline casing
 - b. Overhung Pump Types
 - flexibly coupled
 - rigidly coupled
 - close coupled
 - c. Between Bearings Pump Types
 - 1 and 2 stage
 - multistage
2. Are you a distributor for any pump manufacturers?
 - a. If so, which ones?
 - b. Are you certified to perform pump repairs for the manufacturers that you represent?
 - c. Do you have access to certified drawings from said manufacturers?
3. Do you have a test stand to performance test the pumps post repair?
 - a. If so, is your test stand certified by the Hydraulic Institute?
 - b. Do you maintain a list of measuring/testing equipment?
 - Is your equipment calibrated on a regular basis?
4. What is the largest pump for which your service center is fully equipped to repair and test in-house?
 - a. What is your maximum lifting capacity?
 - b. What is your maximum lifting elevation?
 - c. Do you have a stacking pit?
 - d. Do you have two-plane balancing equipment?
 - If so, what is the largest rotating element that you can balance?
5. Do you have a coordinate measuring machine?
6. How many employees do you have and at what experience levels?
 - a. _____ Number of employees
 - b. _____ Maximum number of years of experience
 - c. Do you have a degreed pump engineer on staff? What is their name, years of experience and where did they gain their experience (pump OEM)?
7. What supplemental training or professional development activity is offered to service center employees?
 - in-house training or structured mentoring (describe)
 - off-site short courses, workshops or seminars one or more days in length
 - subsidized evening or part-time classes at college or trade school
 - attendance at trade conferences or conventions
8. How much training or professional development do service center employees receive?
 - a. _____ Percentage of employees receiving off-site training annually
 - b. _____ Average days off-site per year per employee receiving off-site training
 - c. _____ Annual training expenditure per employee receiving off-site training
9. What trade or professional associations is your service center a member of?
 - a. Are you a member of the Hydraulic Institute?
10. Do you have a formal quality management system involving third-party inspection and certification? Do you have a quality manual and/or published directive?
11. Do you have the capability of taking any brand of centrifugal pump and returning it to OEM conditions via reverse engineering and knowledge of pump hydraulics?
12. Do you have a pump engineer on staff?
13. Are you familiar with Six Sigma protocol?
14. Do you have a safety program in place for shop and field work?
15. What are the qualifications of your field service personnel?

color and price range, etc., identified prior to walking in. A pump shop is no different. Providing clear, concise expectations in writing eliminates any misunderstanding down the road.

Establish Expectations

When establishing expectations, include all parties with a vested interest in the pumping system. This can avoid issues down the road should there be a problem with the performance and/or reliability

of the pump. Team members should include, but are not limited to: purchasing, reliability engineer, maintenance manager, operations manager, production manager, electrical engineer and instrumentation and controls engineer.

This may appear to be overkill. However, if there is a problem with the repair that disrupts plant operations, you will be glad you had everyone's buy-in on the scope and quality of the repair. It is an unfortunate reality that someone

must always take the blame if production is disrupted, resulting in lost profits. Working as a team (safety in numbers) can minimize risk of lost production/profits while maintaining an open line of communication within the plant.

Selecting Industrial Pump Repair Service Providers

To begin the process, the team members must establish two things: Are they OK with shipping the pump out of state, and

do they want a full-service shop, that is “push, pull” (removal and installation) and startup? Using a full-service shop is the ideal solution for critical pumping applications because the repair shop has total control of the entire process and limits potential warranty repair claims (finger-pointing) that might be associated with installation and startup. At the very least, if plant personnel performs the “push, pull,” it is recommended to have a repair shop representative on-site to witness the installation and startup process.

These two factors can limit your selection process based on input from the team and possible plant management philosophy. Also, it is best to have multiple facilities qualified to provide service, due to availability and lead times. Another consideration is qualifying certain shops for noncritical pump repairs. This would increase the overall number of shops to choose from. Users must be careful when choosing a pump repair service provider. Taking your pumps to an untrustworthy service center could worsen the pump's condition. On the other hand, approaching a reliable repairing center not only helps ensure the pump's reliability and performance but also ensures that the repair is delivered in a timely manner.

Selection Process

Having identified several facilities, the next step is the phone interview. This process can be handled as a team or one member of the team with a list of qualifying questions, again based on criteria and expectations developed by the team. If your team is comfortable with the answers received by the service facility, the next step is to perform a vendor audit. This process requires a site visit by a qualified audit team knowledgeable in quality control procedures as well as pump repair processes. A site visit is necessary to physically validate what was shared during the phone interview and additional information based on the type of pumps you are looking to have repaired.

My next column will address the on-site survey. ■

William Livoti is retired after more than 40 years in the industry. He may be reached at wlivoti@outlook.com.



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IoT Creates More Reliable Irrigation System for Oregon Farm

Remote alarm notification software was a crucial component to the operation.

BARBARA PADGETT | WIN-911

To meet the growing population and increased demand for food, farmers and agricultural companies are turning to the internet of things (IoT) for analytics and greater production capabilities. Technological innovation in farming is nothing new. Handheld tools were the standard hundreds of years ago, and then the Industrial Revolution brought about the cotton gin. The 1800s ushered in grain elevators, chemical fertilizers and the first gas-powered tractor. Fast forward to the late 1900s, when farmers started using satellites to plan their work.¹

The IoT is set to push the future of farming to the next level. Smart agriculture is already commonplace among farmers, and high-tech farms are becoming the standard thanks to agricultural drones, sensors, supervisory control and data acquisition (SCADA) and remote alarm notification systems.

Threemile Canyon Farms

Located in Oregon's Columbia Basin, Threemile Canyon Farms LLC was founded in 1998 with a vision to create a modern agriculture operation at the intersection of productivity and sustainability. Threemile has built its farming operations on a closed-loop system of sustainable agriculture that recycles organic waste by putting it back to use in the soil, resulting in little to no waste while increasing cost savings.

Growing more than a dozen different fruits and vegetables that are cultivated in 363 crop circles that average up to 120 acres each is no small task. The crops are on different irrigation and fertilization regimens, and the organic crops require an even more specialized



IMAGE 1: Threemile Canyon Farms' central pivot irrigation system. The farm's efficient irrigation techniques and management systems increase the cost-effectiveness of crop production, reduce soil erosion and lessen energy requirements. (Images courtesy of WIN-911)

program. This farm, which encompasses approximately 140 square miles and over 30,000 acres of irrigated farmland, exemplifies high-tech farming.

Center Pivot Irrigation

Center pivot irrigation, which is 10% to 20% more efficient than furrow irrigation², is how each circle is watered and fertilized. The irrigation pipes are supported by trusses mounted on wheeled towers that make a circuit of the field under their own power. Each pivot has a custom-made sprinkler package installed that is designed to apply a specific amount of water on the field. Variable-rate irrigation techniques are also used to turn specific sprinklers on and off depending on the crops' conditions.

Typically, a main pipeline connects to a cluster—where two to four pivots are fed—with a tank head. The pivot pipes leave this location and go out to the center pivot. These clusters contain all electrical, control wires, water valves and cluster pressures. This central spot is where the pivot control panels are located along with network communications equipment.

Threemile's Irrigation System

The water, fertilizer, chemical, speed, direction, duration and variable rate can all be controlled—including different combinations, such as operating at a 50-degree angle at 100% capacity then slowing down to 20% and then speeding up again—and programmed into the panels to keep the crops in optimal conditions. Additionally, there is GPS on the end tower so the team knows exactly where a pivot is directed on the crop circle at any given time. Threemile's irrigation techniques and management systems increase the cost-effectiveness of crop production, reduce soil erosion and lessen energy requirements—including helping to lower its annual energy bill—while enhancing and sustaining crop production, the environment and water use efficiency. This process allows for an increase in crop production and yield, as well as cost savings. As a responsible steward of the land and resources, Threemile feels it is important not to over fertilize or water.

Mark Ashby, Threemile's information technology (IT) and automation systems manager, oversees the farm's control

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Check 108 on index.

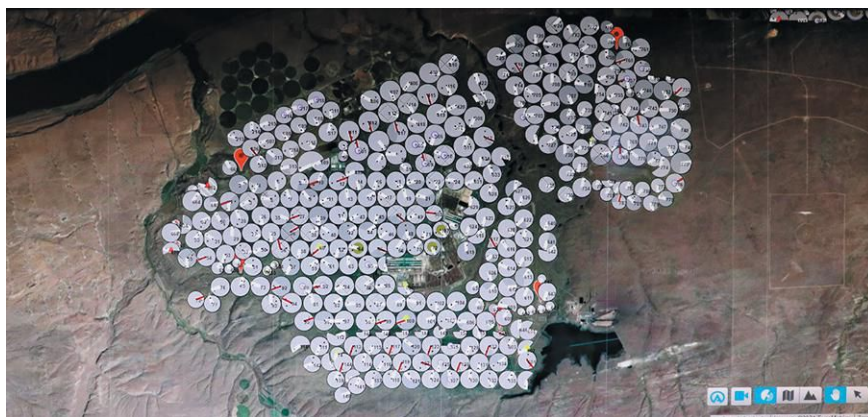


IMAGE 2: Site map of Threemile Canyon Farms' crop circles being monitored with a system platform and monitoring software

systems and complex network that ensure the crops, and irrigation and fertilizer systems are continuously monitored.

Increased Technology

This technology has been a work in progress for more than a decade. Ashby and his team began by implementing a large wireless network as the foundation for a better, more reliable system that allows them to control the crops' maintenance to the smallest detail. With the goal of improving reliability and control even further, the pump stations were retrofit with upgraded programmable logic controllers (PLCs) and fitted with medium-voltage variable frequency drives (VFDs) to control the motor/pump speeds to anything between zero to 100%. This now includes over 200 PLCs, a 140-square-mile wireless umbrella, 25 communication towers, a variety of fiber-optic/cat5/cat6

network connections and Gigabit air fiber connects all the systems.

The architecture of network servers runs a SCADA system integrated with remote alarm notification software. The network servers monitor the conditions on the farm and report and collect data on any change. This information is stored in historian databases for mining and provides analytics for review.

Monitoring the System

This network monitors the water pressure through the pipes that connect to the clusters that then feed each pivot. Monitoring is done via pressure transducers to the clusters. In addition to the pressure and flow being monitored, the team watches many other components. For example, at the river stations, the water that is pumped out of the Columbia River uses 1,500-horsepower (hp) and 1,250-hp pumps, and high-pressure shutdown techniques for the river and booster stations also require monitoring.

With peak volumes during summer months of up to 200,000 gallons of water per minute being pumped, any aberration from normal levels can lead to devastating consequences including costly machine repairs and damaged crops.

Alarm Notification

When things do not operate as they should, alarm notifications are sent out via SMS or emails that allow Ashby and his team to intervene and rectify the situation.

"I can't only depend on someone sitting at the control desk to notice everything. For example, it's a lot easier to pull a pump/

motor when we're alerted to a possible problem than down the road when it burns up; particularly when a rebuilt motor costs up to \$50,000," Ashby said.

In addition to forecasting potential problems, since everything is interconnected, an alarm is critical when something is not working. If one of the 72-inch pipes coming from the river station shuts down, multiple pumps that are pumping between 10,000 to 15,000 gallons of water per minute will stop, leaving the crops vulnerable and causing safety issues.



IMAGE 3: The pump stations were retrofit with upgraded programmable logic controllers and fitted with medium-voltage VFDs to control the motor/pump speeds to anything between zero and 100%.

Having the ability to go back and compare past data to see why an event like this happened helps users prevent future problems. Threemile has a significant investment in pumps and motors, upwards of \$200,000 each set. Ensuring that they are running correctly is critical to the farm's operation and bottom line. ■

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IMAGE 4: A main pipeline connects to a cluster where two to four pivots are fed with a tank head. The pivot pipes leave this location and go out to the center pivot. These clusters contain all electrical, control wires, water valves and cluster pressures. This is where the pivot control panels are located along with network communications equipment.

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The Advantages of Popular Fieldbus Networks

How to use smart instrument measurement for better monitoring and control.

PETER CHRONIS | Winters Instruments

Effective pressure and temperature measurement of process media ensures efficiently run facilities. A key component in high-quality measurement is the implementation of smart pressure and temperature transmitters with leading-edge functions for high-speed network communication.

Historically, transmitters in industrial and process environments would rely on an analog output variant to send pressure ratings or temperature information further upstream to a programmable logic controller (PLC) or process automation controller (PAC). A common output type is 0-10 volts of direct current (VDC). This communication type is simple to implement, readings are easy to take and 0-10 VDC input devices are mainstream and embedded in many electronic devices. However, when it comes to durability, the preferred choice among automation specialists is a milliamp (mA) signal, typically 4-20 mA output. Again, the installation architecture's advantage is that it can travel long distances without causing signal degradation and is robust

against electrical noise (often induced by surrounding electric equipment).

While considering more integrated internet of things (IoT) communications, digital platforms will need to be considered for full integration of field devices. Of the options available, the fieldbus network with the longest legacy and open infrastructure is Modbus RS485 (Modbus protocol defines the messaging structure used in the data exchange, while RS485 defines the physical level of electrical signals and wiring between the host and the field devices). There are many advantages of this protocol, including wide global acceptance with low cost of implementation, serial communication tolerant to electrical noise, cables that run up to 1,200 meters or 4,000 feet, capacity for multiple field devices on a single rung (up to 32 nodes can be connected on one network or up to 127 devices on a multi-drop network), and the offer of fast data transmission speed.

Another popular fieldbus network and one installed across the process world is HART (Highway Addressable Remote Transducer). This is a hybrid analog and digital open protocol that can communicate over existing 4-20 mA communication platforms, allowing the user to upgrade to a "smart" protocol without the cost of rewiring. Other advantages of implementing HART include:

- simplicity with programming and network setup
- speeds up the time for troubleshooting between identifying and solving issues
- real-time detection of connection

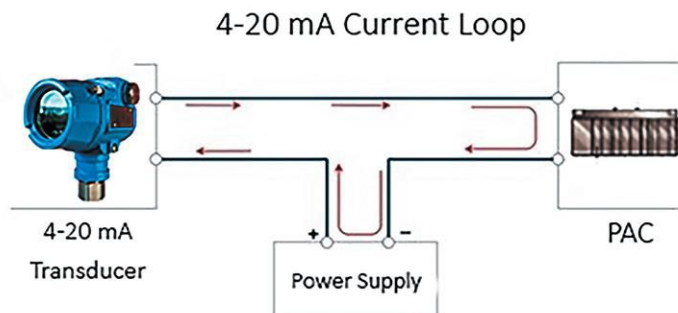


IMAGE 1: 4-20 mA communication with PAC (Images courtesy of Winters Instruments)

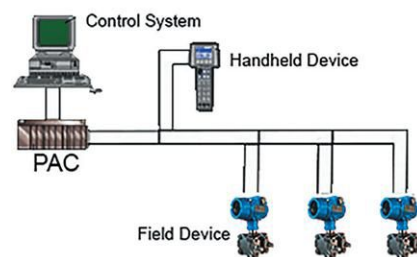


IMAGE 2: HART network

problems in device and/or process

- uses remote diagnostics to reduce unnecessary field checks
- improves regulatory compliance as sophisticated diagnostics increase the safety integrity level (SIL) with automatic safety shutdown
- seamless and continuous integration, allowing existing process plants to be continuously expanded

Once the communication network has been determined, there is a plethora of application opportunities for these smart transmitters to be integrated into. Industry, location and ambient conditions of the installation will often dictate the type of communication output that is selected.

For newer green field process installations, the default network is usually HART. However, often missed installations are in remote areas. For example, in the oil and gas market, well pads, pump jacks and compression stations (to name a few) are not considered in the overall networking scheme, as they typically operate as decentralized systems. These installations are typically interfacing both analog and digital signals at remote sites and communicating through remote

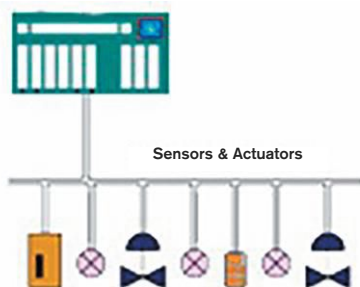


IMAGE 3: RS485 network

terminal units (RTUs) by radio, telephone lines, cellular signals, microwave and satellite to a central controller, commonly a supervisory control and data acquisition (SCADA) station. Remote locations with challenging environments have the potential for transient electrical noise and lengthy distances, the legacy network most often requested is Modbus RS485. With the loss of implementation and some allowable field devices, once this network is installed, especially in a remote location, it is difficult to convince a field operator to upgrade.

Upstream oil and gas facilities can generate their power through renewable energy such as solar, wind or geothermal. These sources can often power small e-houses but have limited power supply, therefore the power consumption of installed devices needs to be considered. Standard smart transmitters with 4-20 mA analog signal outputs or even the RS485 models with digital protocols rely on large amounts of power consumption. In these installations, the better choice is a low voltage 1 to 5 VDC analog output. This will ensure continuity for the remote location while adhering to the power consumption requirements.

A classic application, found in both commercial and process segments, is a heat exchanger. A heat exchanger is a device that allows heat from a fluid (or gas) to pass to a second fluid (or gas) without the two having to mix. This equipment, with age or misapplication, can suffer from leaks through cracking or blockages, and clogs due to an irregular maintenance schedule. If these issues arise, the heat exchanger will not properly perform and result in inferior quality product, unregulated climate control or personal harm. The installation of a smart differential pressure transmitter will allow for proper monitoring of the inbound and outbound pressure and display critical differences while sending the analog or digital information upstream for proper processing and control. ■

Peter Chronis is the vice president of business development at Winters Instruments. He holds a Bachelor of Commerce from Ryerson University and an MBA from Athabasca University. For more information, visit winters.com.

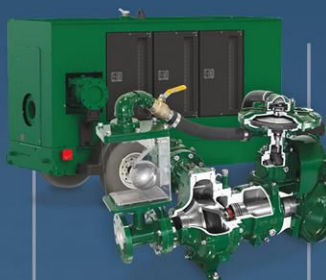


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What Can Remote Monitoring Tell You About Your Pumps?

It is critical to have a system that ensures equipment is running efficiently.

BY ROB FUSCO | Sensaphone

Operators of water and wastewater management facilities use remote monitoring systems connected to a variety of sensors and accessories to keep tabs on important environmental conditions such as temperature, humidity, water leak detection, power failures and unscheduled entry.

These systems are also used for preventative pump maintenance when they are programmed to watch specific conditions that could point to a problem with the pumping system. For example, users can use a remote monitoring device to observe pulse counts to detect total flow output from a pump, as well as follow runtimes to avoid overworking a pump or generator. In addition, they can monitor equipment vibration as an early indicator of an impending malfunction.

Fundamentals of Remote Monitoring

A monitoring system can be installed at both staffed facilities and unattended



IMAGE 2: Remote monitoring base unit in a protective enclosure

When vibration characteristics of pump components change, it might be a signal that they are damaged and on the brink of failure.

sites. It consists of a base unit that constantly collects data from sensors or existing equipment. The number of external sensors applied depends on how many inputs are on the base unit. Users program the device to designate the necessary high or low parameters on the monitored sensors. The base unit contacts designated personnel when a sensor reading moves out of the preset limits. Managers can receive these notifications via phone, email or text. Users can also access real-time and historical data log information to look for trends that could suggest a problem and generate records to use in preparing regulatory reports. This information is helpful in determining if certain equipment and components are not performing at a satisfactory level.

Monitoring Flow Rate Levels

Facility operators can wire a remote monitoring system to a flow totalization meter, which measures the amount of liquid or gas traveling through pipes and emits a pulse with each turn, or several turns, of its wheel.

The monitoring system is then programmed to read, count and interpret the pulses to alert personnel of changes in the flow of the current. Once the monitoring



IMAGE 1: Thermal flow meter with digital display (Images courtesy of Sensaphone)

device is installed and programmed, it will display the total amount of liquid or gas passing through the pipe in real time. Users can set high- and low-flow limits and set the unit to send alarm notifications when readings fall out of this range.

Monitoring Pump & Generator Runtime

Observing runtimes on pumps and generators is useful for managing active hours of operation and scheduling maintenance, which can extend the life cycle of the equipment. Many pumps and generators have relays or switches that



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B

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Gary Patterson
Municipal Market Manager
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Gary Patterson is the municipal market manager for Dynamatic. Patterson holds a bachelor's degree in electrical engineering from Michigan Technological University, where he pursued the power option, specializing in rotating equipment and electrical power generation, transmission and distribution. He began his career with a manufacturer of large motors, assigned as a factory application engineer, specializing in the firm's line of eddy current variable speed drives and emerging variable frequency drive technology. He served later as a field sales engineer in Chicago and eventually assumed regional responsibility. He has worked in field sales as a region manager for a variable frequency drive manufacturer and has also been employed as a sales engineer with a manufacturer's representative firm, responsible for a large variety of electrical and mechanical equipment. His current focus at Dynamatic/Drive Source International, Inc. is on pumping and similar applications in the industrial and municipal markets.

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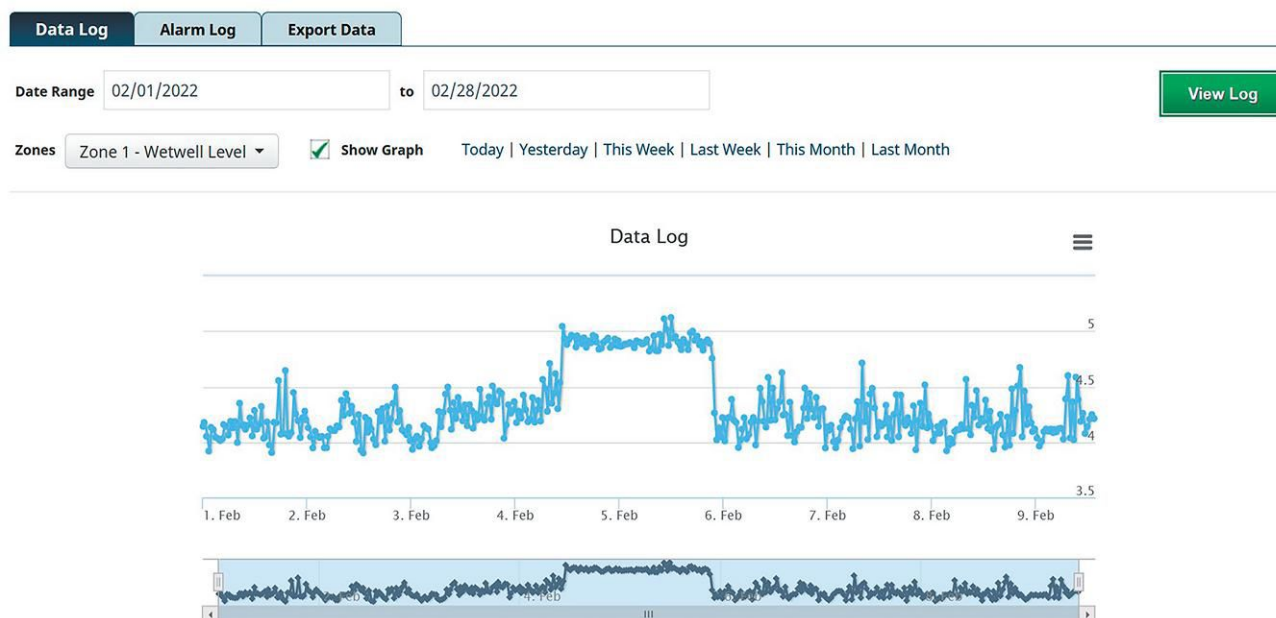


IMAGE 3: Monitoring system data log indicating a high flow rate

change positions when the pump is on. In these situations, operators can wire a monitoring device to them to detect when the pump or generator is switched on and maintain an ongoing log of the time. Users can program the monitoring device to send an alert when the runtime has reached a certain number of hours.

Peace of Mind Operating Older Pumps

Monitoring pulse counts and runtimes is an easy way to keep an eye on operational data from remote locations that have older pumps and generators. Of course, many modern flow meters offer a 4-20 milliamp (mA) or Modbus output that provides automatic, user-friendly operation. In fact, certain generators or pumps have built-in smart Internet of Things (IoT) functionality. However, for operators of legacy pumps and generators, using a remote monitoring system with existing flow meters is a cost-effective way to know whether everything is functioning properly.

Monitoring Vibration

When vibration characteristics of pump components change, it might be a signal that they are damaged and on the brink of failure. For instance, vibration increases

when an impeller breaks or pump bearings or seals begin to wear out. Personnel often cannot see or hear this subtle change but a vibration sensor installed in the pump can detect it easily. The sensor focuses on a pump's acoustics to identify imbalances, providing early warning of changes occurring within the pump.

Vibration sensors measure the vibration velocity of the pump ranging from 0 to 25 millimeters/second (mm/sec [root mean square]) over the frequency range 10 to 1,000 hertz (Hz). For example, an output of 4 mA is consistent with no vibration at 0 mm/sec, whereas an output of 20 mA indicates intense vibration at 25 mm/sec.

Low-frequency vibrations can indicate system faults like pump bearing fluid lubrication whirl. Mid- to high-frequency vibrations can reveal malfunction of the drive motor or impeller. Very high-frequency vibrations can suggest high-pressure leaks, entrained gas and pump cavitation, as well as emerging faults on castings, piping, rotors and bearings.

Vibration sensors are permanently attached to the equipment by a magnetic mount or screwed in via the sensor's threaded mount. Next, they are hard-wired to the remote monitoring device. Then, the user programs the system to

send alerts and log the information coming from the sensor.

Each vibration sensor communicates its frequency readings in real time to the remote monitoring device. When the system detects a reading outside of the preset range, it sends a notification to designated operators. This gives personnel time to take action to prevent equipment failure, secondary damage and costly downtime.

Selecting a monitoring system that also functions as a data logger is helpful for capturing vibration readings at set time intervals. Users can view real-time and historical data to look for trends that indicate a potential equipment failure.

With water and wastewater facilities processing millions of gallons of water every day, it is critical to have a system in place that helps to ensure equipment is running as efficiently as possible. Remote monitoring systems can achieve an extra layer of maintenance protection at the plant. ■

Rob Fusco is director of business development with Sensaphone. He may be reached at rfusco@sensaphone.com or 877-373-2700. For more information, visit sensaphone.com.

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Michael Howard
CEO
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Michael Howard is an American entrepreneur, a veteran of the U.S. Air Force, and leader in the predictive maintenance industry. He is the CEO of Erbesd Instruments and responsible for strategic direction, distribution, sales, marketing and operations. Howard, who holds a doctoral degree of science, is a native of South Glens Falls, New York, and a graduate of Excelsior College, Capella University, and Charter University with degrees in electro-mechanical engineering, leadership, and organizational management, and engineering management. He is a certified reliability engineer, Six Sigma Black Belt and certified maintenance and reliability professional. Howard is an advocate of the use of wireless instrumentation and the IIoT communities for the maintenance and reliability industries.

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Water Infrastructure Improvement Efforts Begin Following Passage of IIJA

The historic bill allots \$55 billion for water infrastructure projects nationwide.

EVI ARTHUR | Pumps & Systems

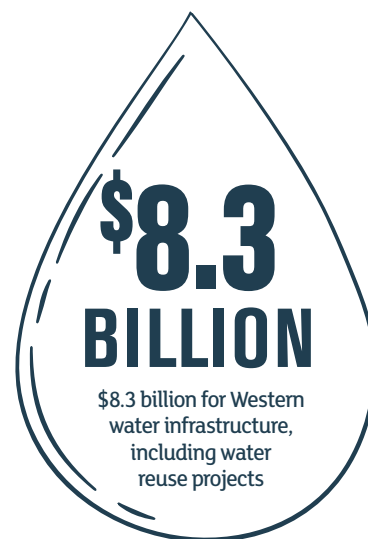
On Nov. 5, 2021, President Joe Biden signed the Infrastructure Investment and Jobs Act (IIJA) into law. The IIJA allocated \$1.2 trillion for infrastructure in the United States, including \$55 billion for water pipe upgrades, investments in clean drinking water and water recycling programs. This is, to date, the largest investment made in water infrastructure by the federal government.

Alongside wastewater, infrastructure resilience and other environmental allocations, according to the Chamber of Commerce, the bill's \$55 billion water infrastructure provisions include:

- \$50 million annually for the Water Infrastructure Finance and Innovation Act programs from 2022 to 2026
- \$15.7 billion for the Drinking Water State Revolving Funds (DWSRFs)

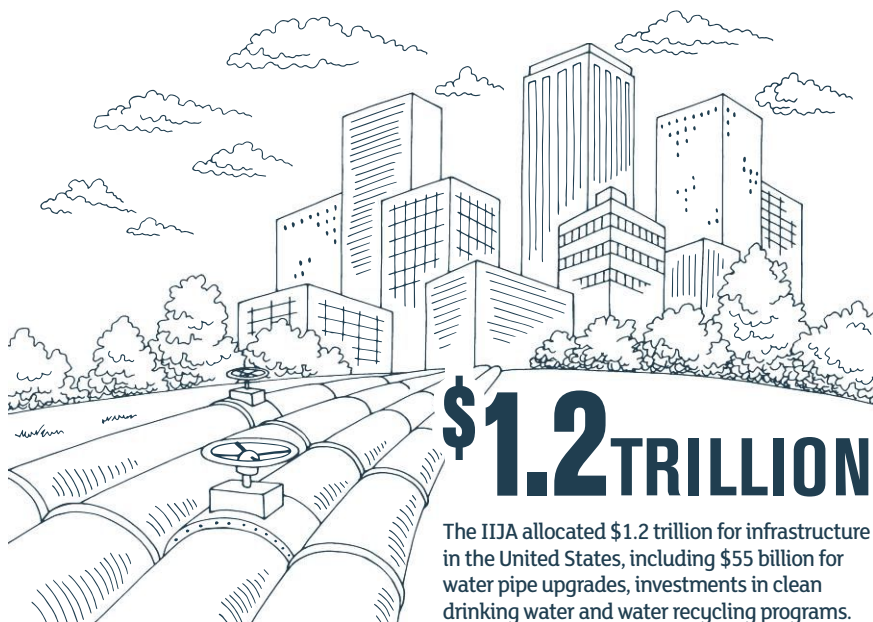
- \$15 billion for lead service line replacement
- \$4 billion in grants for DWSRFs to address emerging contaminants, including per- and polyfluoroalkyl substances (PFAS)
- \$5 billion to deal with emerging contaminants in economically distressed communities
- \$8.3 billion for Western water infrastructure, including water reuse projects

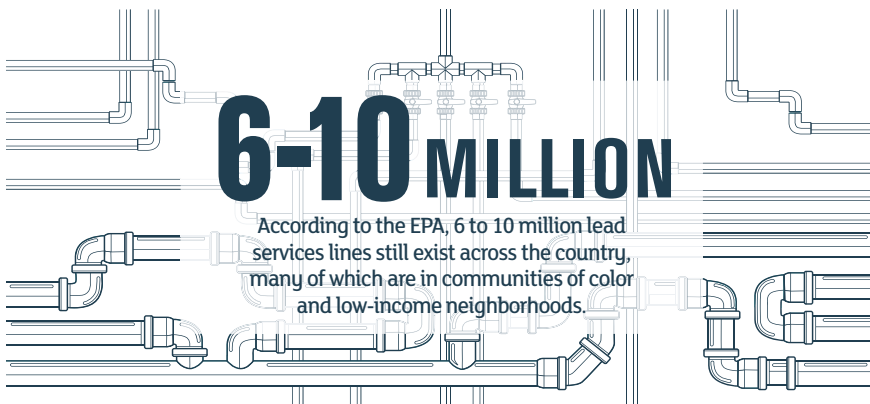
There is also a line item for the establishment of regional technical assistance hubs in regions with a large concentration of lead service lines. The hubs are meant to help local communities develop service line inventories and model contracts for removal projects.



One of the main tenets of the bill is the replacement of lead pipes nationwide, as part of the Biden-Harris Lead Pipe and Paint Action Plan. According to the White House, “up to 10 million households and 400,000 schools and child care centers are served by a lead service line or pipes and other fixtures. Approximately 24 million housing units have significant lead-based paint hazards, of which 4 million of these are home to young children.” According to the U.S. Environmental Protection Agency’s (EPA) 2021 Economic Analysis, benefits of lead service line replacement can include increases in lifetime earnings, avoided intelligence quotient (IQ) loss in children, as well as reduced risks of cardiovascular disease, kidney disease and other adverse effects.

Since the law was just signed in November, and the wheels of federal government turn slowly, it is still too soon to know what this widespread replacement will look like in the coming years. However, applications for grants from local DWSRFs are now open in many areas.





6-10 MILLION

According to the EPA, 6 to 10 million lead services lines still exist across the country, many of which are in communities of color and low-income neighborhoods.

While past water infrastructure funding has gone solely toward building dams, aqueducts, irrigation systems and river and port transportation systems, according to the Pacific Institute, this new bill also focuses on more modern priorities focused in nature-based solutions. These include ecosystem restoration, water efficiency, water reuse, flood and drought programs and dam safety, which all go toward “a longer-term water resilience view.”

In a letter to governors, Michael S. Regan, administrator of the EPA, instructed states to prioritize the safe drinking water efforts in disadvantaged communities and those disproportionately affected by lead. He also expressed his and the EPA’s support for all water infrastructure investments

across the country. “The EPA will be with you every step of the way. In the coming months, the Office of Water will work with you to identify the tools, resources and targeted technical assistance that will best support states in achieving these goals,” Regan said. “We stand ready to work with your state to ensure an effective, efficient and equitable implementation of the Bipartisan Infrastructure Law.”

One such example of the work that needs to be done is in New York. Newburgh, New York, has about 2,500 service connections that need to be replaced. In New York City and its suburbs, officials are hoping federal money will be used to improve sewers, many of which are a century or more old, as well as accelerate progress on the St. Albans, Queens, pumping station. According to the EPA, New York state has been allotted \$428 million over five years, in addition to annual SRF appropriations to improve projects like these and more.

California’s allotment of funds was \$600 million, according to the EPA. “Shoring up our water resilience,” said California Governor Gavin Newsom, “especially in small and disadvantaged communities, is imperative to safeguarding the future of our state in face of devastating climate change impacts that are intensifying drought conditions and threatening our communities, the economy and the environment.” ■



\$5 BILLION

\$5 billion to deal with emerging contaminants in economically distressed communities

What Is the DWSRF?

Much of the effort to replace deteriorating water systems will be funded by the Drinking Water State Revolving Fund (DWSRF). Established in 1996 by the Safe Drinking Water Act, the DWSRF is a partnership between the EPA and the states to distribute federal funding for drinking water projects. According to the EPA, Congress first allocates funding, then the EPA awards low-interest loans to each state based on its most recent Drinking Water Infrastructure Needs Survey and Assessment. The state typically matches 20% of the allocated funds. This money is then placed into the revolving fund where it provides loans and other assistance to state and local water systems.

Loan repayments made by the systems are then put back into the fund.



Evi Arthur is associate editor of Pumps & Systems. She may be reached at earthur@cahabamedia.com.

'Big Problems Take a Long Time to Solve'

How the EPA is working to combat PFAS and why that is easier said than done.

DREW CHAMPLIN | Pumps & Systems



Ben Frech
Public Relations and
Government Affairs Manager,
National Groundwater
Association



Nick Armstrong
Global Product Manager,
De Nora Water
Technologies

Per- and polyfluoroalkyl substances (PFAS) have been in the news for their damaging health effects and links to contamination of drinking water around the world. The Environmental Protection Agency (EPA) is making a concerted effort to examine the risks and stop the spread of PFAS, but it has not been easy.

Pumps & Systems reached out to several industry sources for insight on PFAS and how the EPA's efforts affect operation of water systems. Ben Frech, public relations and government affairs manager at the National Groundwater Association (NGWA), and Nick Armstrong, global product manager at De Nora Water Technologies, provided responses to challenging questions about PFAS.

P&S: Why is limiting PFAS a challenge in the U.S.?

Frech: Limiting anything that has been so prevalent in our environment and society will always be a long and difficult process because it involves movement from all stakeholders, wide-reaching regulations and usually a great deal of money. Remember, Congress banned lead pipes from being used in 1986 and we are still investing in efforts to remove and replace them across the country.

And, while PFAS and PFOA (perfluorooctanoic acid) chemicals have become largely phased out in the U.S., we are in a global market and the U.S. is filled with imported goods from places that have yet to take strict actions on the chemicals. PFAS is truly a big problem—and big problems can take a long time to solve.

Armstrong: When people hear the term PFAS or PFOA, that's almost the equivalent of saying "plastic" or "metal"—neither mean anything alone. There's steel, iron, polypropylene, other types of plastics

and so on. Similarly, there are so many different compounds that can be classified as PFAS that it's hard to fully lock in on one specifically, and [the] list of identified compounds continues to expand. Aside from classification issues, the biggest challenge utilities face on the drinking water side is having the proper equipment in place to treat for PFAS, which requires significant capital expense. Some of the larger municipalities or water suppliers may have the budget and ability to take on some of the costs, but when you're dealing in some of the smaller rural areas, the cost of filtration and treatment after may be too much for them to bear.

P&S: How will these stricter rules on PFAS affect water treatment policies?

Armstrong: The challenge will extend all the way through the water life cycle, whether that be municipal or industrial. The tighter the drinking water standards are, the tighter the regulations will be on wastewater as well—things such as industrial runoff from manufacturing,

What Are PFAS?

Per- and polyfluoroalkyl substances (PFAS) are chemicals with components that break down slowly over time. Many PFAS are found in the blood of people and animals all over the world and are present at low levels in a variety of food products and the environment. PFAS are found in water, air, fish and soil. Studies have shown that exposure to some PFAS in the environment may be linked to harmful health effects in humans and animals. As there are thousands of PFAS chemicals found in many different products, it is difficult to study and determine health and environmental risks.

Source: EPA

What Is the EPA Doing to Combat PFAS?

On Oct. 18, 2021, EPA Administrator Michael S. Regan announced the agency's PFAS Strategic Roadmap—laying out a whole-of-agency approach to addressing PFAS. This sets specific actions and commits to bolder new policies to safeguard public health, protect the environment and hold polluters accountable. The EPA will account for the full life cycle of PFAS, ensure science-based decision-making and protect disadvantaged communities.

Source: EPA

landfill leaching, sewage treatment and so on—all of these will be affected by stricter water treatment policies.

P&S: What changes will water utilities or municipalities have to make to how they are currently testing treated water?

Armstrong: Most utilities are not actively testing for PFAS at this time due to lack of regulation. Therefore, the first step will be developing testing methods for PFAS and integrating that into existing procedures.

Based on the data we have seen to date, there is a good chance traceable amounts of PFAS will be detected in the water, so the next step will be mapping out a course of action for treatment, including waste disposal. On the drinking water side, the most commonly used technologies are either granular activated carbon, oftentimes referred to as “GAC,” or a synthetic media, ion exchange (IX), which is formulated to specifically attract the charged ionized head and grabs all of the PFAS—small and long chain. Once spent,

both methods require proper disposal of media once their lifetime has been reached. Since it's not currently listed as “hazardous waste,” the media could technically go to the landfill but the rules could change in the future. Therefore, the best plan of action is to use the media until it is spent and then send it off for incineration. Now again, that opens up new challenges due to the fume gases associated with incineration and its large carbon footprint. It doesn't necessarily solve the problem as much as it moves



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Check 125 on index.

the problem from one spot to another. There will always be new challenges to overcome as processes change.

P&S: How is contamination of PFAS more prevalent than previously reported?

Frech: I imagine much of this can be contributed to the fact more people and institutions are testing for these chemicals than ever before, and we've also invested more at the state and federal levels in tracking these chemicals down. If PFAS is truly as prevalent as many scientists believe, then there are always going to be good odds that populated areas will have a certain level of PFAS contamination.

Armstrong: It's a very prevalent issue that we're dealing with as a planet. PFAS has been found in all living organisms, from humans to plants. I even read recently it was found in the blood of polar bears at

the North Pole. So, this is really a global problem that maybe doesn't get as reported as often as it should, and it doesn't get reported because it's not necessarily in the public consciousness. It's not part of global policies. Here in the U.S., there are some individual states that have warning limits, but none have a true action limit. That becomes more the issue. PFAS is everywhere. You get lunch at a fast-food restaurant—the reason the melted cheese doesn't stick to the wrapper is because it's coated in PFAS. You purchase stain-resistant clothing or wrinkle-free clothing—these are also coated in PFAS. These are just two examples. It's prevalent in our day-to-day life that we're not even aware of it. There are plenty of identified PFAS, but since we're still in the infancy stages of testing, there are likely a lot more that have yet to be identified. But we are also in the infancy of treatment. New methods and processes are being developed to not only remove PFAS

but ensure these are no longer viewed as "forever chemicals" by destroying them.

P&S: Will drinking water have different PFAS parameters than other types of "treated" water?

Armstrong: Ultimately yes, drinking water will have tighter specs, because it's the No. 1 interaction with humans—that's how these compounds make their way into our bloodstream. But I could see that having an impact down the line for water used on food via irrigation, as well as the water we feed animals that eventually become food. As PFAS get more into the public consciousness and into political policy, it goes back to my earlier point—there will be a need for tighter restrictions on all water. ■

Drew Champlin is managing editor of Pumps & Systems. He may be reached at dchamplin@cahabamedia.com.

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Check 122 on index.

Lowering Reverse Osmosis Costs for Small to Midsize Watermakers

Understand considerations of pre-treating with filtration, not chemicals.

BRIAN JACOBY | ITT C'treat

Reverse osmosis (RO), or using a semi-permeable membrane to remove dissolved solids from water, is the most common type of desalination. There is a wide range of reverse osmosis systems, producing anywhere from a few gallons to millions of gallons of clean water per day.

Due to the differences in scale, it is important to treat a system that produces only a small amount of water per day differently than those in the millions. One difference lies in how often the membranes of these systems should be cleaned.

Each membrane, as well as the watermaker around it, is designed differently. The manufacturer of the product will specify how often its membranes should be cleaned to prevent scaling (when salts and other particles plug the membranes) and fouling (when dirt, marine growth or algae clog the membrane). Maintaining a rigorous cleaning schedule, per the manufacturer's instructions, can help maintain the membrane for a lifetime of three to five years.

However, in smaller-scale watermakers with fewer membranes, there is a better way. With no cleaning at all, and some minor adjustments to the pretreating process, these membranes can last up to two years at a fraction of the cost—even when factoring in the need to purchase membranes more often.

It is a complicated process; so, let's break it down.

Inconsistent Cleaning Practices

The membrane cleaning process is, to put it mildly, a drain on resources. Since all sources of feed water can have slightly

different characteristics, the suggested cleaning method of RO membranes differs greatly from one location to the next. Most manufacturers suggest cleaning when water flow and salt rejection reduce by a certain percent, as well as how to clean the membrane based on the type of scaling or fouling (such as calcium scale, iron oxide and others).

Once users know what the membrane is scaled or fouled with, they may need either acid or alkaline cleanings—or both. During the cleaning process, users also need to maintain a specific temperature, pressure and pH to ensure a full clean. However, since the pH can change during cleaning, the user must constantly adjust the cleaning chemical concentration, soak the membrane, flush and repeat two to three times.

Aside from the manpower required during the process, cleaning-in-place also requires a storage tank, pipes and hoses and a significant amount of expensive chemicals. Once the membranes are cleaned, workers must also dispose of and store the remaining chemicals, which places an additional burden on the operation.

In many operations, this complex process is left by the wayside, as busy workers prioritize meeting daily quotas over spending precious time and resources on cleaning. Through 40 years of building reverse osmosis systems, even when users are supplied with the needed equipment and instructions to clean-in-place consistently, it usually does not come to fruition.

Those who follow this rigorous process a few times a year still have no guarantee

that the system will gain back the flow or salt rejection it lost prior to cleaning.

When Size Makes a Difference

In some cases, following a rigorous cleaning schedule is the most time-efficient and cost-effective way to manage watermaker membranes.

Generally speaking, for watermakers that generate over 80,000 gallons of fresh water per day (which likely have 24 or so membranes), it is preferable to follow the manufacturer's guidelines and clean the membranes rigorously. The more membranes a system contains, the more expensive it would be to purchase new ones after two years. Also, cleaning hundreds of membranes has a lower cost per membrane than cleaning 10, as a direct function of the chemical and labor costs.

However, for desalination systems under the 80,000 gallons and 24 membranes threshold, that begins to change. As chemical costs add up and the expense of purchasing new membranes decreases, the alternative becomes more attractive. Simply by following a more conservative recovery approach coupled with a powerful method of pretreatment, users can decrease both chemical costs and planned downtime.

Conservative vs. Aggressive Recovery

All reverse osmosis systems can be designed with either a conservative or aggressive recovery. Conservative recovery is designed to generate less output but it also decreases the amount of scaling that occurs. If 100 gallons of seawater are sent through an RO

Anything from dirt and algae to marine growth can affect the membrane's lifetime, and conservative recovery cannot stop fouling from occurring.

membrane, a percentage of that turns into fresh water. A more conservative recovery of 30% would generate 30 gallons of fresh water, while an aggressive recovery of 55% would generate 55 gallons.

It seems like a no-brainer to go aggressive—until risks are considered. With a system designed for aggressive recovery, membranes must either be cleaned and chemical antiscalant added diligently, as the amount of salt that precipitates and crystallizes on the membrane increases. And, for systems below that 24-membrane threshold, the cost of labor, chemicals, disposal and lost production to clean

diligently, resulting in an expected lifetime of three to five years, is greater than the cost of replacing the membranes every two years with no cleaning.

Conservative recovery allows membranes to last roughly two years without excessive scaling—but there is another factor to consider: membranes can also fail due to fouling. Anything from dirt and algae to marine growth can affect the membrane's lifetime, and conservative recovery cannot stop fouling from occurring. To prevent fouling without the need for consistent cleaning of the membranes, it is all about the pretreatment process.

Pretreating With Filtration, Not Chemicals

A traditional method of pretreating seawater before it enters the reverse osmosis system is using chemicals, such as flocculants, coagulants and antiscalants. This method causes several concerns, from the cost of acquiring and storing chemicals to properly disposing of the chemicals on a consistent basis.

The biggest risk of using chemicals for pretreatment can occur if the chemical pumps fail or if the user runs out of chemicals. For systems designed with aggressive recovery that rely on chemicals

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Check 120 on index.

for pretreatment, the membranes would scale or foul quickly.

However, by using a higher level of filtration before the reverse osmosis process, a greater amount of suspended solids can be removed, lessening the likelihood of fouling on the membrane. A simple four-stage filtration process can remove most unwanted materials before the water ever touches the membrane:

1. Granulated activated carbon filtering out anything larger than 25 microns
2. Bag filters to filter out anything > 5 microns
3. String-wound filters to filter out anything > 1 micron
4. Pleated cartridge filters to filter out anything > 1/2 micron

Some reverse osmosis system manufacturers filter suspended solids down to only 5 microns, to limit costs on filter housings and filters. However, the cost of the additional filters to remove solids down to 1/2 micron pales in comparison

to either cleaning consistently to avoid fouling or addressing excessive fouling after the fact.

To confirm this hypothesis, a study was conducted with an offshore platform to determine its costs per gallon of fresh water produced. To do so, it compared a watermaker that followed the above filtration process with conservative recovery and no cleaning of the membranes against a watermaker with aggressive recovery, less filtration and consistent cleanings. Two pieces of data were tracked: total volume of fresh water produced and the total cost incurred on each piece of equipment, including replacement membranes, replacement filters, labor costs, membrane cleaning chemicals and the lost production while cleaning.

The end result: the system designed with conservative recovery and more thorough pretreatment filtration came out to a cost of roughly \$0.01 per gallon, while the system designed with aggressive recovery, less filtration and that underwent consistent

cleanings landed significantly higher than \$0.01 per gallon. When considering the thousands of gallons produced per day, cents add up.

At the end of the day, every RO system is built differently and has its own cleaning requirements. For larger watermakers, there is a cost benefit of cleaning the RO membranes on a consistent schedule to protect against scaling and fouling and improve the lifetime of the product.

However, as the size of the system decreases, it becomes more efficient to cast aside the hassle, cost and time of cleaning in favor of a carefully designed strategy built on conservative recovery and diligent pretreatment filtration. Though a lifetime of two years seems less favorable at first, there is value when considering cost savings over time. ■

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Check 124 on index.



Potable Reuse as an Alternative Water Supply

Florida community Altamonte Springs' potable reuse pilot treats 28,000 gpd.

KEVIN FLIS | Xylem

Due to population growth and dwindling Floridan aquifer levels, experts have long predicted that groundwater sources alone will not meet future freshwater demands for central Florida residents. To address this looming issue, central Florida water utilities have begun exploring viable alternatives to diversify their water supplies. There are several options water utilities can consider when expanding their drinking water sources, including surface water, groundwater and desalination. One opportunity gaining popularity nationwide is potable water reuse.

The city of Altamonte Springs, located in Seminole County, Florida, was one of the first in the area to address its water challenges by investigating drinking water reuse. In 2017, the municipality implemented a pilot program called pureALTA. The pilot was designed with two primary goals—to serve as a platform for Altamonte Springs' future potable water reuse efforts and to educate the city's 45,000 residents about the benefits of potable water reuse.

St. Johns River Water Management District (SJRWMD) shared the city's vision of creating a sustainable water supply and provided grant funding to jumpstart the pilot. The project, which utilizes technology to purify reclaimed water to drinking water standards, also helps the city diversify its water source options.

The pureALTA Project

The pureALTA project is a treatment facility that treats reclaimed water by employing an advanced treatment train, which includes a paired ozone and biological active filtration process. The city worked with an engineering firm and a water solutions and technology company to develop an ozone-biologically active filtration-based (O₃/BAF) advanced water treatment train that also included ultrafiltration (UF) membranes, granular activated carbon (GAC) filtration and ultraviolet advanced oxidation (UV AOP).

This solution was chosen over reverse osmosis (RO)-based systems. The pureALTA treatment process begins with reclaimed water that is then treated to meet or exceed drinking water quality standards.

A handful of other cities in the United States have potable water reuse projects, but most rely on high-pressure filtration as the core treatment process of purification, rather than pureALTA's combination of systems that includes biological treatment processes. Proving to be less expensive and more energy efficient, pureALTA does not generate the toxic sidestreams that some other systems produce.

The network of two advanced water treatment processes—ozone and biologically active filtration—is handled by the integrated O₃/BAF system, featuring an ozone generator,

IMAGE 1: Altamonte Springs facility in Florida (Images courtesy of city of Altamonte Springs)

filter underdrain and media retainer technologies. The system treats approximately 28,000 gallons per day (gpd) and uses an O₃ (total organic carbon [TOC] + nitrite) ratio to set the ozone dose. The city monitors system performance with analytics equipment, including TOC and nitrite measurements upstream of the process and TOC downstream of the process to provide automated, real-time control.

The integrated and automated process sets the tone for the entire treatment train performance. The TOC-reduction across the system ranges from 25% to 37% and operates as a barrier for the UF membranes.



IMAGE 2: Biofiltration column with underdrain

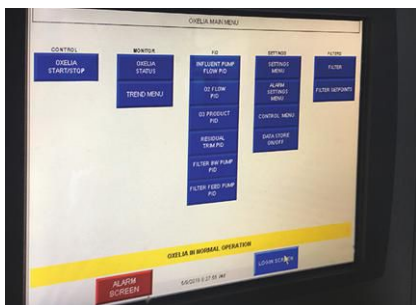


IMAGE 3: Main menu for integrated O₃/BAF solution

Pilot Results

During its first year of operation, the UF did not require any maintenance cleans and performed one clean-in-place. Most membrane operations require cleanings every six months.

Also, the UV-transmission average across the O₃-BAF process improved from 71% to 86%, which enhanced the performance of the UV advanced oxidation process and reduced the overall operating costs of the UV reactor. Based on the results of the pilot project, the city could develop a full-scale

system with the potential to create about 5% of Altamonte Springs' daily water demands, reducing stress on the aquifer.

Altamonte Springs frequently conducts educational tours at the pureALTA facility, providing students and utilities a first-hand view of how the potable reuse project works and how it can be a component of Florida's future water supply.

The city also developed the Altamonte Springs Science Incubator (AS2 I) program, which offers hands-on science, technology, engineering and math (STEM) learning for Seminole County students. The program includes field trips to various sites, including the pureALTA project site, with discussions of treatment processes, safety, drought and the importance of diverse water supplies.

Altamonte Springs and the pureALTA project has won two awards. The 2018 International Water Association Project Innovation Awards recognized the city as the only U.S. project with a top award in the Market-Changing Water Technology

and Infrastructure category. The pureALTA project also received the 2017 Water Reuse Innovative Project of the Year award. The award recognizes solutions for expanding the use of recycled water and the creation of future models that advocate the implementation of water reclamation nationwide. Since its implementation, water treatment experts, city engineers and water agencies around the country have come to observe pureALTA.

"They're interested in how they could adapt this technology to augment their own water supplies," Altamonte Springs City Manager Frank Martz said. "We see the project as not only something that can benefit our residents but as a model that can be adapted by other utilities throughout Florida as well as the rest of the country." ■

Kevin Flis is a client solutions manager with Xylem and has over 14 years of experience in the water and wastewater industry. He holds a Bachelor of Science in chemical engineering from Iowa State University. For more information, visit xylem.com.

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Check 123 on index.

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Off-Grid Solutions for Providing Potable Water

There are several options available to draw water from existing natural resources.

SETH VATTILANO | JH Process Equipment Inc.

As of 2015, the average American uses approximately 82 gallons of water per day, which can be taken for granted. Most people expect water to be available at all times without considering what their lives would be like without easily accessible water sources. The Conservation Institute estimates that 1.7 billion people in the world live off the grid, which means being self-sufficient and not using any utilities or other modern-day conveniences. That number increases each year.

To achieve this independence, electricity must be on-site and powered by renewable energy sources if possible, such as solar, wind or geothermal. Backup/emergency power via generators and fuel reserves should also be on hand. Many people simply do without electricity. However, doing without water is not an option. Those living off the grid must have a water source such as a well, spring, stream or nearby lake. The means to extract/pump the water for its intended use is vital.

People living without a convenient water source must travel to obtain and transport what is needed. There are several

options available to draw water from existing natural resources.

Lever-Operated Manual Well Water Pumps

Lever-operated manual well water pumps are an option for established communities that makes transferring the water into a portable container relatively easy.

How lever-operated manual well water pumps work

The manual water pump is a device that works thanks to a piston or plunger, a lever attached to a moving point, a connecting rod and a washer. As the hand pump lever is raised, the piston goes down and the water enters through the holes or tubes in the pump body and the washer is lifted by the pressure of the water. A suction effect is created by this action. When the lever is lowered, the washer does the same, cutting off the flow of water and causing it to accumulate inside the pump. When the process is repeated a few times, the amount of water that accumulates in the pump increases and eventually flows out of the outlet valve with each stroke.

Advantages

The manual water pump is typically dependable and durable. It is operated with minimal strength or effort and is easy to service. It is also inexpensive and self-priming.

Disadvantages

A well is needed for operation. The pumps work best with an extraction pipe diameter of 4 inches with a depth based on

underground water level. Depending on the area and cost, a well may not be a viable option. Also, hand-operated water pumps are not portable in most cases.



IMAGE 1: Solar-powered pump (Images courtesy of JH Process Equipment)

Solar Powered Water Pumps

Solar-powered water pump usage is becoming increasingly popular. The cost of a low-maintenance solar pumping system may make sense compared to the cost of a generator to run a typical water pump, with continual fuel and maintenance costs. A good solar pumping system is often more economical, which is why many nonprofits use solar pumping to provide clean water to remote communities around the world.

How solar-powered pumps work

Solar-powered photovoltaic solar panels produce electricity from sunlight using silicon cells, with no moving parts. Low volume pumps use positive displacement (volumetric) mechanisms that seal water in cavities and force it upward. Lift capacity is maintained even while pumping slowly. These mechanisms include the types used in diaphragm, vane and piston pumps.

Advantages

These pumps are becoming more affordable. Modern systems are reliable and most are easy to service. Many options are available depending on required flow rates, and the technology continues to improve.

Disadvantages

They are not easily portable in most cases, especially with required solar panels. Cost



IMAGE 2: Lever-operated manual well water pump

can still be prohibitive depending on the system required. Solar pumps work best in full sun. As a result, performance will decrease significantly in low light before turning off. With use in low-light, a battery may be required, further impeding portability and raising costs.

Portable Impeller Pumps

Portable impeller pumps in various forms have been used for years to handle everything from small jobs around the house to fluid transfer in an industrial setting. They are available with alternating current (AC) or direct current (DC) motors and can also be operated with a variety of different drills, including rechargeable, depending on how remote the application may be.

How portable impeller pumps work

A flexible impeller with five or more impeller blades applies pressure to the inside of the pump housing. A shaft with a key runs through the center of the impeller. The shaft is powered via drill or remote power source. The positive displacement rotating impeller transfers the liquid from the inlet to the outlet port of the pump.

The design allows for dry self-priming and discharge pressures up to 60 pounds per square inch (psi), which equates to a travel distance of over 100 feet of hose. Depending on the manufacturer, reliable versions are offered in housing materials from aluminum to stainless steel and impellers are offered in Food and Drug Administration (FDA) approved elastomers if required.

Advantages

These pumps are designed to be portable. The compact lightweight pump and a rechargeable drill can be carried anywhere the user chooses/is able to travel via a tool belt or carry case. The pump can be carried in a user's pocket. Depending on the model, they are able to self-prime with water up to 14 vertical feet and develop pressures high enough to move water over 100 feet through hose if needed. This is useful when transferring water from a creek

with a steep embankment or to a larger container on a bank uphill from a water source.

A portable impeller pump has shallow well water transfer capacities up to 16 gallons per minute (gpm). They are durable and easy to service depending on the brand, and the most cost-effective remote water pump option listed in this article. They can be powered by most standard rechargeable drills and are the most straightforward way to provide potable water without cumbersome equipment in a variety of circumstances.

Disadvantages

It requires a rechargeable battery power source to operate. A portable drill must be held to operate properly in most cases. It requires a short-length suction hose. Suction lift is no more than 14 feet from ground level.

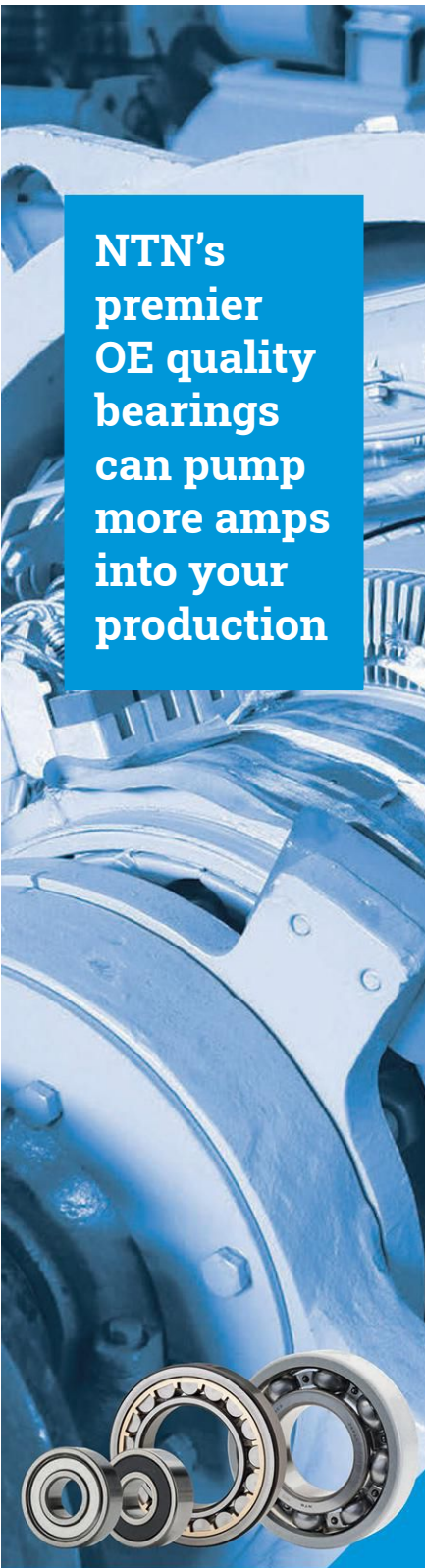
There is an increasing need worldwide for off-grid pump systems. The reasons for this range from economic factors and population growth to those who want to purposely reduce their carbon footprint and remove themselves from risks involved with living in more densely populated areas. The requirement for clean water has also increased due to the need for proper sanitation in today's world. Remote communities are at higher risk of disease transmission without an accessible clean water supply.

The pump options listed only consider the ability to transfer water. They do not include filtration that may be required based on the water source and its intended use. ■

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Check 129 on index.

Potable Water Disinfection With Chlorine Gas

Full vacuum principles regulate the addition of gaseous chlorine.

JJ BEKKER & STEVE FRANGIONE | Grundfos

With today's methods of treating drinking water being effective, users rarely think about what happens behind the scenes prior to turning on the tap. Much of the water that users consume or use on a daily basis has contained a collection of harmful microorganisms at one point in time. Prior to the introduction of water treatment and disinfection technology, there was a large risk of becoming ill from the available water sources, as they were often contaminated.

Early cases of diseases or sicknesses such as typhus, paratyphoid, cholera

and diarrhea with vomiting, as well as viral infections such as hepatitis and poliomyelitis, can be directly linked to contaminated drinking water. Many public water circuits including municipal water supplies, lakes, pools, commercial building systems and cooling towers can also provide an environment susceptible to Legionella contamination. Exposure to this bacteria can cause respiratory illness and even lead to death, which is why proper water treatment techniques are so important.

Chlorine has been used to treat drinking water for more than 100 years.

Chlorine has been used to treat drinking water for more than 100 years due to its low cost and effectiveness against harmful disease. It is the most widespread

Case Study

An OEM's disinfection team in Mexico was involved in a major project to provide a chlorine gas dosing system in Nicaragua. The WTP Bluefields in Nicaragua is an important project to cover and secure potable water for more than 6,700 people in the city. The water treatment capacity in the plant is 260 liters per second (lp/s), and the disinfection process involves chlorination (4 kilograms per hour [kg/h] capacity) and post-chlorination (2 kg/h capacity). The complete chlorine gas treatment system was supplied by the OEM.

The main components provided were chlorine gas extraction, main and final chlorination including a dosing regulator, a vacuum regulator, an injector, a changeover device and water booster pumps. This was all controlled by a dedicated chlorine gas control panel. The system also includes a neutralization chamber



IMAGE 1 (above): Chlorine gas dosing system controlled by a dedicated chlorine gas control panel (Images courtesy of Grundfos)

containing sensors that detect gas leaks and alerts operators of any critical conditions.

The OEM partnered with personnel from the Bluefields Water Treatment Plant, along with local contractors to successfully install and commission the chlorine gas dosing systems.



IMAGE 2: Chlorine neutralization system

disinfectant in the world and is used for a wide range of applications such as potable water treatment, wastewater treatment and pool water treatment. Chlorine can be introduced into these water systems in a variety of ways to help target the elimination of certain strains of harmful bacteria and viruses such as hepatitis, E. coli and Salmonella. The levels of added chlorine are just enough to kill off the bacteria while remaining safe for users to consume.

Manufacturers around the world offer a variety of chemical disinfection systems to ensure appropriate treatment for water applications. The method of treatment depends on a few variables like the application, size of the system, present bacteria and costs constraints. Options include chlorine gas, sodium hypochlorite and chlorine dioxide.

Chlorine gas dosing systems work in accordance with the full-vacuum principle that regulates the addition of gaseous chlorine reliably and precisely. These systems reduce the pressure of the chlorine gas to a vacuum, which successfully eliminates the risk of leakage. In the event of a pipe breakage, no chlorine gas can escape and only ambient air is drawn in.

Vacuum Regulator

The vacuum regulator is a pressure-reducing valve that reduces the overpressure from the chlorine tank side to the negative pressure on the vacuum side. The valve opens when a sufficient vacuum is present on the outlet side. Vacuum regulators with pressure gauge and liquid trap are available for more safety.

Dosing Regulator

The chlorine gas volume flow is adjusted with the dosing regulator. This can be done manually or automatically via motor control. Models can combine a vacuum regulator and a dosing unit in a compact enclosure.

Injectors

Injectors create the vacuum for the transport of the chlorine gas into the water flow. They operate according to the principle of a water jet pump. An integrated non-return valve protects the chlorine gas dosing system from the ingress of chlorine solution.

Changeover Devices

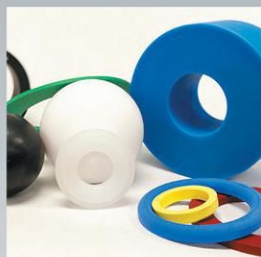
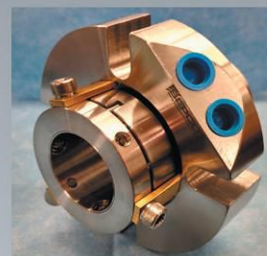
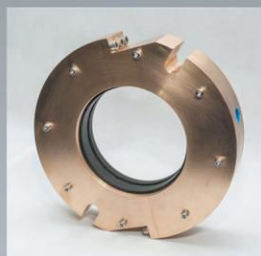
Changeover devices ensure a continuous supply of a chlorine gas dosing system by changing over from the empty bank of cylinders or drums to the standby bank. ■

JJ Bekker is lead sales engineer for dosing and disinfection in the U.S. and Canada at Grundfos. Bekker is experienced in the water and industrial applications industry with more than 20 years of experience in dosing and disinfection applications.

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Check 126 on index.

Key Considerations for Selecting a Portable Mixer

Variables that should be considered include fluid viscosity and category type.

EULIS ESTER | Neptune

The needs of fluid-handling operations are as varied as the kinds of liquids they handle. For those that mix fluids together, some might require small-batch blending while others need to mix large quantities. Some operations need only gentle mixing while others may require vigorous agitation. Thankfully, one piece of equipment can fulfill the needs of nearly any fluid-blending operation: the portable mixer.

Portable mixers come in a variety of shapes and sizes, with each model designed for specific applications. Properly designed and engineered mixers provide years of trouble-free service in a wide variety of blending or mixing operations. When configured and used properly, the right mixer can handle several important tasks, including suspending or dissolving solids, dispersing immiscible liquids, blending fluids of varying viscosities and dispersing small amounts of gases in liquids.

This article will identify the variables that should be considered before choosing the mixer technology that will result in an optimized mixing or blending operation.

Fluid Viscosity

One of the first and most important things to consider when selecting a mixer is the

Viscosity (cPs)	Materials Approximating That Viscosity
1	Water, gasoline, kerosene, solvents, milk
100	SAE 10 motor oil, olive oil, concentrated sulfuric acid
250	Mayonnaise
500	Paint, high-concentrate glucose solutions
1,000	Castor oil, ketchup, glycerol
2,500	Molasses
5,000	Honey, corn syrup
15,000	Cold molasses, molten glass
5,000+	Resins, high-concentrate polymers

IMAGE 1: Viscosity information for selecting the right mixer (Images courtesy of Neptune)

viscosity of the liquids being handled. The type of mixer and its related components can only be selected once viscosities of the fluids are known.

Various mixers can handle commodities with viscosities ranging from 1 to more than 25,000 centipoise (cP) including paints, varnishes, polymers, textile dyes, pharmaceuticals, food products and soaps. Users should keep the following information in mind when selecting the right mixer for the specific fluid type.

Portable Mixer Categories

Once the viscosity of the fluid in question has been determined, the next consideration is the types of portable mixer categories.

Batch size

For smaller mixing applications, the optimal style of portable mixer is lab and pail. Lab and pail mixers are best suited for mixing in small vessels for labs or industrial applications where a liquid product is provided in a pail. For industrial applications requiring larger containers or higher mixing speeds, drum and tote-tank mixers are the most used. Tote (IBC containers) sizes can vary anywhere from 220 gallons to more than 500 gallons, whereas drum mixers are used with the 55-gallon drums in which many industrial chemicals are shipped. Most models of portable mixers are either gear-driven

The type of mixer and its related components can only be selected once viscosities of the fluids are known.

with speeds of 350 or 420 rotations per minute (rpm), or direct-drive, with speeds of 1,750 rpm. Most can be fitted with variable speed drives (VSDs) or air motors that can provide variable speed if needed.

Mounting

The ideal mounting configuration varies depending on the application at hand. The three main types of mounting configurations for mixers are C-clamp, flange mount and angle riser. C-clamp mounts normally feature an adjustable angle of entry controlled by a ball-and-socket design. Flange mounts attach to a flange that is located on the lid of the drum, tote or bulk tank. Angle risers provide a fixed 10-degree angle of entry into the mixing vessel.

Props

Like mounting configurations, there are three common types of portable mixer propellers: 1.0 pitch, or marine prop; square pitch; and super pitch. A 1.0 pitch is one of



IMAGE 2: Portable mixers play a significant role in industrial applications for blending and mixing operations.

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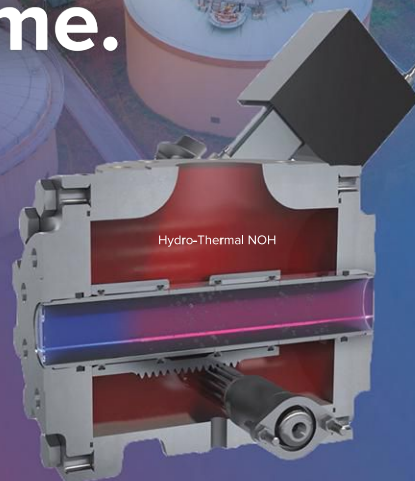
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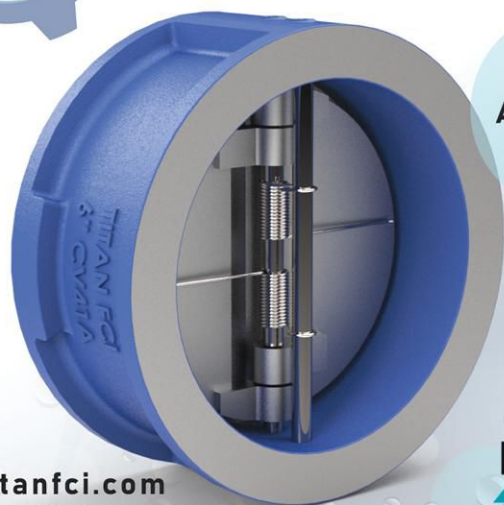
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MIXERS

the most effective pumping devices, while super pitch has a 1.5 pitch that delivers high pumping rates at the tradeoff of a higher horsepower requirement.

Shafts

Ideal shaft length is determined by the positioning of the mixer's propellers. A good rule to follow is to position the mixer propellers one to two propeller diameters from the bottom of the tank (only position the propeller one diameter from the bottom when mixing slurries or products with solids) to gauge shaft length.

Mixer Agitation Rate

Different applications require different agitation rates, so it is important to know the degree of agitation required. Agitation rates range from mild to violent, with tank turnover varying from half turns to more than three turns per minute.

- **Mild:** 1/2 to 1 tank turnover per minute
- **Medium:** 1-1/2 to 2 tank turns per minute
- **Vigorous:** 2-1/2 to 3 tank turns per minute
- **Violent:** More than 3 tank turns per minute

Consult with mixer manufacturers to determine the prop's pumping rate for a specific model type and size at the various rpms at which they will operate. These rates are normally measured in gallons per minute (gpm) of water pumped. Use this information to select the right agitation rate. For example, a 100-gallon tank of a water-like chemical requires vigorous agitation or 2.5 turnovers. Knowing that a 4-inch square pitch prop at 1,750 rpm delivers a pumping rate of 250 gpm, a portable mixer could be selected. Keep in mind, however, that as liquid viscosity increases the pumping rate decreases.

Mixer Positioning

The positioning of the shaft and prop within the mixer container is vital to enabling any portable mixer to blend, dissolve or disperse effectively. In most mixing applications involving small cylindrical tanks of 1,000 gallons or less,



IMAGE 3: Operational variables and characteristics must be considered before selecting a mixer.

the mixer is clamped to the side of the container. Effective mixing patterns will be achieved if the mixer is angled 10 to 15 degrees away from the vertical, either off-center or on-center.

When mixing a slurry, angling the mixer 15 to 20 degrees off the tank's centerline will result in good material turnover. On-center angling is better for gentler mixing and creates a vortex. Vortexing occurs when the contents of the tank swirl around the walls of the tank without much top-to-bottom turnover; this creates a less-efficient mixing operation and the possibility of uneven mixing or blending.

Cylindrical tanks with capacities of more than 1,000 gallons may require that the mixer be mounted directly in the center of the tank with the shaft in a vertical orientation. In this configuration, it is recommended that the user put baffles on the walls of the tank to prevent the contents of the tank from turning in the direction of the mix or creating an inefficient vortex. When this occurs, the mixing action in the tank will be poor.

Be advised, though, that the presence of vortexing during the mixing or blending process is not always detrimental. For

example, creation of a vortex is desirable when solids or powders are added to the top of the batch or liquids need to be drawn rapidly into the batch. The level of vortexing also becomes less severe with fluids that have higher viscosities.

Portable mixers play a key role in industrial manufacturing or fluid-handling applications. The right mixer can streamline any operation and provide operators with a consistent, hassle-free experience. By ensuring that users select the proper mixer for the specific situation, they can gain an important advantage toward optimizing any fluid mixing application. ■

Get More Info



For more on mixers and food and beverage processing, visit pumpsandsystems.com/tags/food-and-beverage.

Eulis Ester is a product manager for Neptune. She may be reached at 909-222-1310 or ester@psgdoover.com. For more information, visit psgdoover.com/neptune or psgdoover.com.

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Check 128 on index

Deragging Technology Aids Municipal Wastewater Spillage Prevention

Automated deragging is an important function and real-time data monitoring is critical.

SIMON CROMPTON |

Clearwater Controls,
an Industrial Flow Solutions Company



IMAGE 1: Impeller after installation of deragging technology (Image courtesy of Industrial Flow Solutions)

Blockage and spillage woes are a constant problem in the wastewater industry. The pump systems that keep sewers flowing often are not adequately designed to handle the nonflushable items that find their way down toilets. Even flushable items are not always easy to handle. The consequence is ragging buildup, clogs and damaged pump equipment. Add stormwater and the risk of unacceptable spills and overflows becomes serious.

Ragging is nothing new—updated solutions to pump system failure regularly come up. Shredders and macerators reduce the size of solid materials before they pass through pumps. Variable frequency drives (VFDs) allow pumps to operate in reverse upon startup or at a high-current set point.

Although such technologies are a step in the right direction, they often treat the symptom without addressing the underlying problem. Rather than passing through, materials that cause pump failure make their way back into the well. To achieve proactive pump care and predictability, wastewater treatment systems need to go a step further.

Deragging Technology

Traditional VFD-controlled systems are designed to reverse on startup or when they

reach a high-current set point. What system engineers find is that reversing the pump at this point is often too late—a large rag ball has already formed. Reversing the pump will throw the rag ball back into the well, causing a blockage later.

The risk of blockages goes up when the rain comes down. Legacy sewer systems are especially vulnerable to chokepoints that form during storms. As stormwater enters the system, rag balls within the well can get flushed into the pumps causing them to fail at the very time they are most needed. The consequence is not just equipment damage. The choked-off system may overflow, causing environmental consequences and costly cleanup.

Modern deragging technology offers a path forward. Today's deragging systems incorporate digital monitoring modules that monitor the pump's torque profile in real time.

When solids catch on the impeller, the system instructs the deragging pump to stop and briefly reverse flow. The agitating action loosens debris before it has a chance to form an aggregate that is too large for the system to process. Instead, the impediments efficiently pass through to be collected by treatment facility screens.

Intelligent Efficiency in Pumps & Mixers

A deragger performs dynamic torque monitoring in real time. Most VFDs do not run at full speed and run at reduced voltage, current and torque—meaning the high-current set point is unlikely to be reached, creating undetectable blockages that wreak havoc on the pump. Deragging technology solves this issue by offering a proactive approach to pump monitoring—detecting potential blockage issues early.

More importantly, a deragger has variable settings all along the torque curve, enabling detection of any inconsistencies from potential blockage. This makes it far more effective at instigating a cleaning cycle to alleviate ragging concerns.

Size Matters

No discussion of deragging is complete without addressing shredders and macerators. These systems can be ideal solutions in some cases, but their impact on wastewater composition can replace pump clogage and failure with pollution.

The destructive approach taken by macerators and shredders can cause a high volume of microparticles in the wastewater system. These particles pass through screens at treatment facilities only to

aggregate in downstream aeration basins. Process equipment at this stage often is not designed to handle the resulting large-diameter aggregates, causing blockages. Microparticles are not just a problem for wastewater—clean water systems face the same challenge, with corresponding health and environmental risks.

Most wastewater managers understand the advantages of keeping rags and other impediments intact as larger solids. In this case, size matters. Deragging technology keeps impediments whole, allowing them to pass through the system to be caught by treatment works screens. As a result, solids are safely collected and microparticle concerns are reduced.

Real-Time Monitoring & Automation

Deragging technology is evolving. Technology designed for municipal wastewater pump applications may feature a wet-well clean cycle option that addresses rags and other impediments so they pass through the pump instead of congregating

in the well. Modern pumps are getting better at taking care of themselves, which makes a difference for maintenance in wet-well environments. Dry-run protection stops the pump if the well contains insufficient liquids to operate level instruments. Onboard software can also streamline installation and repairs.

Health and safety improvements are also hitting the market. A deragging technology that automatically monitors and keeps a pump clean prevents users from having to perform tasks such as lifting and cleaning pumps. Some technology also features an odor control function that periodically instructs the pumps to run during low activity to avoid water stagnation and odor buildup. Features such as these should become more common across the industry as manufacturers incorporate smart technology into their designs.

Enhanced data collection helps users measure results. Users can use this data to monitor equipment efficiency, adjust settings and predict when maintenance

is required. With the ability to track and adapt to conditions in the well, users can get ahead of weather events and catch problems. Spillage risks also must be reduced as much as possible; so, automated deragging can be important to have within a wastewater pump system. It is impossible to maintain constant visibility of pumping assets. Sophisticated deragging technology and real-time data monitoring are critical. Blockage problems can be anticipated and resolved proactively to provide peace of mind for wastewater operators.

With environmental and safety compliance becoming ever-more complex for wastewater treatment organizations, deragging offers a solution to pump blockages caused by nonorganic material. ■

Simon Crompton is a managing director of Clearwater Controls, an Industrial Flow Solutions company. He may be reached at simon.crompton@clearwatercontrols.co.uk or +44 1324 485557. For more information, visit clearwatercontrols.co.uk or flowsolutions.com.

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Bowl Efficiency & System Curves for Viscous Applications

HYDRAULIC INSTITUTE

Q | What is bowl efficiency and is it different than pump efficiency?

The term bowl efficiency is specific to vertically suspended (VS) pumps. These pumps have the pumping element (bowl assembly) submerged in the liquid with a column pipe attached that transmits the liquid to the surface. Focusing on the VS0 and V1 types of vertically suspended pumps in Images 1 and 2, it can be seen that there are multiple pumping stages (bowls) that connect to the column pipe going to the surface. Depending on the application, the length of the column pipe and the number of column bearings (VS1) will change. Additionally, it is noticeable

The performance curve for the rotodynamic pump falls off more quickly with increased velocity, which reduces the flow through piping.

that the V0 type has a submerged motor whereas the VS1 type has a motor above grade. The variability of the column length, bearings and motors make it necessary to look at the efficiency of just the bowl assembly for proper comparison of the pumping elements.

Pump efficiency is similar to bowl efficiency in that it is considering the pump without the driver and is often used for overhung and between bearing pumps. If pump efficiency was applied to the VS1 and V0 types above the pump, efficiency would change depending on the length

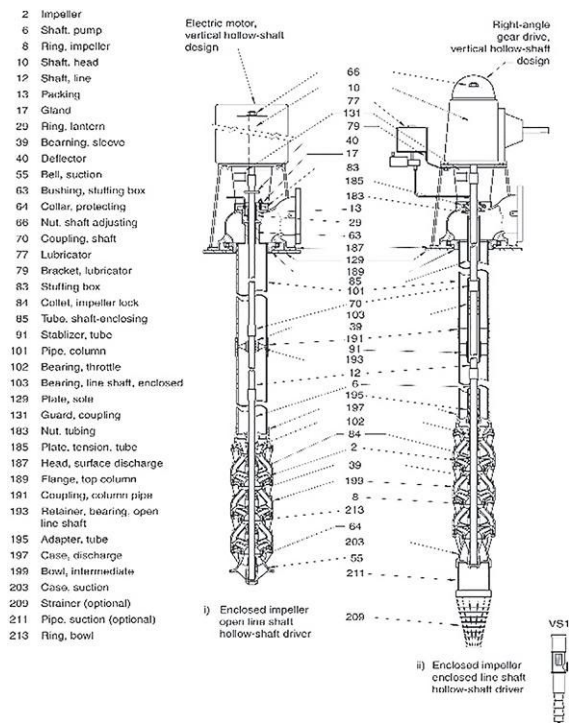


IMAGE 1: VS1—Vertically suspended, single-casing, discharge through column, deep-well (set) pumps (Images courtesy of Hydraulic Institute)

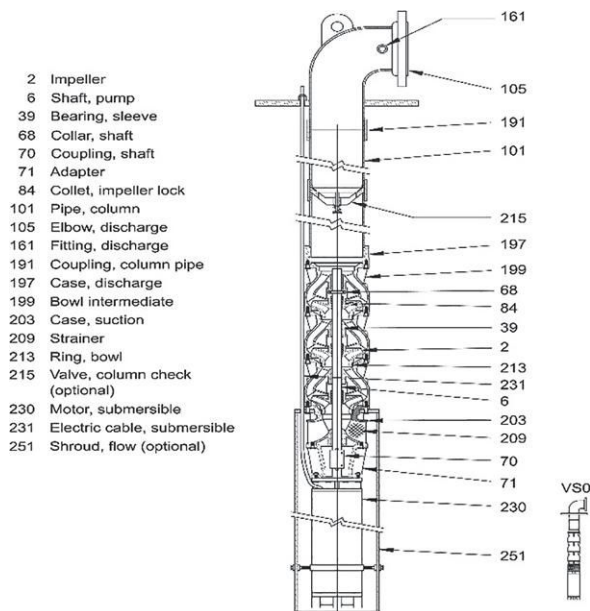


IMAGE 2: VS0—Vertically suspended, single-casing submersible pump

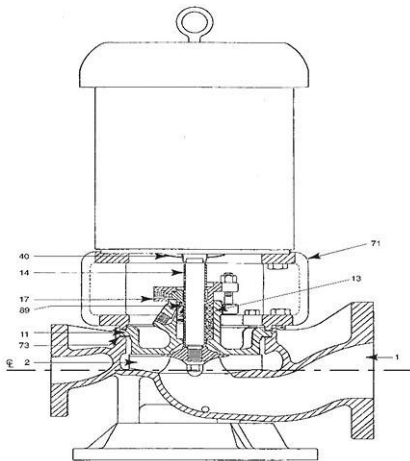


IMAGE 3: OH5—Overhung impeller, close-coupled, vertical in-line single stage

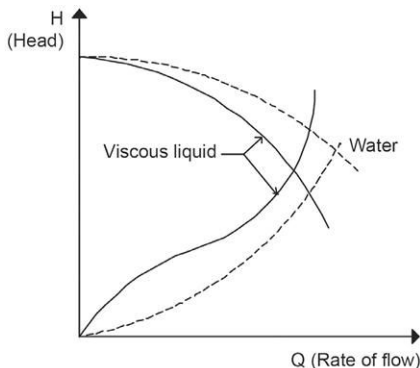


IMAGE 4: Pump and system curves for more viscous liquids as compared with water

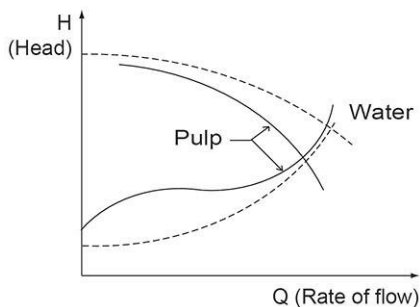


IMAGE 5: Pump and system curves for water and pulp suspension

of the column pipe and bearings, which is a function of the specific application. Image 3 shows an overhung pump, and the inlet and outlet system piping will connect to the pump casing (Item 1). The measurement of pump efficiency is relative to the power added to the system relative to inlet and outlet

flange and the power input the shaft. For more information on pump efficiency, refer to HI's Standard for "Methods for Rotodynamic Pump Efficiency Testing (HI 40.6)" at pumps.org.

Q | Will a system curve look the same for pulp or viscous applications as it does for water?

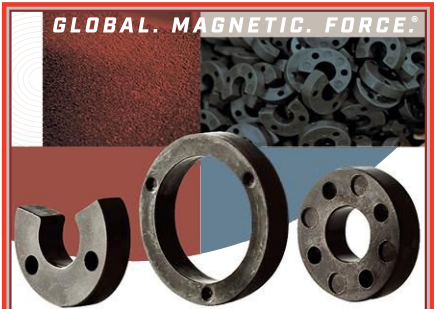
Pump and system curves are often represented based on water-like liquids. The curves have different shapes for viscous and non-Newtonian liquids, as illustrated in Image 4. In these images, the pump head decreases as a function of increased flow and the system curve increases as a function of flow. Their intersection point is the operating flow and head.

The laminar flow regime is maintained at higher flow velocities for the viscous liquid and a more typical shape occurs, but at lower flow velocities, there is a turbulent flow regime and the shape of the system curve changes. The performance curve for the rotodynamic pump falls off more quickly with increased viscosity, which reduces the flow through the piping. The efficiency curve will also be reduced.

The pumping of a pulp suspension is shown in Image 5 as an example of system curves for non-Newtonian liquids. The liquid characteristics of a pulp suspension are reflected in the shape of the system curve. The pump curve also changes to some extent in comparison to water. Much of this change is caused by the higher air content in the pulp.

For more information on pump system efficiency, refer to HI's "Pump Life Cycle Cost: A Guide to LCC Analysis for Pumping Systems" at pumps.org. ■

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Factors to Consider When Selecting & Installing a Submersible Motor

The motor's long-term performance depends on having the right configuration for your site.

JESSIE HINTHER | SWPA Member

A submersible pumping system consists of a multistage centrifugal pump coupled to a submersible motor that has been designed for installation in a narrow well. Submersible motors are available in various construction designs—including encapsulated and rewindable—and their horsepower ranges and physical size vary. So, what is right for each user's application needs? This article takes a closer look at what users should consider when selecting a submersible motor.

Motor Pairing Options

When it comes to selecting an electrical submersible motor, not all manufacturers will use the same design. There are several technologies to choose from, including induction and permanent magnet (PM).

Induction motors have often been considered the workhorse of submersible systems. They typically feature a squirrel-cage design as there are no electrical connections between the rotor and stator that need to be kept watertight. Additionally, induction motors of this type can be repeatedly produced to ensure high quality and low cost, making them an accessible solution for pumping system owners and operators.

Since the motor is induction-driven, the rotor turns at less than synchronous speed, which is why this motor type is often referred to as an asynchronous motor. This speed differential is defined as slip. Due to the rotor slip and the shape of the motor's torque-speed characteristic curve, the motor has stable operating characteristics, even under short overload and peak-load conditions that make it an ideal driver. When properly selected, the squirrel-cage

induction motor can easily meet the load demands of a centrifugal pump.

PM motors are growing in popularity in submersible applications. Unlike an induction motor where the internal rotor is an electromagnet and becomes energized by the system's power supply, PM rotors are always magnetized due to the raw material selection. These internal magnetic rotors make them more efficient, especially at

reduced speeds and partial loads.

The inclusion of the rare earth magnet rotor removes the slip factor seen in an induction-style motor. This creates the opportunity to achieve full synchronous rotational speeds in cases where that provides an operational benefit. Another way to view this is that lower input power is required for an equivalent output power produced by an induction design



IMAGE 1: Well replacement (Images courtesy of Franklin Electric)

motor—saving on operational costs every time the motor runs.

Installation

Submersibles are normally classified to indicate the smallest well-casing diameter to accommodate the pump: typically, from 4 inches to 12 inches. These often include power ratings as low as one-third horsepower (hp) up to 250 hp.

Because drilling and well construction costs increase dramatically with borehole diameter, submersible pumps and motors are characterized by their slender construction. During installation, the device should be set as close as possible to the running amps, with a maximum setting at 90% of nominal motor current and a trip time less than 10 seconds at 500% nominal current. It should also protect against single phasing and voltage variation.

Maintenance Best Practices

There are many things to think about when protecting the motor, including properly sizing the system to ensure long-term operation. Overload protection is also important and should be selected based on the motor nameplate current.

For daily startup, variable frequency drives (VFDs) improve system life with a soft-start feature. This controls the electrical current and voltage as it is provided to the motor, and it reduces the system stress associated with each startup. This “easing-in” to running at full speed minimizes pressure on the entire system. It also helps reduce the heat output on the motor, a big help in prolonging motor life.

When a motor fails, it is important to quickly determine the cause. If the failure is related to misapplication or improper installation, all installation deficiencies must be corrected before another motor is installed. Both motor types are repairable and spare parts are often readily available. The modular concept divides the motor into its main parts: stator, rotor, upper and lower end bell, seals and bearings.

The reliable and proven mechanical parts, end bells, seals and bearings are interchangeable for both induction and PM designs. When the failure mode is that of a failed stator, the encapsulated motor's

stator may be replaced or the rewindable motor may be rewound.

An encapsulated motor can be repaired quickly with a factory original stator. This results in no change in motor performance since each stator is wound using the same raw materials, automated winding lines and manufacturing processes.

The rewindable motor is easy to rewind in the field. The ends of the 18-slot stator are open to allow removal, reinstallation and forming of the winding coils. The motors are wound with polyvinyl chloride (PVC) wire, which is widely available, and the winding data is published. It is important to repair the motor under factory specifications for materials and winding data. Failure to do so will result in altered motor performance.

Repair kits that contain pre-wound coils, slot insulation and cable-splicing materials are available from the factory should the user or the repair shop prefer to use factory components.

Additional Application Considerations

In addition to how the motor will be used, consider the environmental conditions the motor will experience. For example:

1. Is there adequate power supply?

The power supply must provide adequate voltage and current balance to prevent excessive heating in the motor. Properly grounded surge protection should be installed to protect against high voltage spikes. In addition, the supply cables must be large enough to allow adequate voltage to reach the motor terminals. Motors are designed for a wide voltage variation range. The current imbalances must not exceed 5% from line to line.

2. Can proper motor temperature be maintained?

Some submersible motors are designed to operate in water at higher temperatures or lower flow conditions. For example, some motors can operate with nominal load at a maximum water temperature of up to 86 F (30 C). Other motors are specifically engineered to operate in much higher water temperatures—some even up to 194 F (90 C).



IMAGE 2: Well replacement

Choosing the best motor to power a submersible pump is critical to a system's success. The motor's long-term performance—and the performance of the pumping system—relies heavily on having the right configuration for the user's site and user needs. ■



*The Submersible
Wastewater
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Association's*

(SWPA) purpose is to enhance the global wastewater environment by informing, educating and providing leadership in the design, procurement and operation of submersible wastewater pumping systems. For more information, visit swpa.org.

Jessie Hinthier is a business unit sales manager—OEM products at Franklin Electric and president of the Submersible Wastewater Pump Association (SWPA). Hinthier received The Chairman's Award from Franklin Electric in 2010, recognizing him for outstanding performance. For more information, contact Hinthier at jhinther@fele.com or contact SWPA at swpaexdir@sbcglobal.net.

Your Guide to Expansion Joints in Pulp & Paper

This component keeps equipment running efficiently.

BRANDON PHILLIPS | FSA Member

The pulp and paper industry provides products—such as paper stationery, cups, tissues and paper-based packaging, including cardboard—that are integral to modern life. The process of manufacturing paper products requires the movement of wood particles, chemicals and water through networks of piping to be processed. Rubber expansion joints mitigate pipe stress resulting from thermal fluctuations and vibrations from pumps or other specialty machines found in this industry.

Piping systems facilitate the constant movement of wood, pulp, chemicals and a constant circulation of water throughout the plant. Various chemicals are introduced to the process stream to break down the wood to make pulp. Spent chemicals are recycled for future use to help reduce waste and create a more sustainable process. A critical component—elastomeric expansion joints—ensure the piping and equipment run effectively.

Pulping

Wood logs are first debarked and then chipped into small pieces so they can later be converted to pulp. Blowers and conveyors send the wood chips from the storage silo to the mill, this is the first stage of the process where expansion joints can be used. Raw wood chips are abrasive and require an expansion joint with a filled arch to facilitate flow without chips accumulating in the arch. In addition to a filled arch, the tube elastomer should be rated to withstand heavy abrasion. Ethylene propylene diene monomer (EPDM), hydrogenated nitrile rubber (HNBR) or natural/gum rubber are best suited

to handle these abrasive applications. Flow liners, also known as top hat liners, can also be used in this area when the velocity of the wood chips is high enough to damage the rubber liner. A flow liner is a metal insert that controls the flow of high velocity abrasives and protects the rubber tube without impeding the movement and vibration absorbing qualities of the expansion joint.

The pulping process will break down the raw wood chips into separate lignin fibers and leave cellulose, which is the key component to making paper. Chemical pulping is the most common process for today's products, employing a digester to cook wood chips in white liquor using high pressure steam. Once the digester has completed its cycle, the black liquor waste product is pumped to an evaporator. The other digester byproduct is wood pulp, which must be purified, washed and bleached before it can be made into paper.

Digesters often have expansion joints located on the white liquor supply as well as attached to the wood chip feeder bin. White liquor is a mild chemical that can safely be handled with an EPDM rubber liner. The bins feeding wood chips into the digester are gravity fed and require low-pressure expansion joints that can be manufactured in round or rectangular shapes, depending on the specific equipment setup. With little movement,

Chemical	Elastomer			
White Liquor	EPDM	Nitrile	Neoprene	PTFE (Hi-Temp)
Black Liquor	EPDM	PTFE (Hi-Temp)		
Green Liquor	EPDM	FKM (Hi-Temp)		

IMAGE 2: Liner materials needed to handle chemical at elevated temperature



IMAGE 1: Wood chip feeder bin with rectangle expansion joint (Images courtesy of Fluid Sealing Association)

an arch may not be required as the feeders are mostly compensating for vibration.

Chemical Recovery

The two byproducts of the chemical process taking place in the digester are wood pulp and black liquor. To reduce waste, black liquor is sent to an evaporator to burn off excess water, then transported to a recovery boiler. The recovery boiler further burns the highly concentrated black liquor and is left with a residue known as green liquor.

Once green liquor is made, it is then combined with lime and recycled back into white liquor. With the white liquor reproduced from the byproducts of this process, it can be reused at the start to break down raw wood chips. The cycle is repeated continuously, known as the Kraft process.

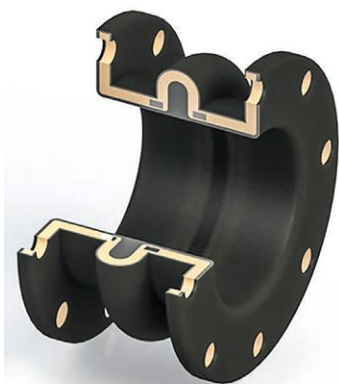


IMAGE 3: Filled arch expansion joint

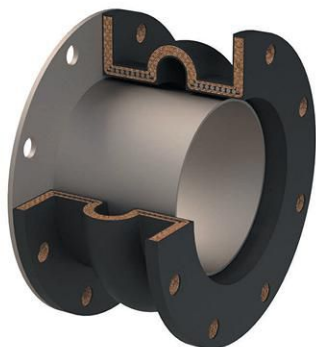


IMAGE 4: Expansion joint with flow liner

Expansion joints are fitted in the intricate piping systems that pump chemicals between the digester, evaporator and recovery boiler together in a safe and efficient manner. This is a critical area to ensure the expansion joint liner material is correctly specified to avoid unexpected failure. The white, black and green liquor can be handled safely with the liner materials summarized in the below table. Because some of these chemicals are cooked at high temperatures, liner materials may need to be specified to handle the chemical at the elevated temperature.

Bleaching

The wood pulp slurry that exits the digester is forwarded to a washer unit that cleanses the pulp from any remaining black liquor residue. A screener unit will further remove any impurities such as bark, stones or any other foreign objects.

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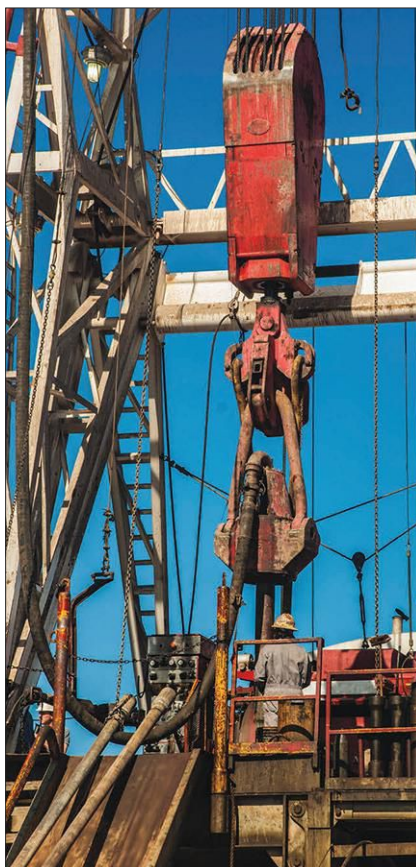
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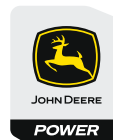
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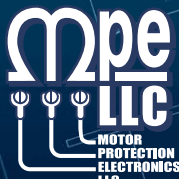
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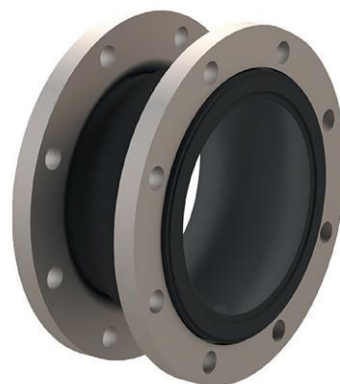


IMAGE 5: Single sphere expansion joint



IMAGE 6: Double sphere expansion joint

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Pulp slurry, at any point in the cleansing stages, has a high concentration of solids and is another example where an abrasive resistant liner is critical for the expansion joint. Natural/gum rubber, EPDM or HNBR are acceptable liner materials. In addition, a filled arch and/or flow liner configuration are ideal additions to avoid buildup of pulp material in the arch.

For products that require bright white appearance, bleaching agents are added to the pulp mixture. This is another area where it is critical that the proper liner compound be specified. Most bleaching agents can easily deteriorate some elastomers upon contact. In the bleaching lines, fluoroelastomer (FKM) or polytetrafluoroethylene (PTFE) lined expansion joints are the optimal materials to be specified.

Paper Machine

Paper machines then convert the purified pulp into the finished product. The machine itself is complex and incorporates a great deal of piping and pumps to circulate water through each stage. The process starts at the head box, where pulp slurry is pumped in from the blend chest to be prepared for drying and finishing.

The blended stock flows through the wet end of the paper machine and vacuum systems remove water from the slurry. The water vacuumed out of the stock gets transferred to a seal pit. With mainly water extracted from the slurry, general purpose liner materials are sufficient, but it is important to specify an expansion joint with full vacuum rating. With water now evacuated from the pulp slurry, the dry end of the paper

Elastomeric expansion joints ensure equipment in a paper mill runs efficiently and reduces wear that can be caused from thermal pipe stresses and vibration.

machine starts to form the dried pulp into its final form. Presses operate on the dry end to start forming sheets, which are then fed through a series of rollers. This area also has piping fitted with expansion joints handling various penetrating liquids, surface coating materials and dyes for colored products. Depending on the final product, additives will give the paper the desired surface characteristics and physical properties. Pumps are also used to handle overflow of these solutions to be recycled.

General Applications

In general, a paper mill has fluid sealing needs beyond those highlighted as part of the pulp and paper making process. There are generally water treatment plants, powerhouses and water supply pumps that support the facility. Applications in these areas are widely considered as general use as the media is typically water at ambient temperatures.

Some examples of general use are, but not limited to, spherical expansion joints, which come in standard sizing and materials. Spherical expansion joints typically come furnished with floating metal flanges that are ideal for quick installation and inventory reduction when compared to integrated rubber flanges with retaining rings.

The pulp and paper industry uses complex equipment to manufacture important products. Elastomeric expansion joints are a means of ensuring equipment in a paper mill runs efficiently and reduces wear that can be caused from thermal pipe stresses and vibration. The expansion joints that are specified in these applications should take into consideration media, temperature, movement, pressure and vacuum requirements to ensure a safe and leak-free operation. ■



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Brandon Phillips is a product engineer for Garlock Sealing Technologies and holds a bachelor's degree in mechanical engineering from the University at Buffalo. For more information, visit garlock.com.

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Improving Efficiency in Pumping Systems

How reducing losses in the piping system can help.

PETE GAYDON | Hydraulic Institute

Efficiency is the ratio of output and input power expressed as a percent (Equation 1). Pumping systems are no different, but sometimes the terms used to describe efficiency change and can be confusing to someone who is not well-versed. Commonly, you may hear the terms pump efficiency, bowl efficiency, volumetric efficiency, overall efficiency, wire-to-water efficiency, system efficiency or some other term. Interpreting these terms and what they mean requires a review of fundamentals.

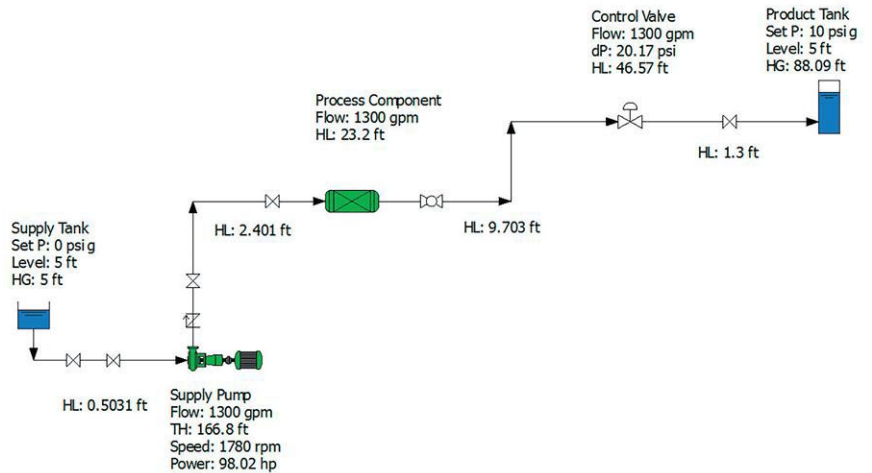


IMAGE 1: Pumping system pressure, head loss and pump information (Images courtesy of Hydraulic Institute)

$$\text{Efficiency} = \frac{\text{Power output}}{\text{Power input}} \times 100$$

Equation 1

A simple pumping system is provided in Image 1. In this system, there is a supply tank that is open to atmospheric pressure (0 pounds per square inch gauge [psig]), with a 5-foot (ft) level and 5-ft elevation above grade. These values represent the potential energy forcing liquid into the pump. Next, there is a head loss (HL) term representing the friction losses in the inlet piping and valves. Moving through the system, there is a pump adding energy to the system and other components (piping, valves, process component, control valve and a product tank) in the system consuming the energy, resulting in a system energy balance. The system energy balance means the system head at a specific flow rate will equal the pump total head at that flow rate.

Using the system in Image 1, we can start defining different efficiency terms but to do that we need to define how power is calculated. The starting point is to calculate the power required by the system or what is defined as pump output

power (P_w) shown in Equation 2. Pump output power is sometimes referred to as hydraulic power or liquid/water power. The terms used in Equation 2 are flow rate in gallons per minute (Q), pump total head in feet (H), specific gravity (s) and a conversion constant for U.S. units to result in horsepower (hp). Specific gravity refers to the ratio of the liquid density to the density of water at standard temperature. In this example, water is at ambient temperature so the specific gravity will be 1.0. Using the flow and head for the supply pump in Image 1, the calculations show the pump output power to be 54.6 horsepower (hp) and in Equation 3, the pump efficiency (η) is calculated to be 55.9% by dividing by the 98.02-hp pump input power (P) listed in Image 1. The pump efficiency calculation is specific to the bare pump (Image 2) and does not include the driver or other drive train components. A similar efficiency term used with vertically suspended pumps is bowl efficiency. These pumps typically have a series of impeller/diffuser bowls that are connected to the surface by a column pipe (Image 3). The column pipe length and number of line shaft bearings will vary

depending on the depth of the well. For this reason, the head loss in the column pipe is not considered in the bowl assembly head and other mechanical power losses may be excluded in the bowl efficiency.

$$P_w (\text{hp}) = \frac{Q(\text{gpm}) \cdot H(\text{ft}) \cdot s(-)}{3960}$$

Equation 2

$$\eta = \frac{P_w}{P} \times 100$$

Equation 3

$$\eta_{OA} = \frac{P_w}{P_{\text{Drive}}} \times 100$$

Equation 4

Image 2 includes the driver and control as additional components. In this example, the control is a variable frequency drive (VFD). The red arrows go from larger to smaller from left to right, which represents an efficiency loss in each component that

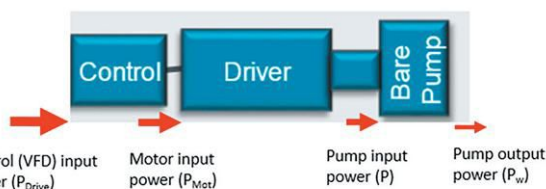


IMAGE 2: Bare pump + driver + control

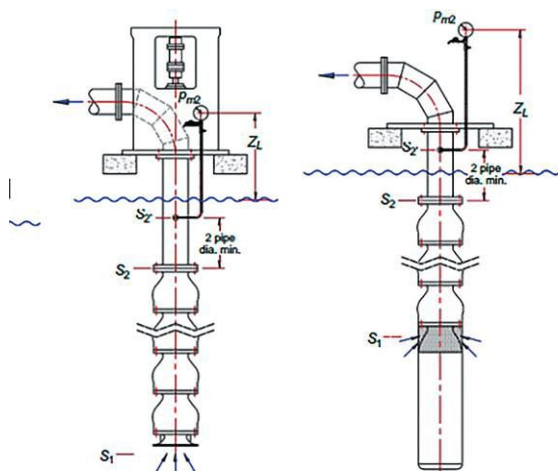


IMAGE 3: Bowl assembly total head determination

is added to the system. Considering the power into the VFD in Image 2, the overall efficiency (η_{OA}) can be calculated as shown in Equation 4. Another term used to describe this is “wire-to-water” efficiency—meaning that it is considering the electrical input power. The drive input power includes the individual component efficiency of the driver and VFD in this example. If it is assumed that the driver (motor) efficiency is 95% and the VFD efficiency is 97%, the input power to the VFD and the overall efficiency can be calculated as shown in Equations 5 and 6.

$$P_{\text{Drive}} (\text{hp}) = \frac{98.02 (\text{hp})}{95\% \cdot 97\%} = 106.4 \text{ hp}$$

Equation 5

$$\eta_{\text{OA}} = \frac{54.6 \text{ hp}}{106.4 \text{ hp}} \times 100 = 51.3\%$$

Equation 6

Another term commonly used is “system efficiency.” It should be noted that system efficiency is not defined within Hydraulic Institute standards, and when it is used, it typically is not clear if the person is referring to the pump and drive train efficiencies (i.e. overall efficiency) or a more theoretically calculated

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EFFICIENCY 101

efficiency that considers the piping system that the liquid is flowing through. If used to relate to unnecessary head loss within the piping system, then the "optimal" system hydraulic power consumption would need to be defined (i.e. minimum flow rate and head to achieve the system requirement). There is no standard method to define this; so, look at the concept in simplistic terms with several assumptions. In Image 1, there is a head loss across a control valve of 46.57 feet. Assuming this is the only unnecessary head loss in the system and 1,300 gallons per minute (gpm) is the minimum required system flow, then the hydraulic power loss across the valve could be calculated using Equation 2 and subtracted from the pump output power (Pw). A system efficiency could also be calculated assuming the flow remains constant at a lower head and other component efficiencies in the pump drive train are constant.

To illustrate this concept, the supply pump with driver and VFD operating at full speed (106.4 hp) is operating with the control valve head loss of 46.57 feet. Assume the pump speed is then reduced so the system operates with the valve fully open to achieve the 1,300 gpm, and the efficiency of the pump, motor and VFD remain constant. For this simplified example, the power loss across the valve is described in Equation 7, and the system efficiency is calculated as 37% in Equation 8 compared to 51.3% overall efficiency in Equation 6.

$$\text{Power loss valve (hp)} = \frac{1300 \text{ (gpm)} \cdot 46.57 \text{ (ft)} \cdot 1.0}{3960} = 15.3\% \text{ hp}$$

Equation 7

$$\text{System efficiency (\%)} = \frac{54.6 \text{ (hp)} - 15.3 \text{ (hp)}}{106.4 \text{ (hp)}} \times 100 = 37\%$$

Equation 8

The point of this example (and the many assumptions) is to illustrate that efficiencies can be gained by reducing losses in the piping system. As illustrated, it is always a good idea to look for losses in the piping system and determine if there is a way to eliminate them while meeting the system requirements. However, the concept of system efficiency beyond the pump and drive components is something that depends on many dependent variables and is not precisely defined. Therefore, it is best to compare the power consumption for different options and calculate the energy consumption for the expected operating points and duration. ■

Pete Gaydon is technical director at the Hydraulic Institute. He may be reached at pgaydon@pumps.org. For more information, visit pumps.org.

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Hydraulic Institute.....	120	42	SIMFLO LLC.....	109	21
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Industrial Flow Solutions.....	105	7	Tigerflow Systems, Inc.....	116	25
Inline Industries.....	128	53	Titan Flow Control, Inc.....	133	52
Jordan, Knauff & Company.....	138	66	Titan Manufacturing, Inc.....	146	70
Keller America.....	106	9	Tuf-Lok International.....	158	71
Magnatex Pumps.....	144	71	Uline.....	140	65
Metropolitan Industries.....	122	40	United Rentals.....	110	BC
Mission Communications.....	123	45	Val-matic Valve & Mfg. Corp.....	141	62
Motor Protection Electronics.....	139	62	Vanton.....	114	29
Moving Water Industries Corp.....	155	69	Vaughan Company.....	111	5
National Pump Company.....	124	43	VEGA Americas.....	112	23
NTN Bearing Corp.....	129	47	Vertiflo Pump Company.....	147	70
Pacer Pump.....	142	71	Vesco Plastics Sales.....	148	70
Pedrollo Group.....	107	17	Vulcan Seal.....	117	13
Resimac Americas, Inc.....	145	71	West Coast Rotor.....	153	70
Rosedale Products.....	151	69	WILO USA LLC.....	125	39
Rotech Pumps & Systems, Inc.....	156	69	JH Process Equipment (ZUWA).....	143	71
Seepex.....	108	27			

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Company Name	RS#	Page
Crane Pumps & Systems.....	201	67
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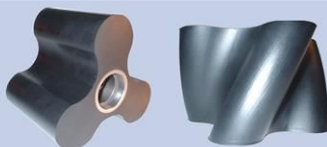
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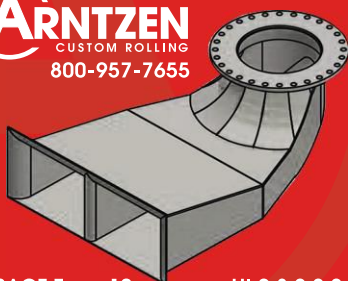
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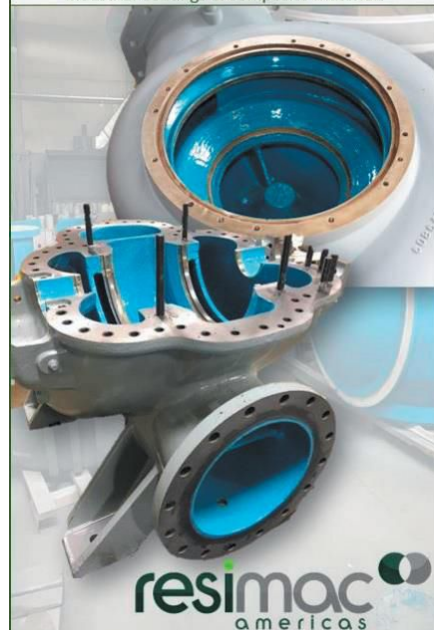


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Wall Street Pump & Valve Industry Watch

JORDAN, KNAUFF & COMPANY

The Jordan, Knauff & Company (JKC) Valve Stock Index was up 7.3% over the last 12 months, and the broader S&P 500 index was up 12.7%. The JKC pump stock index rose 8.5% for the same period.¹

The Institute for Supply Management's Purchasing Managers Index (PMI) fell 1.5 percentage points to 57.1% in March, the lowest reading since September 2020 of 55.4%. New orders fell by 7.9 percentage points to 53.8%, while new export orders fell by 3.9 percentage points to 53.2%. The backlog of orders index fell to 60% from February's 65%. The production index decreased 4 percentage points to 54.5%, while the employment index rose 3.4 percentage points to 56.3%. Survey respondents reported lower rates of quits and early retirements compared to previous months and improving internal and supplier labor positions. The prices index registered 87.1%, up 11.5 percentage points from February. Fifteen of 18 manufacturing industries reported growth, with five of the six largest industries showing moderate to strong growth.

The Labor Department reported employers added 431,000 jobs in March, the 11th month of job gains above 400,000. Job gains were seen in restaurants, manufacturers and retailers. In addition, more than 300,000 women joined the labor force. There are still fewer women in the labor force than before the pandemic while male levels have fully recovered.

The unemployment rate fell to 3.6% from 3.8% a month earlier. Average hourly earnings grew 5.6% compared with last year. However, on average, annual inflation of nearly 8% is erasing gains by workers. The economy has about 1.6 million fewer jobs than in February 2020. Jobs in leisure and hospitality remain below prepandemic levels while retail has fully recovered.

In response to Russia's invasion of Ukraine, the U.S. Department of Energy committed to releasing 30 million barrels of crude oil from the U.S. Strategic Petroleum Reserve (SPR) to help ensure an adequate supply of petroleum. Other International Energy Agency

member countries collectively agreed to release an additional 30 million barrels of petroleum from their emergency reserves, bringing the total release to 60 million barrels. SPR stocks have been declining in recent years. At the end of February, the SPR held 580 million barrels of crude oil. This release commitment is the first emergency drawdown since 2011.

On Wall Street, the Dow Jones Industrial Average, the S&P 500 Index and the NASDAQ Composite gained 2.3%, 3.6% and 3.4%, respectively in March. Negotiations between Russia and Ukraine, slowing commodity prices and expectations of an interest rate increase by The Federal Reserve Bank helped stocks rally. For the quarter, the Dow, the S&P 500 and the NASDAQ fell 4.6%, 4.9% and 9.1%, respectively. The market was concerned about a possible recession and weak economic data. ■

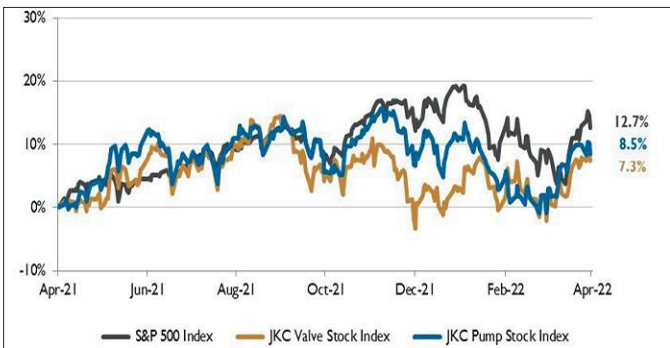


IMAGE 1: Stock Indices from April 1, 2021 to March 31, 2022
Local currency converted to USD using historical spot rates. The JKC Pump and Valve Stock Indices include a select list of publicly traded companies involved in the pump & valve industries, weighted by market capitalization. Source: Capital IQ and JKC research.

Reference

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

Jordan, Knauff & Company is an investment bank based in Chicago 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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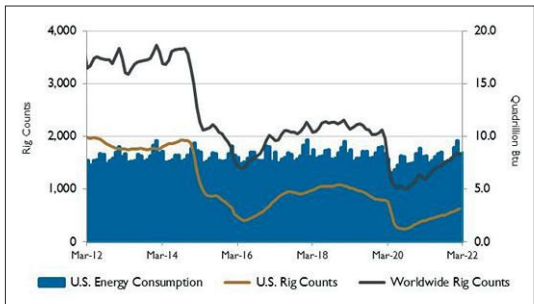


IMAGE 2: U.S. energy consumption and rig counts.
Source: U.S. Energy Information Administration and Baker Hughes Inc.



IMAGE 3: U.S. PMI and manufacturing shipments.
Source: Institute for Supply Management Manufacturing Report on Business and U.S. Census Bureau

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