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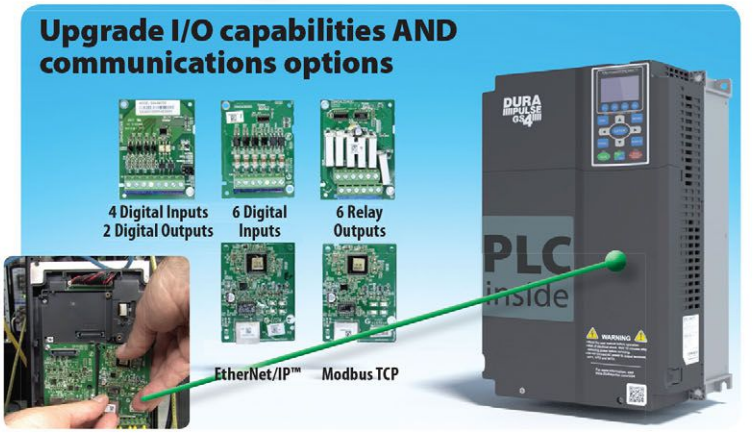

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January 2019

A NOTE ON THIS ISSUE:

J. Campbell, Editor
Modern Pumping Today

It's a new year, but the same valuable content you expect from MPT! In this month's issue, start out with SWPA's "2019 Industry Outlook for Submersible Wastewater Pump Manufacturers" (pg. 14). SWPA Executive Director Adam Stolberg, Walt Erndt of Crane Pumps and Systems, and Stephen Doolittle of Zoeller Company, engage in a wide-ranging conversation on what 2019 has in store for submersibles.

Also, the feature in this month's Motor Solutions section will be of interest to any segment of the industry looking to improve their product support systems. "Improving an Organization's Engagement and Agility Through Evidence-based Product Support" (pg. 38) presents an informed and detailed case for identifying and following value metrics throughout the product development cycle.

Lastly, be sure to check out "A Guide to Selecting and Configuring Portable Mixers" by Tom O'Donnell of Neptune™ Chemical Pump Company (pg. 30). Pumps may grab the headlines in industrial applications, but mixers are the leading technology for many critical mixing and blending tasks, provided they are configured and utilized properly.

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www.mptmag.com
P.O. Box 660197 | Birmingham, Alabama 35266

@modpumpmag

J. CAMPBELL Editor
jay@mptmag.com

VINCE MARINO Publisher
vince@mptmag.com

JOHN FRIEND Account Executive
john@mptmag.com

LAURA GRACE RENFROE Account Manager
lauragrace@mptmag.com

LISA AVERY Art Director

SETH SAUNDERS Graphic Artist

RICHARD COUNSELL Digital Media Specialist

INGRID BERKY Office Manager

SUBSCRIPTION
inquiries or changes:
205.380.2048

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312 Lorna Square | Birmingham, Alabama 35216
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TIM GARMON
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RUSSELL HADDOCK
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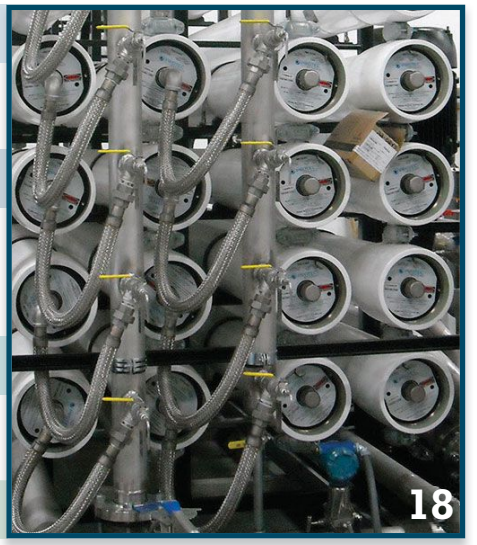
CONTENTS



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AUTOMATIONDIRECT OFFERS FREE ONLINE PLC TRAINING

AutomationDirect first partnered with Interconnecting Automation in 1996 to create a hands-on training program to familiarize customers with the ins and outs of their PLCs. Eventually, this program led to the creation of an online video training series that encompasses various levels of training from entry level programming to advanced PLC functions.

Due to the high demand and requests for training in the field of industrial automation, AutomationDirect is now offering unlimited access to selected Interconnecting Automation training series for anyone interested in learning about industrial controllers. A repository of training videos is available to all registrants free of charge with no purchase necessary. One online video series initially offered covers non-brand specific PLC basics with topics on logic gates, basic switches, sinking and sourcing, scan time, I/O fundamentals, memory addressing, and more.

Also available with the initial release are videos specifically covering the AutomationDirect CLICK PLC and include topics on how to use CLICK's navigation, address picker, rung editor, logic instructions, internal control relays, data view window, and many other functions. These completely free online PLC training courses are available 24/7, allowing users to learn at their pace and at their convenience. To get unlimited access to the free online PLC training program, or to learn more about what is provided, visit **www.automationdirect.com/plc-training**.

MARK WEINBERGER APPOINTED Q.E.D. ENVIRONMENTAL SYSTEMS PRESIDENT

Mark Weinberger has been appointed president of Q.E.D. Environmental Systems, Inc., a subsidiary of Graco Inc. Weinberger brings years of leadership on product design, engineering, and development to Q.E.D.'s environmental business, which manufactures fluid management and gas analysis solutions for the environmental monitoring and remediation markets.

As an engineering manager in Graco's Applied Fluid Technologies Division (AFTD) since 2008, Weinberger led a team responsible for the development of several key product lines, including Fusion guns, Integrated Reactors, InvisiPac, and Therm-O-Flow. He holds 144 global patents, including nineteen U.S. utility patents.

Mark has held a variety of other engineering and design roles since joining Graco in 1992. Prior to joining Graco, he spent seven years in Honeywell's military and commercial avionics business.


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PROCESS DIAPHRAGM PUMP MANUFACTURER LEWA JOINS THE STAR PUMP ALLIANCE

The Star Pump Alliance (SPA) is an information platform for professional pump users that was founded by companies from the pump industry offering various application technologies. It launched at ACHEMA 2018 in June. The goals of the SPA include offering users around the world a broad spectrum of pump technologies and making the pump search considerably easier, all while strengthening the positions of technologically innovative, independent, medium-sized pump manufacturers in an increasingly concentrated market. Since July 2018, LEWA has also been an official member of this alliance.

The website **www.starpumpalliance.com** makes it easier for users to search for the correct pump solution. This is achieved by explaining all technologies and their suitability for various application areas, then quickly guiding the user to the right supplier. The platform guarantees that any concrete inquiries from potential customers will receive a response within forty-eight hours of submission.

ELECTRO STATIC TECHNOLOGY APPOINTS NEW GLOBAL SALES MANAGER

Electro Static Technology, the manufacturer of AEGIS® Shaft Grounding Rings, has appointed Matthew Laufik as global sales manager. In this new role, Laufik will be responsible for the sales of AEGIS® products to motor repair shops, end users, and motor manufacturers worldwide through the company's international sales organizations and distribution network. He will also manage all sales, marketing, and customer service personnel.

Prior to joining Electro Static Technology, Laufik held several positions of increasing responsibility at Parker Hannifin Corporation, Cleveland, Ohio. Most recently, he was national accounts channel sales manager. Prior to that, he served as Asia Pacific distribution development manager, based in Shanghai, China.

Electro Static Technology manufactures and sells AEGIS® Shaft Grounding Rings, which protect motors by diverting damaging VFD-induced currents away from bearings and safely to ground. Available for low- and medium-voltage motors, AEGIS® Rings have been proven effective in millions of installations worldwide.

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MFG CHEMICAL RECEIVES PLANT SAFETY PERFORMANCE IMPROVEMENT HONOR

MFG Chemical, a global leader in specialty and custom chemical manufacturing, received an award for Safety Performance Improvement from SOCMA, (Society of Chemical Manufacturers and Affiliates) at the trade association's 96th Annual Dinner, held December 10 at the Crowne Plaza in New York City.

On receiving the Award, CEO Keith Arnold, of MFG Chemical comments, "MFG has been working hard to make plant safety the core value of the company, a value which is shared by all of our employees. We are happy to receive this industry recognition for our continuous improvements in plant safety, and even more pleased that we have achieved and are maintaining a safe work environment, with a strong EHS&S program."

SOCMA President and CEO Jennifer Abril adds, "As specialty and fine chemical manufacturers, we understand that maintaining a safe environment for your staff and community is not an easy task. It takes time, buy-in from both employees and leadership, and resources to achieve your goals."

FAMILIAR NAME RETURNS TO KTR CORPORATION AS NEW CEO

Marcelo Marcos returns to the company where his career began, starting a new chapter as president and CEO of KTR Corporation. Marcos was the marketing manager from 1995 to 2002. In 2002, Marcos was tapped to start up KTR Brazil and he was ready for the challenge.

Marcos has developed KTR Brazil into a solid and aggressive company whose biggest trademark is service-outperforming competitors in agility and quality. "KTR Corporation is home professionally speaking. Twenty-three years ago, I started with the goal to help the company to grow into Latin America. I think we succeeded in this task," Marcos says.

The retirement of KTR Corporation's President William Ketcham at the end of 2018 brought Marcos the opportunity, coming full circle. Marcos plans to capitalize on the accomplishments reached during Ketcham's tenure, add his own motivation and intense sales focus to lead KTR Corporation. ◆

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2019 International Production & Processing Expo

America's food processing leaders come together in Atlanta

The International Production and Processing Expo (IPPE) is a collaboration of three shows—the International Feed Expo, International Meat Expo and International Poultry Expo—representing the entire chain of protein production and processing. The event is sponsored by the American Feed Industry Association (AFIA), North American Meat Institute (NAMI), and U.S. Poultry & Egg Association (USPoultry). IPPE will be held February 12 through 14, 2019, at the Georgia World Congress Center in Atlanta.

The 2019 IPPE will have almost 600,000 square feet of exhibit space and is expected to attract more than 32,000 attendees. IPPE is a collaboration of three trade shows—International Feed Expo, International Poultry Expo, and International Meat Expo—representing the entire chain of protein production and processing.

2019 IPPE AT A GLANCE

When: February 12–14, 2019

Where: Georgia World Congress Center
Atlanta, Georgia

Website: www.ippexpo.org

WASTEWATER TREATMENT CHALLENGES PROGRAM

Water is an essential component of producing a safe and wholesome source of protein. While the poultry and the egg industries have a long history of efficiently treating the wastewater generated in poultry and egg processing plants, industry wastewater professionals face new challenges stimulated by the use of antimicrobial compounds to address food safety requirements. USPoultry is hosting an education program, "Wastewater Treatment Challenges for the Poultry and Egg Industry," which will examine some of the challenges involved in wastewater treatment.

The program is free for all registered IPPE attendees. Topics to be discussed include "Food Safety Regulations and Intervention Practices"; "Antimicrobials: What Are

They and How Are They Used''; ''Fate and Transport of Peracetic Acid in Wastewater Treatment Unit Operations''; and ''Carryover of Antimicrobial Compounds into Wastewater Treatment Plants.''

FREE ATTENDEE ACTIVITIES, NETWORKING OPPORTUNITIES

IPPE is planning a variety of free activities and networking opportunities for attendees. The Welcome Reception at the Georgia Aquarium will be held Tuesday, February 12. Complimentary tickets will be available on a first-come, first-serve basis to all IPPE attendees. Tickets will be distributed at a special desk in the B-Building and C-Building lobbies on Monday and Tuesday of the Expo.

IPPE attendees can attend daily TECHTalks. These short, educational exhibitor presentations address operations and technical issues critical to all aspects of the animal food, meat, and poultry industries. The presentations will be offered throughout the event.

A Poultry History Museum/Hall of Fame display takes attendees back to the beginnings of the American poultry industry and describes how the industry became the world's largest producer of poultry products.

IPPE is also hosting a ''Chicken and Turkey Cutting and Cooking Demo'' at the Event Zone. Shaun O'Neale, Season 7 champion of the television program MasterChef on FOX, will demonstrate cutting and preparing chicken and turkey products.

TASTE OF IPPE COMPETITION

IPPE's first ever ''Taste of IPPE'' will be held at 2:30 p.m. on Wednesday, February 13, and will bring together a group of highly competitive Atlanta chefs who will be preparing their favorite recipes featuring beef, pork and poultry. Attendees can try as many samples as possible and cast their vote for the ''Taste of IPPE'' at the Event Zone. ◆

2019 Industry Outlook for Submersible Wastewater Pump Manufacturers

Each January, the Submersible Wastewater Pump Association (SWPA) selects experts from within its membership to reflect on the previous twelve months and look ahead to the coming year to discuss which trends, obstacles, and opportunities may await those in our industry. Below, SWPA Executive Director Adam Stolberg is joined by Walt Erndt, vice president and general manager pressure sewer/grinders for Crane Pumps and Systems, and Stephen Doolittle, product marketing manager of commercial and municipal products for Zoeller Company, in a wide-ranging conversation on what 2019 has in store for submersible wastewater pump manufacturers.

Before we look ahead, how would you assess 2018? What areas of the market were most receptive to submersibles?

Stephen Doolittle: 2018 was a good year, across the board, for most all products and territories.

Walt Erndt: Submersible pumps continue to grow in acceptance due to their reliability and initially has a smaller outlay and requires less engineering than a non-submersible system design. Non-submersibles typically require additional design engineering to accommodate the pump and suction pipework.

What strategies have you seen working for OEMs? Which ones should they adopt going forward?

Stephen Doolittle: OEMs do not make up a large share of our business, but we do partner with some pump station and treatment plant packagers who need a line of dependable submersible pumps. These firms have in-house engineering capabilities and a supply channel enabling them to sell, manufacture, install, and support the systems they design. These companies have been busy.

Which applications do you see OEMs relying on in 2019? Which customers are driving the market?

Stephen Doolittle: Those that we deal with manufacture lift stations and/or packaged treatment plants. The convenience and economics to having these systems designed and built at a central location, then shipped to the site for installation is a method preferred by many developers. Based on the number of orders we have already booked for 2019, they are expected to have another good year.

Which innovations or products do you expect to become integral to the wastewater sector?

Walt Erndt: As more maintenance departments and municipalities gravitate toward the Internet of Things (IoT), monitoring of pumps and other equipment will become integral to the system design of the pump station.

Stephen Doolittle: While solids handling pumps capable of passing a 3-inch and larger spherical solid continues to be the workhorse of the industry, impeller designs, and grinding/cutting techniques will continue to be introduced for difficult wastewater applications where ragging is anticipated. Along with these new products, greater awareness as to why these problems occur are being recognized and engineers will design systems that will alleviate some of the problem being experienced.

How impactful have the new pump efficiency standards been on submersibles? Do you see any consensus growing?

Stephen Doolittle: The new pump efficiency standard has impacted the industry, even though submersible wastewater pumps were exempted from the regulation. The impact has come from the number of manufactures who have added high efficiency motors to their product offering.

Walt Erndt: At this point, the DOE has only focused on non-submersible pumps relating to the industrial and commercial sector. I would expect the efficiency standard to also impact submersible pumps, but there has been no information regarding an official time line.

Stephen Doolittle: Whether or not customers are asking for—or engineers are specifying—these motors is a question yet to be answered. For pumps having high horsepower motors, 50 horsepower and greater, that would be expected to occur over time. But the question is still out on pumps having smaller motors and only time will tell. ◆

An "Egg"cellent Wastewater Treatment Solution

Rental system successfully meets standards for municipal discharge

By Justin Olson, World Water Works, Inc.

Treatment and removal of industrial wastewater is a constant concern in the food processing sector, as well as other industries. The twin concerns of meeting environmental regulations and incorporating into municipal infrastructure have to balance out with each industry's production process. Thankfully, World Water Works, Inc. has been providing systems that meet these challenges.

MEETING A DISCHARGE TREATMENT CHALLENGE

In 2016, the egg processing facility of a leading U.S. marketer of premium, further-processed egg products was given a consent order by the local government to treat its wastewater for biochemical oxygen demand (BOD), total Kjeldahl nitrogen (TKN), and total suspended solids (TSS) prior to discharge to the local municipal treatment facility. Additionally, the host city greatly limited the allowable chemical usage in the facility's wastewater treatment process for fear of disrupting the city's activated sludge treatment system.

INNOVATION ON DISPLAY

With the consent order deadline quickly approaching, World Water Works, Inc. provided a 500 gallons per minute dissolved air flotation (DAF) rental system in order to immediately address and comply with the TSS limits as well as significantly reduce BOD and TKN. The DAF rental system would temporarily satisfy the city and allow the facility to continue operations while a permanent system was engineered, manufactured, and installed. Though challenged with high and variable loadings and a limit on the allowable

Design Parameters and Quality Summary

	Flow (gals/day)	BOD (mg/L)	BOD (lbs/day)	TSS (mg/L)	TSS (lbs/day)	TP (mg/L)	TP (lbs/day)	TKN (mg/L)	TKN (lbs/day)	NH3-N (mg/L)	NH3-N (lbs/day)
Influent Design	230,400	2,342	4,500	1,650	3,171	17	33	195	375	12	23
Effluent Design		200	384	100	192	5	10	15	29	10	19
Typical Daily Effluent	194,354	3	3	11	11	1	1	3	3	0	0

chemical dosage, the DAF rental system performed extremely well due to its innovative design, five-micron bubble size, and a flexible, efficient onsite chemical program.

THREE STAGES OF SUCCESS

Following the installation of the temporary DAF system, World Water Works provided a complete treatment process solution to bring the facility's wastewater discharge into compliance with city regulations. The new, robust treatment process consists of a primary treatment DAF system, first stage moving bed biofilm reactor (MBBR) for BOD removal, second stage MBBR for nitrogen removal, and a secondary DAF for final clarification of biological solids. This allows the facility to maintain discharge below permit limits while also handling strenuous conditions due to volatile loadings, variable flows, and high dosages of CIP chemicals.

Slight adjustments were made to the DAF rental system already onsite to serve as the permanent primary DAF system, saving a significant amount of money as well as allowing the company to install the permanent system without shutting down production. The Ideal DAF-MBBR™ process fit easily into the footprint available and is simple for non-licensed operators to manage.

CONCLUSION

The Ideal DAF-MBBR™ process exceeded the provided process guarantees by regularly providing TSS, BOD, TKN, and NH_3 levels in the single digit range. After startup completion, optimization, and training support, the facility's wastewater operations team can now easily manage the wastewater treatment system and continue providing clean, safe water to the city. ◆

Justin Olson is a regional industrial sales manager for World Water Works, Inc., an innovator in the wastewater treatment industry. World Water Works, Inc. is driven to help industrial and municipal customers find wastewater treatment solutions that deliver clean water, perform better, recover resources, and save money. Working hand-in-hand with our customers, we design, build, implement, and optimize our wastewater treatment systems, having successfully done so for industrial and municipal customers on every major continent. Through our products and technologies, we help customers achieve cost-effective performance, resource recovery, and yield the highest water quality. For more information, call 800.607.PURE or visit **www.worldwaterworks.com**.

Design and Care of Reverse Osmosis Systems

Part 1 of 3: Design

By Wes Byrne, U.S. Water Services

Reverse osmosis (RO) systems offer power plant owners and operators a reliable and well-proven water treatment solution. However, designing and caring for an RO system requires a thorough understanding of a plant's water supply and the technology's capabilities. Part one of this series will review the importance of water samples and pilot studies as plant engineers begin to design an RO system to match their needs.

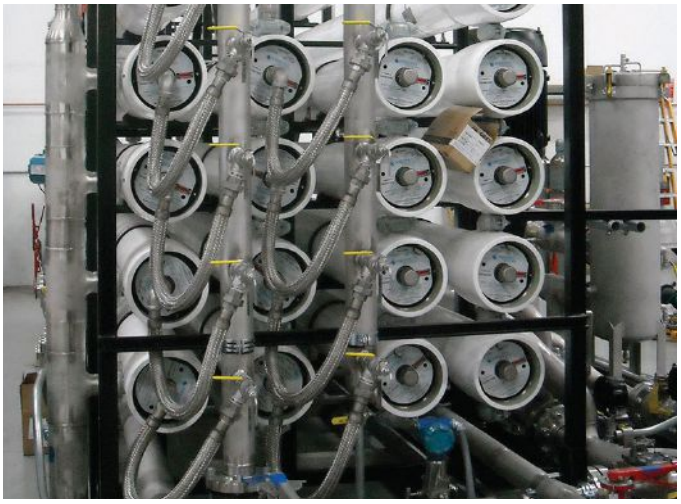
THE HUNT FOR PURITY

Pure water does not exist in nature; all water in its natural state contains varying amounts of dissolved and suspended matter. Osmosis is the process in which a solvent, such as water, flows through a semipermeable membrane from a less-concentrated solution to one with a higher concentration. This normal osmotic flow can be reversed (reverse osmosis) by applying hydraulic pressure to the more concentrated (contaminated) solution to produce purified water.

There is no perfect semipermeable membrane. A small amount of dissolved salt is also able to diffuse through, but this results in low concentrations relative to the feedwater values. The benefits of reverse osmosis technology should be well understood in water treatment for power generation, particularly because of its potential to reduce operating and maintenance expenses. For most sources of water, RO is the least expensive way to remove the majority of a large concentration of dissolved salts.

AN ELECTRIC APPLICATION

The term total dissolved solids (TDS) refers to mostly inorganic salts present in solution. The salts exist as cations (mostly calcium, magnesium, sodium, and potassium) and anions (mostly bicarbonate, chloride, sulfate, and nitrate). These positively and negatively charged ions can pass electrical flow, thus determining the conductivity of the water as a measurement of its TDS concentration. Pure water is a poor conductor of electricity.



For plants originally built using only ion exchange, adding RO can reduce chemical regeneration requirements by a factor of 20 or more. Complete removal of regenerable systems might even be considered. With RO upstream removing the bulk of the dissolved salts, the polishing ion exchange systems might be economically replaced with service demineralizer beds that are chemically regenerated by an offsite water service company, or they might be replaced by electrodeionization (EDI). EDI units use electricity to continuously regenerate their ion exchange resins.

Some new and existing plants are now required to remove dissolved salts from wastewater streams prior to discharge. A well-performing RO system can make it possible to re-use the water within the plant. The concentrated salt stream remaining after RO treatment can then be more economically hauled to an area better able to handle it environmentally, or it could be evaporated or discarded in some other manner.

The political and regulatory advantages of becoming a zero-liquid discharge (ZLD) facility can offset part of the capital and operating costs. But the superior economics

of RO operation are only achievable if the system and its upstream treatment components are correctly designed, operated, and maintained.

ANALYSIS OF A WATER SAMPLE

Pulling a water sample for laboratory analysis is a good start in preparing an RO design (Table 1). A comprehensive analysis provides data on the metals in the water, such as iron, manganese, and aluminum; the dissolved salts (cations and anions); the water pH (acidity); and possibly the inorganic total suspended solids (TSS). A measurement of the total organic carbon (TOC) often correlates with the potential for biological activity.

A TSS analysis reveals the concentration of filterable solids in the water. The concentration of dissolved metals in the water, such as iron, changes in the sample as they react with oxygen introduced by contact with air. This causes some of the metals to oxidize and become insoluble. The metals that remain suspended may cause the TSS value to increase significantly with many well-water sources.

Biological fouling solids are not well-represented in TSS results. The mass of these solids typically becomes negligible when the TSS filter is dried prior to weighing for results. The water could be tested for its silt density index (SDI) if the metals are first separated out of the sample. This test is highly sensitive to the ability of biological solids to coat and reduce the flow rate through its 0.45-micron test filter. Its results correlate with the fouling tendencies of a membrane system.

No analysis is perfect, and water quality can change over time. Even the characteristics of a well-water source can change if the well is relatively shallow. Sampling methods also affect results; some concentrations can change between sample pull and analysis. Metals may attach to the container's inner surface. Ammonia and carbon dioxide (CO_2) may degas or CO_2 may dissolve from exposure to air. Any of these changes will cause the water pH to change. An accurate water pH is best measured on-site.

Chemical suppliers can use a water analysis to predict how much purified water (permeate) the RO might safely separate from the source before the dissolved salts become too concentrated in the remaining water and form scale within the membrane elements (Table 2). The water analysis is also used in designing the RO system, both in projecting the purified water quality and in assessing any effect of the salts on system hydraulics.

PILOT STUDY FOR AN RO SYSTEM

An RO system and its pretreatment equipment designed solely on one water analysis may not be fully optimized for the fouling characteristics of the source. It might be oversized or, of greater concern, it might not be ideal for water that has a high membrane-fouling potential. This can best be determined with a pilot study.

Sample identification: Water sample

Results: Results are listed down to the detection limit of the instrument used. Where results fall below these limits they are reported as less than and the detection limit. A dash indicates testing was not requested or was unable to be run.

A well-designed pilot study uses components that have been scaled down but still offer the same type of media,

System	Well	
Lab Sample ID	Total	Dissolved
pH (units)	7.40	-
Conductivity (umhs/cm)	2440	-
Total Organic Carbon (ppm)	3.76	-
P-Alkalinity (ppm $CaCO_2$)	0.00	-
M-Alkalinity (ppm $CaCO_2$)	400	-
Bromide (ppm)	<0.50	-
Chloride (ppm)	26.4	-
Fluoride (ppm)	<0.40	-
Nitrate (ppm NO_3)	<1.00	-
Nitrate (ppm NO_2)	3.31	-
Sulfate (ppm SO_4)	1117	-
Total Phosphate (ppm PO_4)	0.438	-
Ortho-Phosphate (ppm PO_4)	0.12	-
Total Dissolved Solids (ppm)	2055	-
Total Suspended Solids (ppm)	10.5	-
Ammonia, Nitrogen (ppm NH_3-N)	0.768	-
Total Hardness (ppm $CaCO_2$)	1325	1325
Calcium (ppm $CaCO_3$)	913	913
Magnesium (ppm $CaCO_3$)	412	412
Aluminum (ppm)	<0.01	<0.01
Arsenic (ppm)	<0.01	<0.01
Barium (ppm)	<0.01	<0.01
Boron (ppm)	0.215	0.215
Chromium (ppm)	<0.01	<0.01
Copper (ppm)	<0.01	<0.01
Iron (ppm)	1.62	1.62
Manganese (ppm)	0.447	0.447
Molybdenum (ppm)	<0.01	<0.01
Nickel (ppm)	<0.01	<0.01
Potassium (ppm)	11.5	11.5
Selenium (ppm)	0.057	0.057
Silica (ppm)	24.9	24.9
Sodium (ppm)	134	134
Strontium (ppm)	2.44	2.44
Tin (ppm)	<0.02	<0.02
Vanadium (ppm)	<0.01	<0.01
Zinc (ppm)	<0.01	<0.01

Table 1: Water analysis. This table shows results from an actual water analysis. Results are listed down to the detection limit of the instrument used. Where results fall below these limits, they are reported as less than the detection limit. A dash indicates testing was not requested or was unable to be run.

	RO Concentrate
Langelier Saturation Indes (LSI)	2.04
Stiff and Davis Index	1.72
Calcium Sulfate Saturation ($CaSO_4$/KSP x100%)	9
Strontium Sulfate Saturation ($SrSO_4$/KSP x 100%)	8
Barium Sulfate Saturation ($BaSO_4$/KSP x100%)	2495
Calcium Fluoride Saturation (CaF_2/KSP x100%)	126
Calcium Phosphate Stability Index	-8.97
Calcium Silicate Saturation Index	-885.79
Magnesium Silicate Saturation Index	-178.17
Dissolved Silica Saturation	7.7
Scale inhibitor: USW RO-504 Dosage Rate: 8.42 mgIL	

Table 2: Scale formation potential. This table shows partial results generated by a scale inhibitor dosage program for a given reverse osmosis (RO) recovery. The sale inhibitor utilized was USW RO-504 at a dosage rate of 8.42 milligrams per liter (Ksp = solubility product constant).

Figure 1: Example of a pilot Ro system. The pilot RO system should duplicate the permeate recovery, the permeate flux rate (that is, the permeate flow per unit of membrane area), and concentrate stream vessel exit velocities, along with the scale inhibitor dosage and shutdown flush methods.

and use similar flow velocities and exposure times. The pilot RO (see figure 1) should duplicate the permeate recovery, the permeate flux rate (that is, the permeate flow per unit of membrane area), and concentrate stream vessel exit velocities, along with the scale inhibitor dosage and shutdown flush methods.

When the pretreatment methods are piloted along with the RO, the system operation can be adjusted to minimize the rate of RO membrane fouling, such as by modifying the permeate flux rate, or the rate at which water passes across the membrane surface and through the membrane elements. With the right equipment choices and sizing, it might be possible to eliminate membrane fouling, which could then dramatically reduce operating costs and maximize membrane life.

The choice of membrane might also be evaluated. With larger systems, demonstrating that a low-fouling membrane element performs better than a standard element helps justify the higher cost. Low-energy elements might be evaluated for their potential to reduce pump sizing and associated power consumption.

The pilot study also offers an opportunity to learn more, specifically about what could foul the RO system. A membrane element from the pilot study might be pulled and autopsied, and analysis of the solids makes it possible to choose cleaning solutions best-suited for removing the fouling materials. The effectiveness of the solutions and cleaning methodology could then be verified with the pilot unit. The longer the pilot system is operated, the more information is gained; a minimum of several months is recommended.

A LOOK AHEAD

The next section of this article will discuss the issues related to the water treatment equipment that reats the water before it gets to the RO system. In the final installment of this series, we will take a closer look at membrane fouling and filtration. Fouling doesn't necessarily reduce RO membrane life if the RO is effectively cleaned. If the RO is allowed to foul too severely and cleaning is not effective, then the membrane will likely continue to lose performance. Furthermore, membrane filtration is becoming more common in various applications, including pre-treatment for RO systems.. ◆

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Shopping for Water

How the market can mitigate water shortages in the American West

By Peter Culp, Robert Glennon, and Gary Libecap

For the past two decades, the American West has experienced a widespread and severe drought that has strained water-supply systems. This prolonged drought has exposed substantial deficiencies in our nation's approach to water management, leading to widespread shortfalls in water supply and increasingly unsustainable use of groundwater resources. The United States needs a fundamentally new approach to water management in order to address the long-term challenge of rising water demand in the face of an increasingly scarce and unpredictable water supply.

In the U.S. economy, well-functioning markets help to allocate many resources, with the quantity and price of traded goods determined by supply and demand. For a host of reasons—including physical and legal restrictions—opportunities to trade water are limited. Rather than using markets, the historical solution to water scarcity challenges in the United States has been to increase the supply of water—for example, by additional pumping of groundwater—and to reduce demand—for example, by strengthening conservation measures. These traditional approaches are inadequate in the face of increasingly unreliable water supplies in many parts of the West.

Absent new and innovative approaches to addressing the issue, the economic costs of an inadequate water-supply system will intensify. For example, in 2014 alone, the drought cost California's agriculture sector $2.2 billion and resulted in the loss of more than 17,000 seasonal and part-time jobs. But the economic consequences of water scarcity extend far beyond California's farmers, potentially impacting a variety of industries ranging from commercial fishing to energy production to technology. In line with The Hamilton Project's vision that long-term prosperity is best achieved by promoting sustainable growth, there is an important national interest in identifying mechanisms to address the Western water crisis that will improve the efficiency of water use, safeguard the future of farming communities, and ensure a reliable supply of water for domestic companies.

In this brief, The Hamilton Project provides context to the Western water crisis, and details a proposal by Peter Culp of Squire Patton Boggs, Robert Glennon of the University of Arizona, and Gary Libecap of the University of California, Santa Barbara. In their discussion paper, the authors suggest using market mechanisms to increase flexibility and resilience in water management. To address the water crisis, the authors call for five bold new proposals and guidelines, four of which state and local governments can readily implement. Their proposals would strengthen water markets across Western states by reforming legal barriers to transferring water rights; establishing water-trading institutions; and supporting mechanisms for mitigating risk related to water-supply disruptions. The authors also call for improved management of precious groundwater resources, together with a stronger role for the federal government, especially in encouraging better data on water use. Together, these five reforms will help promote markets for water trading and mitigate the water supply challenges that plague many areas of the West.

THE CHALLENGE

Prolonged drought has subjected water systems in the American West to increasing stress. The authors contend that even after the current drought ends, the water challenges facing the West will continue, exacerbated by population growth in Western states and the concurrent rise in water demand. These constraints, combined with the potential for climate change to markedly increase variation in precipitation, would dramatically exacerbate pressure on the West's water supply and infrastructure.

Water reserves in underground wells and aquifers have traditionally served as a buffer against shortfalls in water supply. Because many states do not adequately regulate groundwater, water users have little incentive to avoid exploiting this seemingly unlimited resource, and have drawn down the supply of underground water to unprecedented levels. Such a result is predicted by economic theory, which posits that a common resource, which is shared by many but owned by none, can become overexploited. Indeed, in the American West the absence of robust water markets—systems to buy and sell water-use rights—has intensified the economic costs of water scarcities and prevented the efficient use of water.

Barriers to effective water markets are diverse: for one, the physical difficulty and expense of moving large quantities of water pose significant challenges to getting water to where it is needed. In addition, a myriad of legal and regulatory restrictions—that limit the trade of water among its users—aggravate relative water scarcity and existing price disparities, and act as an equally important obstacle to the establishment of markets.

Open access to groundwater has also substantially impeded the development of water markets. In the absence of regulation, a prospective water user will choose to access free groundwater instead of paying for access to a more sustainable, but comparatively expensive, supply of surface water. As a result, overexploitation of underground water sources has not only caused irreversible environmental damage, but also impeded the development of robust water markets.

The lack of effective markets for water has produced the perverse situation where water itself cannot be easily traded, but the commodities that are produced with water can be, and are, traded. For example, farmers in California used more than 100 billion gallons of water to grow alfalfa that they shipped to China to support its rapidly growing dairy industry, even as the rest of the state struggled through the worst drought in recorded history. If those alfalfa farmers were given an opportunity to sell water to their water-starved neighbors in other parts of the state, that might have alleviated some of the economic damage to California's economy caused by the drought, while simultaneously generating higher economic returns for farmers.

Some states and localities have adopted innovative market mechanisms—such as water banks and exchanges—to support markets for water trading. As a result, a variety of tools and institutions for facilitating the trading of water and for mitigating water-supply risks already exist. Yet these tools and institutions are underutilized, and have not allowed water markets to fully develop across the West. Furthermore, private market mechanisms for managing risk in other industries, such as option contracts, can serve as a model for innovative strategies to insure against costs associated with inevitable supply disruptions in the water sector.

In sum, water scarcity is an economic problem that demands an economic solution. A host of

impediments to water markets, ranging from burdensome regulation to underutilization of proven risk mitigation strategies, have exacerbated the costs of water scarcity. The authors suggest ways to overcome these physical, legal, and regulatory restrictions through an innovative and diverse set of solutions to promote effective water markets in Western states.

A NEW APPROACH

Growing uncertainty over water supplies means that Western states must adapt their water management frameworks and prepare for meeting the demand for water during periods of prolonged scarcity. The authors contend that the United States needs to restructure its approach to water management and create institutions that would make water allocation more flexible and resilient, so that users of water can thrive even in the face of substantial disruption of supplies. Water markets represent an important tool for achieving that flexibility and resilience.

REFORM LEGAL RULES THAT DISCOURAGE WATER TRADING TO ENABLE SHORT-TERM WATER TRANSFERS

One important mechanism for achieving more-robust markets for water is to reform legal doctrines that obstruct the trading of water. Water markets fundamentally depend on a system of property rights; exchanges cannot realistically take place in the absence of recognized owners and legally enforced contracts. The authors propose reforming the legal and regulatory framework to create a more efficient system of property rights. These reforms would require three elements: a complete definition of property rights so buyers and sellers know what is being exchanged; exclusivity, meaning the right to exercise control over the asset; and transferability, or the ability to sell or bequeath ownership.

While acknowledging that a comprehensive legal overhaul would take decades, the authors propose a series of targeted reforms to legal doctrines to clarify property rights, and consequently facilitate trading of water rights in the short run. As an example, one of these legal doctrines, called the salvaged water doctrine, effectively encourages overuse of water because it does not allow farmers and other parties who reduce their water use to lease or sell conserved water. The authors advocate for reforms to this legal doctrine in order to allow existing

THE PROPOSAL IN BRIEF

- **Reform legal rules that discourage water trading to enable short-term water transfers.** Western states would remove or provide exceptions to a number of legal doctrines in order to authorize simple, short-term water transfers between parties.
- **Create basic market institutions to facilitate trading of water.** Trading platforms, such as water banks, would promote longer-term water transactions and transfers and allow markets to operate at a number of scales, such as within regions or within the boundaries of urban areas or agricultural districts.
- **Use risk mitigation strategies to enhance system reliability.** The use of market-driven risk management strategies would address growing variability and uncertainty in water supplies. These tools include the use of dry-year option contracts to provide for water sharing in the face of shortages, and water trusts to protect the environment and limit supply risks. New reservoir management strategies that allow for market-driven use of storage would build additional resilience into water management systems.
- **Protect groundwater resources.** States would better regulate the use of groundwater, including monitoring and limiting use to ensure sustainability, in order to preserve essential groundwater reserves, protect against environmental damages, and support the development of effective markets.
- **Continue and expand federal leadership.** Strong federal leadership, from both Congress and the Bureau of Reclamation, would help markets work at scale and promote cooperation between states and agencies in water management.

and to allow those users to lease or sell the conserved water on a short-term basis to others who might value the water more. As another example, the authors also propose that states jettison a rule—known as the anti-speculation doctrine—that requires water users to document the new location, purpose, and use of the water before it can be transferred. Ultimately, the proposed legal reforms would lower barriers to the short-term trade of water by allowing buyers and sellers to feel more secure about property rights; this, in turn, would lead to more trade, which would benefit the involved parties and increase overall economic efficiency.

CREATE BASIC MARKET INSTITUTIONS TO FACILITATE TRADING OF WATER

As a complement to their proposed reforms to clarify property rights, the authors propose the establishment of institutions to facilitate and promote the trade of water. Well-functioning market exchanges involve more than just a bundle of legal right; they commonly also involve a set of supporting institutions. Depending on physical and geographic constraints, water infrastructure, and regulatory restrictions, water markets could potentially operate at a variety of scales—for example, within regions or within the boundaries of urban areas or agricultural districts. Establishing effective frameworks and trading platforms for markets to operate at these various scales is a key prerogative of state and local governments. Properly assembled, these frameworks can employ powerful market forces to achieve water management goals.

To that end, the authors propose that state legislatures authorize the development of local and/or regional water exchanges or banks to facilitate the transfer of interests in water. Water banks function similarly to regular banks, holding deposits of water rights until the depositor decides to use them or allowing depositors to lend, give, or sell these rights to someone else. Existing water banks in the West serve as brokers by helping sellers find buyers and vice versa, as clearinghouses by pooling supplies from willing sellers and making them available to buyers, and as facilitators by using storage entitlements to trade water rights. To facilitate the exchange of information among users, the authors also propose that states develop a central registry of water rights that would disclose information about market participants and exchanges, such as a list of rights holders and recent exchanges including amounts, duration, and prices paid. This registry would help all parties, particularly small users, locate one another and determine volumes to be exchanged and prices to be paid.

USE RISK MITIGATION STRATEGIES TO ENHANCE SYSTEM RELIABILITY

In addition to legal reforms and establishment of trading institutions, the authors discuss the benefits of private risk management strategies to buffer farmers and other water-dependent businesses from the risk of water-supply disruptions. They argue that once basic mechanisms for the lease and transfer of water rights are in place, creative transactions to manage the risk of water fluctuations will likely evolve organically through private-market mechanisms. Borrowing from tools already in use in some jurisdictions, the authors argue that several types of option contracts could be used to create flexibility in water use.

For example, dry-year options can encourage water sharing in the face of shortages. Water users with a low tolerance for loss of water supply—including municipal water users or citrus tree growers—can enter into a contract to pay seasonal agricultural users (or other users with more flexibility to accommodate changes in water supply) a certain amount of money each year. In dry conditions,

the buyers of the option would have a right to use the seasonal agricultural user's water, while the interrupted seasonal user would use the money received to offset the costs or losses associated with the reduced water supply, such as through adjustments to the types of crops grown or the amount of land in production.

The authors also lay out a framework for mitigating individual and system-wide risk through alternative mechanisms. Two examples include the increased tradability of water stored in reservoirs, achieved by allowing reservoir water rights holders to either trade or carry over their water from season to season for later use instead of requiring them to use their entire water allocation each year; and water trusts, which are institutions that acquire water rights and dedicate these flows to limiting both environmental and systemic supply risks.

PROTECT GROUNDWATER RESOURCES

A fourth set of reforms calls for improved groundwater protection. The authors describe how the failure of some states to regulate groundwater use has created an ongoing open-access resource problem that causes erosion of private property rights in both land and surface water. This, in turn, inhibits the development of water markets and distorts market prices. While the regulation of groundwater varies markedly across Western states, the authors propose a general series of recommendations for groundwater management. These recommendations include tradable credits for recharging groundwater, permits for drilling new wells, and demand-offset systems. Together, these innovations would protect surface and groundwater systems and provide incentives for groundwater recharge. In addition, the authors propose increasing budgets at federal and state agencies to promote research that increases understanding of groundwater systems.

The authors also note opportunities created by the recent California law that mandates the adoption of groundwater management plans and expands local authority over groundwater. These recent efforts will be accomplished under the auspices of groundwater sustainability agencies (GSAs), which can be specific local water agencies or cooperative efforts among agencies. With that in mind, the authors propose a set of guidelines modeled after Arizona's successful efforts at regulating groundwater that would guide California's GSAs in managing groundwater resources.

CONTINUE AND EXPAND FEDERAL LEADERSHIP

Finally, the authors propose that the federal government play a role in establishing better water markets in the West. For example, one way the federal government can improve water trading is through improved data collection and measurement of water supply and use. The authors propose that the Bureau of Reclamation in the Department of the Interior require, as a condition in new contracts or renewal of existing contracts, that contractors have meters or other effective measurement devices to measure the quantity of surface water diverted or groundwater pumped. The authors argue that the federal government should also play an important role in supporting and coordinating state and local efforts to generate accurate data.

More broadly, the authors propose various policy recommendations for Congress, and specifically for the Bureau of Reclamation. These proposals include revisiting some of the subsidy assumptions built into early contracts; promoting rules and regulations that require irrigation districts to allow individual farmers an opportunity to benefit from conserving water; undertaking pilot projects to test the viability of conservation approaches; and reexamining current federal agricultural policies. Overall, the authors argue that continued federal leadership is essential to encouraging more-flexible water management, reducing barriers to trade, and developing critical market institutions.

CONCLUSION

Western states continue to struggle with water scarcity in the face of rising demand. Traditional solutions to water-supply challenges are proving increasingly unworkable, with underground reserves dwindling to unprecedented levels in some areas. Instead, the authors argue that a series of reforms to promote more-robust water markets in the West will lead to a healthier water sector and improved outcomes for water-dependent industries. They contend that, by tapping into the power of markets, policymakers and stakeholders can design better tools to halt the excessive pumping of groundwater, avoid the construction of environmentally destructive infrastructure, improve the efficiency of our water use, safeguard the future of our farming communities, and ensure a supply of water for our nation's productive use. ◆

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Venturi Injectors Make Their Impact

A 200-year-old technology improves efficiency of modern pumping systems

By Jim Lauria, Mazzei Injector Company

Modern pump technology has benefitted dramatically from new materials, modern manufacturing methods, and state-of-the-art controller technology. But one of the most impactful technologies that improves the function and efficiency of today's pumping systems is a device designed more than two centuries ago—the venturi injector.

In 1797, Giovanni Venturi observed the effects of constricted channels on fluid flow and designed the venturi tube—an instrument with a narrow throat in the middle. In the venturi tube, the fluid passes through the tube and speeds up as it enters the constricted throat, triggering the pressure to drop. The drop in water pressure causes a liquid or gas to be pulled into the flow.

Over the years, Venturi's design has been modified to precisely inject a wide range of materials, from air to fertilizer to paint and chemicals, and tweaked with ribs and flutes to enhance the mixing effect of the device.

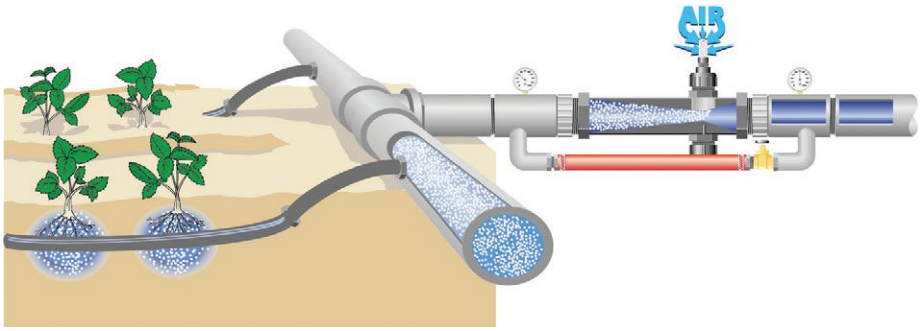
AGRICULTURE AND BEYOND

In California in the 1970s, Angelo Mazzei harnessed the power of Venturi's invention to blend fertilizer into irrigation water without breaking pressure or requiring additional energy. Mazzei's innovative use of venturi tubes led to numerous patents and launched a business that has reached into a wide range of water applications in nearly every corner of the world. The versatility of Mazzei's venturi injectors brings the company closer every day to the goal of outfitting "a venturi for every pump."

Mazzei remains a leader in the agriculture market and has expanded the uses of the venturi injector to the finely tuned Tru-Blend system for precise injection of nutrients and other inputs into irrigation water, as well as the unique AirJection system, which aerates drip irrigation water to deliver more oxygen to the root zone, resulting in higher yields and improved fruit and vegetable quality. University research indicates that aerated irrigation water could impact fertilizer efficiency and even greenhouse gas emissions.

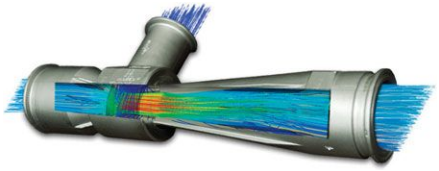
In a system compact enough to mount on a small skid, Mazzei constructed a highly efficient aeration system with a sidestream pump, venturi injector and controls, and includes a Pipeline Flash Reactor. The system raises dissolved oxygen in treated water by more than 60 percent to exceed mandated levels.

Mazzei's injectors have also been integrated into ozonation and oxygenation systems of all sizes. Venturi injectors are paired with compact spa pumps to sanitize hot tub water, employed in pump-over systems to improve the quality of fermenting wine, and coupled with massive industrial pumps in water treatment plants to efficiently treat drinking water for pathogens, taste and odor issues, manganese and iron precipitation, and color.



In Mazzei's AirJection system, a venturi injector (right) uses the flow in the main line to mix air into irrigation water, which delivers it to the crop's root zone.

Maintenance crews also appreciate the fact that venturi injectors have no moving parts. That allows them to focus on pump maintenance, keeping operations simple and cost-effective. The Vaughn Water Company, located near Bakersfield, California, reports that the ozone/venturi injection system it installed in 1997 to treat hydrogen sulfide in well water has been running nearly maintenance-free for more than twenty years.

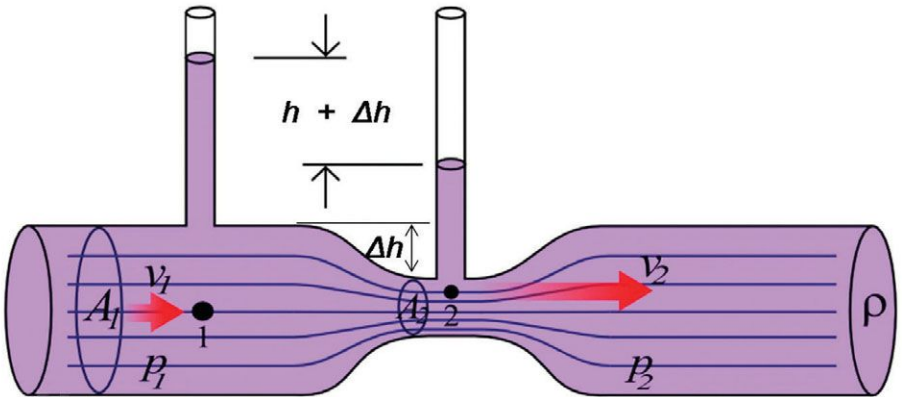


Computational fluid dynamics (CFD) modeling illustrates the mixing and contacting of liquids and gases through a venturi injector.

LONG DISTANCE, HIGH EFFICIENCY

A Texas power plant discharges 1.5 to 3 million gallons per day of cooling tower effluent and pumps it two miles from the cooling tower to a settling pond, then another three-quarters of a mile to the point of discharge at a local creek. State regulators mandated that dissolved oxygen (DO) levels of the untreated water—which experiences seasonal DO levels ranging from 0 to 3 mg/L—increase to a minimum of 5 mg/L prior to discharge.

A sidestream venturi injector system, with a highly efficient mixing system called a Pipeline Flash Reactor (PFR), was installed immediately prior to the discharge point. This system, small enough to fit on a single 30-square-foot skid, requires minimal maintenance—the only equipment with moving parts is the small sidestream pump. Weekly sampling shows the system raises the DO in the water to the 8 mg/L levels requested by the plant managers—well above the minimum mandated levels.



Two centuries ago, Giovanni Venturi harnessed Bernoulli's principle to create an injector that continues to revolutionize pumping systems today.

Venturi injectors, like the ones at this treatment plant, are extremely efficient at injecting ozone into wastewater and have no moving parts.

NO MOVING PARTS

Venturi injectors and their associated pumps are typically installed outside of basins and lagoons, easing system maintenance. Because venturi injectors use the flow of fluid in the line to create a vacuum, there are no blowers, compressors, or splashing paddles to create noise, aerosols, and airborne contaminants.

Dry-mounted pump and injection systems are especially welcome in the pulp and paper industry, where the alternatives include spargers and mixers submerged in corrosive, odorifous water chests. Venturi aeration systems have proven themselves highly efficient at combatting anaerobic bacteria that can form volatile fatty acids (VFAs) and foul-smelling hydrogen sulfide.

Despite the simplicity of Venturi's concept, today's injectors are more sophisticated. Modern injectors have benefitted from cutting-edge computational fluid dynamics (CFD) modeling and have developed into enhanced, next-generation products. CFD enables the fine-tuning of applications and the optimization of venturi injection and mixing systems. It's a perfect pairing of the old and new to create elegantly simple, highly effective tools for the pumping industry. ◆

Jim Lauria is vice president of sales and marketing for Mazzei Injector, a fluid design company that manufactures mixing and contacting systems. He is a leader in the water treatment field with a proven track record of revenue growth, profit improvement, and new business development. Since graduating with a bachelor of chemical engineering degree from Manhattan College, Jim has traveled the world benchmarking the best water management practices. For more information, visit **www.mazzei.net**.

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A Guide to Selecting and Configuring Portable Mixers

By Tom O'Donnell, Neptune™ Chemical Pump Company

Pumps may grab the headlines in industrial applications, but mixers are the leading technology for many critical mixing and blending tasks, provided they are configured and utilized properly.

Pumps are the acknowledged workhorses in industrial fluid-handling applications, capable of reliably, safely and consistently transferring thousands of gallons of varying commodities at a rate that helps plant operators satisfy the strict demands of challenging production schedules. However, there is another technology that, while not necessarily as highly regarded as the pump, plays a significant role in critical production and fluid-handling processes in industrial operations.

Portable mixers play a very significant role in many industrial applications, and if properly selected and configured can provide the user with many years of reliable, trouble-free service for a wide variety of blending and mixing operations. Neptune™ offers an array of mixer styles to meet the needs of unique blending and mixing activities.

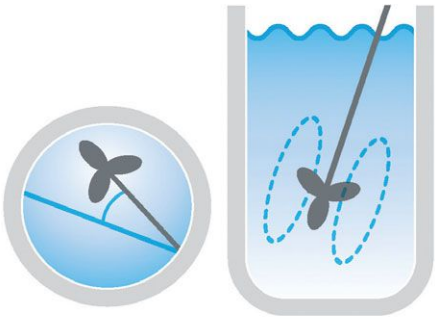
This technology is known as the portable mixer, and properly designed and engineered mixers can provide the operator with many years of trouble-free service in a wide variety of blending or mixing operations. Indeed, while the pump's main job is to facilitate the movement of fluids from Point A to Point B in the most efficient manner, mixers are more of a jack-of- all-trades that possess the ability to perform a number of important tasks, including blend fluids of varying viscosities, suspend or dissolve solids, disperse immiscible liquids (think water and oil), and disperse small amounts of gases in liquids. This makes them ideal for use in a variety of different applications—from water and wastewater treatment to batch chemical preparation—and with a number of commodities with viscosities ranging from 1 to more than 25,000 centipoise (cPs), including paints, varnishes, polymers, textile dyes, pharmaceuticals, food products, and soaps.

Many operational variables and characteristics must be considered before selecting a mixer. These include mixer type, fluid viscosity, rate of agitation, tank shape and volume, and pumping rate.

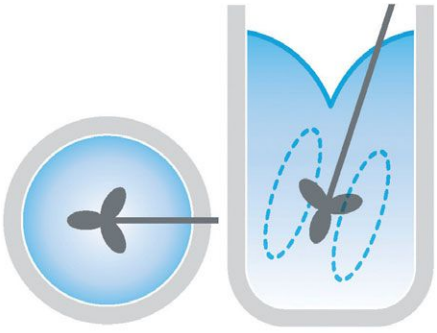
But like any other piece of industrial equipment, portable mixers only operate at their highest level of efficiency, effectiveness, and reliability if they are properly configured for the specific mixing or blending task. With that in mind, there are a number of operational variables that must be taken into consideration when choosing and implementing a mixer. 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.

PORTABLE MIXER CATEGORIES

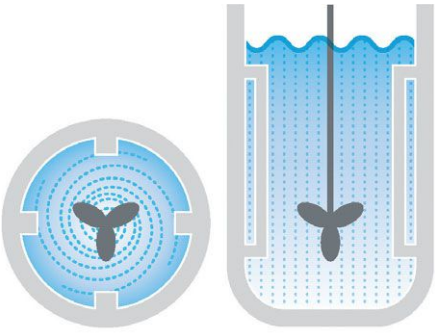
Portable mixers can be separated into many categories with the main ones outlined below.



Angling the portable mixer off-center is the recommended position when rapid turnover of the tank contents with good bottom washing is needed.



On-center mixer angling will produce good blending with minimum vortex creation, resulting in gentle but thorough tank turnover.



When mixing in larger tanks, the mixer should be positioned vertically and on-center. In this configuration, the attachment of baffles to the tank walls is recommended in order to prevent the tank's contents from rotating and creating the vortexing that will hamper proper top-to-bottom turnover.

STYLE

The most common are lab and pail, drum and tote, and light- and heavy-duty mixers. Lab and pail mixers are very small and are most often used, as their name suggests, in labs for mixing in small vessels or industrial applications where a liquid product is provided in a pail. The most commonly used portable mixers in industrial operations are the drum and tote tank-mixer designs. Drum mixers are utilized with the 55-gallon drums in which many industrial chemicals are shipped. Tote (IBC containers) sizes can vary anywhere from 220 gallons to more than 500 gallons. Drums and tote tanks generally have a lid or top opening that have a bung connection or a larger opening. The mixer will require that a small fixed or folding prop be attached to the end of the mixer shaft so that it can be properly inserted into the drum or tote

opening. Most models of portable mixers are either gear-driven with speeds of 350 or 420 revolutions per minute (rpm), or direct-drive, with speeds of 1,750 rpm. Most can be fitted with variable-speed drives or air motors that can provide variable speed, if needed.

MOUNTING

There are three main types of mounting configurations for non-drum or tote portable mixers. One is c-clamp, which normally has an adjustable angle of entry that is controlled by a ball-and-socket design. The angle riser provides a fixed 10-degree angle of entry into the mixing vessel and the flange mount to attach to the flange on the tank. Drum and tote mixers can be threaded into the bung opening in a drum or tote, c-clamped above the vessel, attached to the drum lip, or have special brackets designed to mount on the tote or bulk tank. These brackets can be unattached when the mixing process is completed.

When properly designed, mixing systems will reliably provide the operator with the hoped-for finished product.

PROPS

There are three common models of portable mixer propellers that can be used: Square Pitch; 1.0 pitch, or marine prop, which is one of the most effective pumping devices; and Super Pitch, which has a 1.5 pitch that allows it to deliver higher pumping rates at the same diameter as Square Pitch, though it does require more horsepower to operate. Specialty hydrofoil blades, which offer a more directed flow pattern, can also be advantageous for the user.

SHAFTS

The rule of thumb for portable mixers is to position the mixer propeller one to two propeller diameters from the bottom of the tank, which will determine shaft length. It is desirable to position the prop closer to the bottom of the tank (one diameter) when mixing slurries or products with solids that have a tendency to settle out.

MIXER AGITATION RATE

When sizing a portable mixer it is important to know the degree of agitation required for the application. Mild agitation is normally 1/2 to 1 tank turnover per minute, medium agitation is 1-1/2 to 2 tank turns per minute, vigorous agitation is 2-1/2 to 3 turns per minute and violent mixing has tank-turnover rates of more than 3 turns per minute. The prop's pumping rate is available from mixer manufacturers for each mixer model type and size at the various rpms at which they will operate, and is normally measured in the gallon-per-minute pumping rate of water. Sizing and selecting a mixer can be easily done with this information. For example, a 100-gallon tank of a water-like chemical requires vigorous agitation, or 2-1/2 turnovers. Knowing that a 4-inch square pitch prop at 1,750 rpm delivers a pumping rate of 250 gallons per minute, a portable mixer could be selected. Keep in mind, however, that as liquid viscosity increases the pumping rate decreases.

MIXER POSITIONING

The goal of any portable mixer is to either blend, dissolve or disperse, and to do this in the most efficient manner. With that in mind, the position of the shaft and prop in the mixing container is a critical concern.

In most mixing applications involving small cylindrical tanks of 1,000 gallons or less, 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. Angling the mixer 15 to 20 degrees off of the tank's centerline is preferred when good material turnover is required, as when mixing a slurry. 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 operator put baffles on the walls of the tank in order 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.

It is suggested that four baffles be used in this situation with them placed 90 degrees apart on the walls of the container and sized approximately 1/12th of the tank's diameter. The baffle should not fully extend to the bottom of the tank and a noticeable gap, usually 1/2 to 1-inch in size, should be left between the baffles and the tank walls if solids are present or for viscosities over 500 cPs to prevent a buildup where the baffle connects to the tank wall. If baffles are required in a square or rectangular tank, they should be placed at the midpoint of each of the four walls, with the same

Neptune™ offers a complete array of mixer types and styles, all of which have been designed to deliver the highest levels of performance.

sizing and positioning parameters for baffles that are placed in circular tanks acknowledged.

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.

Another consideration in the realm of vortexing may be the need to use two props on the shaft. Since it may be difficult to create a vortex in a baffled tank, a solution can be to use dual props. In this case, one prop is placed at the top of the shaft, near the surface of the liquid, while the second is located in its traditional position at the bottom of the shaft. This configuration can produce the vortex that is required to draw in powder or liquid materials, even in a baffled tank. In general, dual props will also be required in any container whose height is greater than 1.5 times its diameter. In this case, the props should be located at least two prop diameters apart and the upper prop should be submerged at least two prop diameters below the fluid surface to ensure good mixing.

Keep in mind, though, that when determining mixing rate that dual props do not produce twice the flow of single props. This is because a mixer with dual props of the same diameter has a higher head capacity and will produce an increase of flow of around 20 percent (dependent on propeller spacing), but will require an 80 percent increase in power to create that increased flow.

Viscosity (cPs)	Materials Approximating That Viscosity
1	Water, gasoline, kerosene, solvents, milk
100	SAD 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
15,000+	Resins, high-concentrate polymers

FLUID TYPE

The mixer type and related components can only be chosen when the viscosities of the fluids to be mixed or blended are known. Operators should keep the following information in mind when selecting the perfect mixer for the specific fluid type:

CONCLUSION

Pumps may get the glory in industrial manufacturing or fluid-handling applications, but portable mixers can play an undeniably significant role in optimizing the effectiveness of the entire production operation. As with any technology, knowing the do's and don'ts of mixer selection and operation, as well as the handling characteristics of the fluid to be mixed or blended, will play a major role in selecting the technology that is perfectly suited for the specific operation. ◆

Tom O'Donnell is director of business development for Neptune™ Chemical Pump Company and PSG®. He can be reached at tom.odonnell@psgdover.com or 215.699.8700, ext. 3327. Based in North Wales, Pennsylvania, Neptune is a leading manufacturer of chemical metering and peristaltic pumps, chemical feed systems, chemical injection accessories, make-down systems, and portable mixers. Neptune is a product brand of PSG®, a Dover company, Oakbrook Terrace, Illinois. PSG is comprised of several of the world's leading pump companies, including Abaque®, Almatec®, Blackmer®, Ebsray®, EnviroGear®, Finder, Griswold™, Mouvex®, Neptune™, Quattroflow™, RedScrew™, and Wilden®. For more information, visit **www.neptune1.com** or **www.psgdover.com**.

Different Countries, Different Requirements, Uniform Quality

Customized pump technology enables precision silane metering in accordance with national guidelines

By Roland Schwab, LEWA GmbH

How precisely silane can be metered during continuous plastics processing has a direct influence on the quality of the end product. This is why fast and precise control of the flow rate must always be guaranteed—even when different types of silane are being used for different products. LEWA GmbH from Leonberg, Germany, has a customer that faced this very challenge. The customer is a cable manufacturer that uses various types of silane as crosslinkers and adhesion agents to produce cable insulation.

In order to ensure uniform product quality from various manufacturing sites around the world, the company decided to go with ten metering systems made from outstandingly durable materials. At its core, the customer's system depends on the reliable LEWA Ecoflow diaphragm metering pumps in combination with the company's proprietary "LEWA Smart Control" technology and a high precision mass-flow meter. Continuous guide signal and measuring instrument feedback ensure sensitive and prompt control with only very minor deviations. Since the metering systems are being used worldwide, minor modifications were necessary for adapting to national regulations.

THE ADVANTAGES OF SILANE CROSSLINKING

Silane crosslinking is an established process that improves the performance of cables. In comparison to thermoplastic polymers, crosslinked polymers achieve much better results when it comes to resisting heat, deformation and weather effects as well as electric flow and creep behavior. In addition, the process has the advantage of requiring much less energy for the procedure compared to similar methods such as radiation crosslinking. The results are lower operating costs for production and environmental conservation.

One company that uses this process is a customer of LEWA GmbH. Depending on the application and product, the customer (a cable manufacturer) uses various types of silane to produce cable insulation, such as aminosilane or vinylsilane. Since silanes are usually highly flammable as well as highly reactive in combination with atmospheric oxygen, the systems used for metering must make safe handling possible. For these purposes, the company has been relying on customized metering systems from the LEWA pump experts for many years now. The production expansion in 2016/2017 was no exception. The company was looking to buy systems for plants in Brazil, Colombia, and Peru. And once again, they opted for the experts from Leonberg. The customer's central solution requirements were reliability, safety and precision. LEWA was able to offer a solution that met these requirements, both technically and economically.

TRIED-AND-TESTED SYSTEMS WITH CUSTOM DESIGNS

The LEWA Ecoflow diaphragm metering pumps are the core of the new systems. Customers have the option to select from a variety of pump head types (diaphragm or packed plunger pump head), materials and surfaces, which means that their systems can be built to handle a wide range of fluids, including flammable, toxic, abrasive, viscous, environmentally harmful and sensitive fluids. The Ecoflow series can be used for flow rates up to 5,000 gallons per hour per pump head and discharge pressures up to a maximum of 1,200 bar. Tank sizes also vary between 16 and 63 gallons per hour. The

Silane crosslinking is an established process that improves the performance of cables. In comparison to thermoplastic polymers, crosslinked polymers achieve much better results when it comes to resisting heat, deformation, and weather effects.

hydraulically actuated pump heads stand out in particular for their high operating reliability as well as a long service life, which is made possible by features such as the patented diaphragm protection system (DPS). This ensures that the pumps remain hydraulically stable even in the event of accidents or operating errors. As a result, the pumps are extremely reliable and have low maintenance and operating costs.

The systems have also been adapted to the customer's specific requirements. This way, it is possible to make modifications to the flow rates, connection voltage, system hierarchy and product supply without a hitch. At the same time, it was also necessary to construct the systems in accordance with the valid regulations of the country of installation—for example relating to implementing explosion protection.

Beyond that, the visual displays were each delivered in the language of the specific country. Another one of the purchaser's requirements was that it be possible to use the systems universally for different silane liquid types. LEWA met this requirement by using high-quality materials. Stainless steel was used for the pump housing and PTFE was used for the sandwich diaphragm. These materials show hardly

The LEWA Ecoflow diaphragm metering pumps are the core of the new systems. Thanks to their modular design, the systems can handle a wide range of fluids, including flammable, toxic, abrasive, viscous, environmentally harmful, and sensitive fluids.

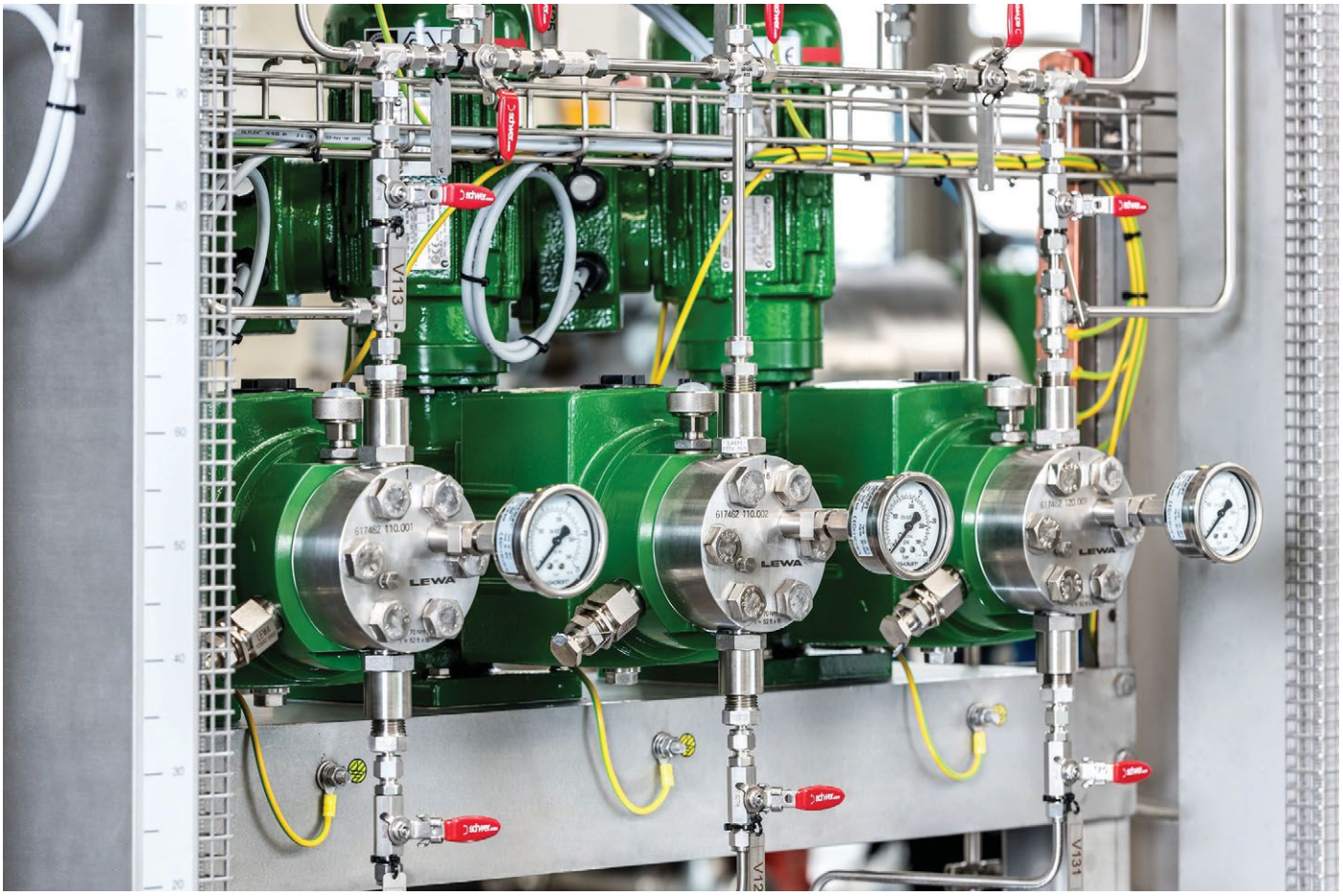
any wear, even when pumping aggressive fluids.

MEASURES FOR GREATER SAFETY WHEN HANDLING SILANE

LEWA took a variety of steps to guarantee the level of safety required by the customer for the handling the silane being used. These steps included designing the system in accordance with Ex-Zone 2 and equipping it with continuous monitoring for certain parameters such as fill level, flow rate and pressure or diaphragm status. Additionally, an inert atmosphere is created by nitrogen blanketing.

The reliable "LEWA Smart Control" controller allows for intuitive operation using a color touch panel directly on the control cabinet. The controller is integrated into the higher-level system control. Among other features, the touch panel delivers a general graphic overview of the individual processes and parameters as well as a summation of production related data. This data can then be used as a foundation for initial analyses in the event that maintenance should be required.

Using an optional data connection, LEWA is able to connect to the system directly and provide support from their headquarters in Leonberg. This data connection even allowed LEWA to provide the customer with support during commissioning. Thereby, the process was able to be significantly shortened.



LEWA Smart Control guarantees metering accuracy. The controller handles this by carrying out a variance analysis and then instantly adjusting the flow rate as necessary.

SMART ACCURACY

Moreover, LEWA also fulfilled the third essential requirement—the requirement for accuracy—using LEWA Smart Control. The controller handles this by carrying out a continuous variance analysis and then instantly adjusting the flow rate as necessary. For the alignment, a high precision mass-flow meter is used as a measurement instrument for the actual value, and an external 4-20 mA guide signal is used for the target value. The customer also receives information on the status of the system by comparing the current flow rate for a specific point of operation with the flow rate stored in the controller for that operating point. For even greater reliability, the systems also each feature a redundant metering pump.

To ensure optimal reproducibility, consistency and product purity of the plastics, it is necessary for the silane to be metered precisely and independently of external influences. The fact that the customer once again called upon LEWA to implement this process at various plants shows that our company has truly earned the trust of this customer thanks to our technical expertise. ◆

Roland Schwab is product manager at LEWA GmbH. LEWA GmbH was founded as a family company by Herbert Ott and Rudolf Schestag in 1952. Today it is the world's leading manufacturer of metering pumps and process diaphragm pumps as well as complete metering packages for process engineering. The Leonberg, Germany-based company developed into an international Group within a few decades and saw further improvement in its position on the world market as part of integration into the Japanese Nikkiso Co. Ltd. in 2009. As a research and production-oriented company, LEWA develops technologies and provides solutions for the vast array of applications among its customers. Its products are used mainly in the oil and gas industry, in gas odorization, in refineries and petrochemicals, as well as in the production of plastics, detergents and cleaners. Additional application areas include the chemical industry, cosmetics industry, pharmaceuticals and biotechnology, food and beverage industry, and energy utilities. LEWA currently employs around 1,200 people and owns fourteen subsidiaries around the world along with having eighty representatives and sales offices in more than eighty countries. For more information, visit **www.lewa.com**.

Improving an Organization's Engagement and Agility through Evidence-based Product Support

By William B. Winkel

Organizations establish standard product development processes to proactively optimize performance versus profit. However, the impact of insufficient quality or reliability are dealt with reactively and often late in the development process. The primary objective for evidence-based modeling is to transition from process measurement to control, by minimizing defect/lesson recurrence through early detection/correction with accountability for prevention directed to affected functional groups. This allows each to improve its procedures, tools, and training based upon documented and validated evidence.

The model dictates that each organization has development and corrective processes operating in parallel across the product lifecycle. Each contributes metrics that measure an organization's reputation, i.e., profit versus value.

The corrective process continually documents, validates, corrects, and communicates lessons. It identifies the need for strategic tools to short-cycle functional silos that deter agility through the delay of functional bureaucracy. Evidence shows that the parameters of the value metrics tie results to the capability of functional groups instantiated to develop products.

The initial results of applying Evidence-based practices and value driven metrics were presented to a Department of Defense (DoD) working group as value-added for DoD contractors (see note 1). However, evidence-based practices are equally applicable to any organization developing products.

The following presents the value proposition in terms of what experience has shown are significant points to consider when the goal is to improve engagement and

Figure 1: Closed-loop organizational model

agility by transitioning from process measurement to control.

ORGANIZATIONAL ENGAGEMENT

Managing evidence to quantify Value metrics impacts the organization's structure and engages employees across the organization. Kotter states that a value-proposition is to be understood and supported by as many as 75 percent of the organization's executives (see note 2). Evidence-based Organizations (EbO) defines "value-added" from a top-down perspective, while Evidence-based Product Support (EbS) presents the upward value of a mathematical, process, and tool driven approach to controlling product performance while improving performance, processes, and agility (see note 3).

THE MODEL

The goal is to establish a structured methodology for maturing the organization and realizing the benefits of a closed-loop business model that ties centers-of-functional-excellence to the organization's value-metrics. Value metrics measure functional performance, quality, and reliability, which enables targeted process improvement and the creation of strategic development tools to breakdown the communication barriers (silos) inherent in process-driven organizations (see note 4). The methodology categorizes defects based upon the physical and process attributes of failure to measure quality and reliability contiguously across the product lifecycle.

COMMUNICATIONS AND EXPECTATIONS

Figure 1 presents the EbS model for organizational maturity. The product development cycle is redefined as a simple closed loop system. Purposefully defined value metrics are key to achieve long-term performance, quality, and reliability goals. Value metrics are defined with parameters that are observable, reachable, and controllable from within the organization.

The Input–Collect external requirements and assume the risks of creating or evolving a product to provide customer value.

The Value Metrics–Provide statistically optimized initial quality and long-term reliability to satisfy the customer and the organization.

- *Customer value* generally relates to time and cost dependent functions to develop products that:
  1. operate in all desired modes of operation,
  2. are easily repaired if failed, and
  3. have replacement parts available and deliverable to a desired location with minimal delay.
- *Organizational value* is provided through controlling the probability of a field escape given corrective decisions made (or not made) during product development.

Product Development—Functional groups operate in parallel during product development. Strategic tools break down the "silos" created by deficiencies attributable to intra-organizational social networks.

Product Improvement Via Correction–Each product team periodically meets to discuss the issues related to product improvement. Objectives include:

1. detect, document, classify, and validate defects,
2. define root cause and corrective action for identified trends,
3. map, then disseminate product and process lessons to their points of escape, and
4. identify the need for strategic tools necessary to 'sew' together the disparate outcomes across functional silos.

Closing the Loop–Product teams independently execute the Corrective process for their given products. The Corrective process, however, is standardized and managed from a central function with goals that are independent from those of Product Development. The loop is closed through a system of three levels of equations.

The first level defines counting processes that normalize defects across the product lifecycle. A second layer combines legacy results with current manufacturing results to:

1. project risk and reliability for new products and,
2. provide measurement of functional capability for the functional processes instantiated to develop products.

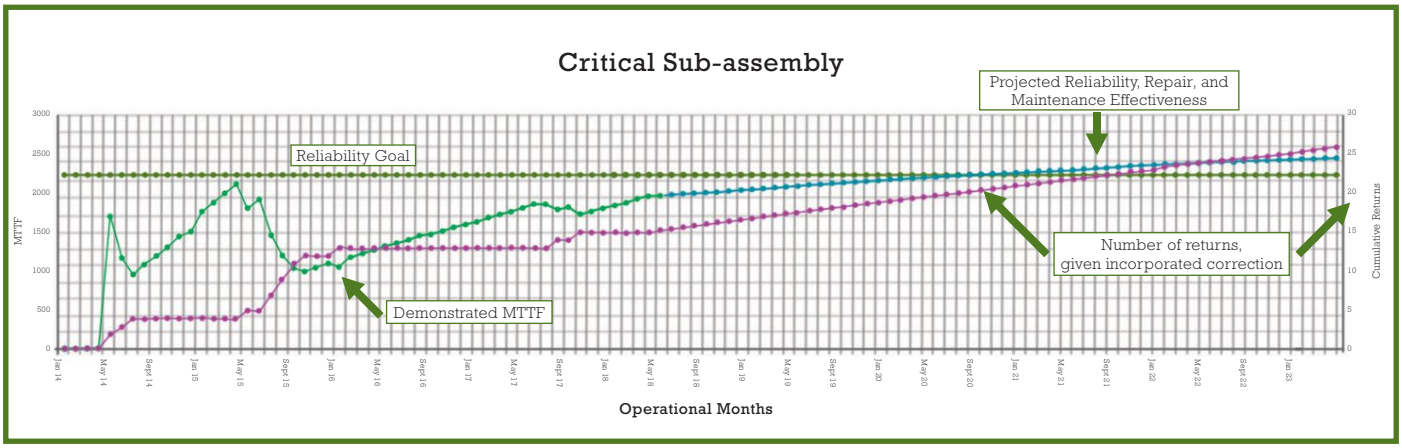


Figure 2: Strategic tool for corrective process

The development of the third layer is on-going. It combines results to form a Bayesian belief network that systematically predicts the probability of a field escape based upon decisions make during design, manufacturing, and field maintenance.

Value Metric Example–Figure 2 shows an example of a value metric, representing a departure from standard reliability growth projections. Non-homogeneous algorithms work in parallel to:

1. track defects based upon failure modes derived from the repair process,
2. mix reliability of the failing defect population with the reliability of modified replacements,
3. quantify the expected sub-population size via binomial sampling, and
4. project operational hours into the future.

Proprietary parameters enable quality and reliability to be controlled via corrections incorporated at the lowest levels of assembly. Results are then automatically rolled-up across sub-assemblies to project product improvement over time.

Strategic Tools–Strategic tools provide automated data entry, analysis, and results reporting. Thus, providing alignment of core competencies and requirements for functional training (see note 5). At completion, each employee can quantify the contribution its function brings to the organization based upon that function's ability to learn and prevent defects from escaping to the customer.

CORRECTIVE AND PREVENTIVE TOOLS EMERGE FROM THE CORRECTIVE PROCESS.

Corrective Tools–Provide the product team with four attributes of value:

1. to perform "what if" testing to control/optimize value metrics for their product,
2. feed lessons back to the organization's processes via a mapping of defects to the Organization's process tree.
3. define requirements for Preventive tools.
4. utilize observable, reachable, and controllable parameters to know where each product is relative to (a) performance, reliability, and quality; (b) how they got here based upon previous decisions; and (c) where they will be based upon future decisions.

Tool	Description
Risk Planning	Identify, document, and mitigate product support risks. Includes new design configurations, materials, component technologies, and manufacturing processes.
Product Support Optimization	Algorithmically optimize desired reliability against built-in versus manual fault isolation.
Durability Analysis	Identify failure mechanisms that products are most susceptible to, develop life models, equate cycle-based to time-based life models of reliability.
Acceptance Test Design	Integrate durability results with available test data to quantify reliability risk against goals.
Lessons Learned	Quantify functional capability related to allowed escapes versus continuous improvement.

Table 1: Preventive strategic tools

Preventive Tools—A stated objective of the corrective process is to drive previously identified risk out of product development and dissolve functional silos. Table 1 provides examples of tools developed to integrate functions associated with product support, design, and manufacturing across the product lifecycle.

CONCLUSION

A structured model is presented that has two paths. The development path creates products while a corrective path improves the products and processes instantiated to develop those products. Value metrics are defined with parameters tied to the capability of the organization's functional groups. Control groups manage corrective action to completion while strategic tools dissolve functional silos. Preventive and corrective tools measure each function's capability to learn and correct functional deficiencies. The closed-loop process enables individual participation with contributions measurable at the product and functional levels within the organization. ◆

NOTES

1. Bill Winkel, Payam Motabar, "The Emergence of Evidence-based Product Support," July 25, 2018, DoD Industry Working Group, PowerPoint presentation. Presentation available upon request.
2. John P. Kotter, "Leading Change: Why Transformation Efforts Fail," *Harvard Business Review*, May-June 1995: pages 1-14.
3. "Product support" is defined as functional core competencies related to quality, reliability, maintainability, logistics, and safety.
4. A "silo" is defined as a social boundary that stifles communication between two or more functional groups. They are inherent in cost and schedule constrained product development activities.
5. Strategic tools are those developed internally to provide proprietary functions not provided by the commercially available third-party tools.

William B. Winkel, B.S. electrical engineering, M.S. reliability engineering, has over thirty years of experience in the field of evidence-based engineering and corrective processes. The experience has spanned multiple industries to include automotive, commercial, and national defense. He provides consulting services to companies seeking to enhance and implement strategies to ensure and quantify success. For more information, visit **www.ebo-co.com** or email william.winkel@ebo-co.com.

Anodizing Aluminum Cylinders

An economical approach to resolving surface finishing challenges

Flex-Hone Tools can address surface roughness and increased dimensional changed for anodized cylinders.

By Jeff Elliott

Flexible hones address surface roughness and increased dimensional changes for anodized cylinders that mate with other parts.

To permit the use of aluminum instead of other, heavier metals in industrial applications, many cylinders are anodized to create an extremely hard surface that is wear-resistant, corrosion resistant, non-conductive and lubricious. Because anodized surfaces are porous, they also improve adhesion of coatings as well as accept a variety of dyes for coloring.

THE ANODIZING PROCESS

Given the myriad of benefits, anodizing is popular for a variety of cylindrical items including lift mechanisms for chairs, lift cylinders for hatchbacks, shock absorbers and forks for bicycles, fuel pumps, water pumps, pneumatic and hydraulic cylinders, spool valves, valve stems and valve bodies.

By definition, however, the anodizing process means the parts grow dimensionally and increase in surface roughness.

For a cylinder, that includes both an increase to the outer diameter (OD) and decreases to the inner diameter (ID). There are several different types of anodizing methods, and each type or class reflects a range of coating thicknesses. As a rule, thicker coatings provide greater corrosion protection and, in harsh environments like salt air, this means longer-lasting surfaces.

As for surface finish, generally a hardcoat that is anodized to a .002 thickness will result in a Ra that is two to three times the original bare metal finish. For example, a machined Ra of 16 can easily become 30 Ra or more after anodizing.

For many parts, this is not an issue. However, when the part is cylindrical and mates with another part, often using a seal, increased dimensions and rougher surface finish can be problematic.

Anodic coatings are very hard (only slightly less than diamond and harder than hard chrome plating) and increased surface roughness can abrade sealing materials. Seal wear and coating irregularities can provide a path for leaks.

For this reason, parts require a fine surface finish for reliable sealing and long component life. To accomplish this, many are utilizing honing tools as an economical approach to treating the surface before or after the electrochemical process to control the dimensions and create a smoother surface.

The result is a cost-effective approach to resolving finishing challenges in the anodizing process to consistently yield high-quality products at a competitive price.

HONING TOOLS

Traditionally, manufacturers have used grinding, lapping, and rigid honing to improve the surface finish of anodized and hard-coat anodized parts. Machine setups are difficult, however, and they must be extremely precise. There are several reasons for this. First, the anodized coating is very hard. Second, the total coating thickness is very thin. Third, the high points and low points of the anodized coating are not absolutely symmetrical around the centerline of the cylinder ID.

When rigid honing is used with anodized parts, the honing stones only contact the coating's high points. In other words, parts of the cylinder ID remain untouched.

There are other issues with rigid honing, too. Because anodized coatings are relatively thin, only a very small amount of material should be removed. Yet rigid honing works best with heavier cuts and greater material removal. Fine cuts combined with tool loading can contributed to smeared surfaces.

THE FLEX-HONE TOOL

The Flex-Hone Tool from Brush Research Manufacturing (Los Angeles, California) provides a better way to improve the surface finish of anodized and hard-coated cylinders.

With its unique construction, the Flex-Hone® is comprised of abrasive globules that are permanently laminated onto the ends of flexible nylon filaments. Because the diameter of the tool is greater than diameter of the bore, the Flex-Hone is used in an oversized condition and is self-centering, self-aligning, and self-compensating for wear.

Importantly, the Flex-Hone tool's abrasive globules "float" to ensure that all parts of the bore—and not just the high spots—are surface finished. Unlike rigid honing machines, Flex-Hone setups are simple, too. Surface finishes can be improved with just a few strokes of the tool and the results are consistent.

The Flex-Hone Tools can be used prior to anodizing to control the size in anticipation of the shrinkage in ID. Honing also removes "fuzz," sharp edges and any amorphous material that might adhere to the surface and affect the quality of the anodizing.

The most common usage for the honing tool, however, is after anodizing to correct unanticipated size and surface finish issues. When the quality of the final anodized finish is of the utmost importance, some even use the tool before and after.

With anodized coatings, the recommended abrasive types are aluminum oxide (400, 600, or 800 grits) and levigated alumina (extra fine only). Choice of grit depends on the type and thickness of the anodized coating and the final surface-finish specification. Flexible honing tools are available in sizes ranging from 4 millimeters to 36 inches. ◆

Jeff Elliott is a Torrance, California, based technical writer. He has researched and written about industrial technologies and issues for the past twenty years. Brush Research Manufacturing is a privately-owned company located in Los Angeles, California, solving difficult finishing problems with brushing technology since 1958. Brush Research was one of the first companies to advocate the critical need for finer surface finishes to optimize performance. Concepts such as plateau finishing were pioneered by our founder, Steve Rands, and are now commonplace goals across many industries. For more information, call 323.261.2193, email info@brushresearch.com, or visit **www.brushresearch.com**.

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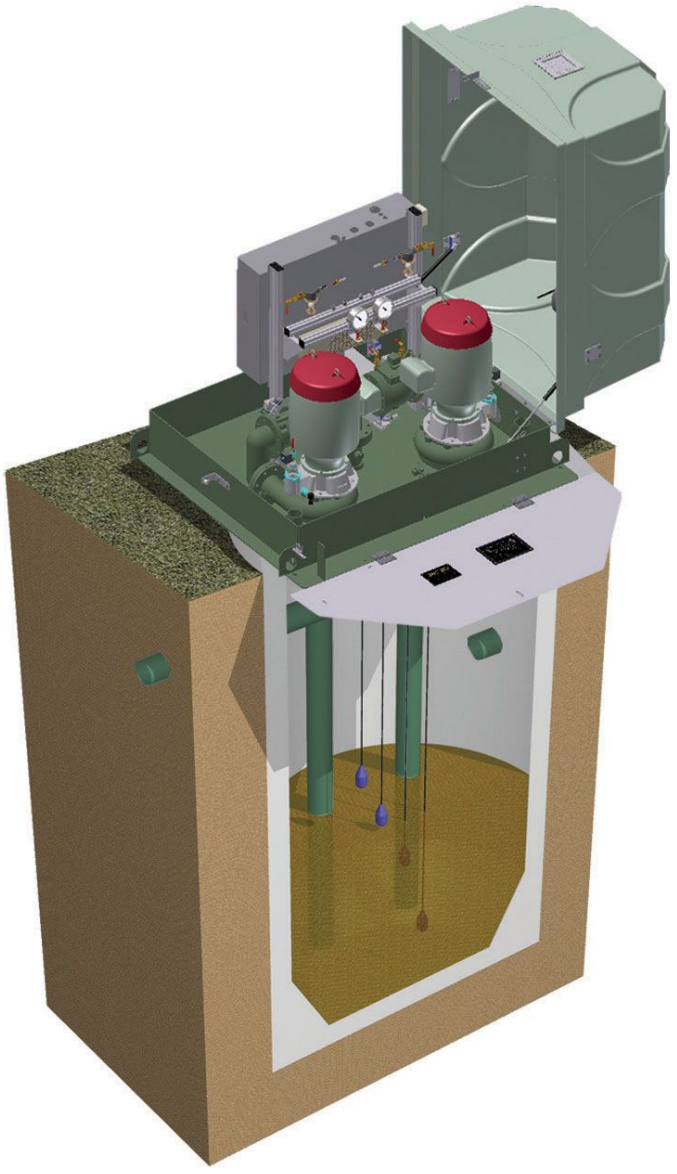


With all pumping equipment, valves, and controls immediately accessible at ground level, these systems are more convenient and cost-effective to operate than traditional submersible pumps. These packaged stations arrive pre-assembled with all equipment installed on a common base and a quick-access enclosure, allowing quick and easy installation on the wet well after basic suction pipe and electrical connections were completed.

Immediate and safe ground-level access to the pumping equipment means these systems significantly reduce the time and personnel required to perform regular O&M. Confined space entry and associated requirements are virtually eliminated, including permitting, harnesses, gas monitoring equipment, and other OSHA and Class 1 Division 1 requirements.

Routine tasks like pulling a pump to change a seal or impeller can be completed in minutes by a single operator, without the use of outside contractors or pricey pump maintenance centers. This contributes significantly to lower S&L EVERLAST® parts and O&M costs when compared to submersibles—documented as much as 50-plus percent—and long service life.

Naturally, operating a pumping system above the liquid level requires priming assistance. There are a variety of ways this can be achieved—including via liquid or compressed air assistance—but S&L's EVERLAST® sets itself apart from other "self-primers" with a proprietary vacuum-priming system that is more energy-efficient, safe, and serviceable.

For more information, visit www.smithandloveless.com.

GEMS SENSORS AND CONTROLS

1200/1600 Series Sensor

The 1200/1600 Series sensor is uniquely designed for improved performance under wide operating temperatures offering 0.5 percent accuracy and 2.0 percent thermal error over Full Scale (Typical). The 1200/1600 product line offers eight electrical connectors and 11 pressure port options for flexibility to meet installation requirements. The multiple electrical connections and pressure ports enables customers with complex systems to reduce lengthy design changes. In addition to meeting IP30 and IP65, Gems 1200/1600 Series meets IP67 for outdoor use reducing customer worry about moisture ingress in tough environments. For more information, visit **www.gemssensors.com**.

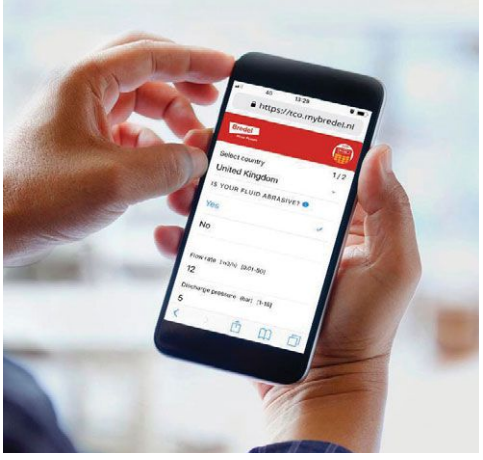
ENERPAC

XC-Series Cordless Torque Wrench Pump

Enerpac introduces its new XC-Series Cordless Torque Wrench Pump that is ideal for maintenance applications in the power generation, oil and gas, and MRO markets. This portable pump is ideal for remote locations, sites that do not have access to power, or where having electric cords could cause trip hazards. The XC-Series Cordless Torque Wrench Pump features an interactive pendant that can be operated in manual or auto-cycle mode. For more information, visit **www.enerpac.com**.

WATSON-MARLOW FLUID TECHNOLOGY GROUP

Bredel TCO Calculator



Designed for use on a mobile device, the Bredel TCO calculator is easy to operate. Users simply enter the necessary parameters including the flow rate and pressure; and whether you are using or considering AODD or PC pumps for that duty. Once the essential information is entered, the user will be given a direct comparison to show which model and size of Bredel pump will deliver optimal pumping and cost savings. The Bredel team anticipates that users will be surprised at the level of operational savings shown by the TCO calculator in abrasive pumping applications. For more information, visit **www.wmftg.com**.

NETZSCH PUMPS AND SYSTEMS

xLC® Stator Adjustment System

The xLC® unit triples the service life of the pump, particularly when conveying difficult, abrasive media. When wear occurs in the rotor-stator system, the new xLC® unit allows the performance of the pump to be re-established by adjusting the preload between the conveyor elements. It is important for the xLC® stator adjustment system that the elastomer in the rigid metal sleeve of the stator is flexible, which was made possible with the development of the proven iFD stator® 2.0. For more information, visit **www.netzsch.com**.

ALLWEILER

IN-1000 Pump Condition Monitoring Device

Allweiler, a CIRCOR International brand, and a worldwide supplier of pumping solutions for chemical engineering applications, announces the IN-1000 condition monitoring device, ideal for pumps in operationally critical and environmentally sensitive chemical engineering applications. With one master and up to ten satellite modules per network, the IN-1000 lets operators monitor as many as eleven pumps at once. Built-in features include a two-level warning and alarm system, logging of sensor data, and remote monitoring with a smartphone app. The IN-1000 is available with ATEX certification for use in EX zones. For more information, visit www.circorpt.com/industrial-smart-technology-in1000.

AVT RELIABILITY

Machine Sentry® MSF-1

Plant reliability specialist AVT Reliability® launches the latest in its new suite of intelligent condition-based monitoring and maintenance (CBM) products—the wireless Machine Sentry® MSF-1 tri-axial vibration and temperature sensor. The MSF-1 constitutes another significant advancement in the field of digital CBM, offering improved visibility, safety, speed of data transfer, and environmental sustainability. The sensor incorporates full tri-axial vibration measurement and automatic fault diagnosis assistance (ADA) to identify potential problems and enable pre-emptive action. For more information, www.avtreliability.com.

MIDWESTERN INDUSTRIES, INC.

Electro-Lift Separator Screen Changing System

Midwestern Industries, Inc. launches their operator-friendly Electro-Lift separator screen changing system. The revolutionary, ergonomically designed lift system is electrically powered to assist in making separator screen changes easier, faster, and safer. Engineered with a 120 volt sealed gear-driven system, operation is as simple as plugging into any convenient outlet and pressing a switch. Quality built and engineered in the USA, Midwestern's Electro-Lift is adaptable to fit a variety of different frame deck configurations. For more information, visit **www.midwesternind.com/electro-lift**.

BIONOMIC INDUSTRIES INC.

Series 6000 Tray Scrubber

Bionomic Industries Inc. announces availability of their advanced Series 6000 Tray Scrubber. Available in sizes to handle gas volumes from 500 to 150,000 cfm, the Series 6000 utilizes special high-performance tray designs in single or multiple stages to achieve maximum gas absorption using once through water at extremely low rates to absorb and concentrate product in one easy step, without the need for recirculation pumps. This once through water flow pattern also enables recovery of higher vapor pressure concentrated solutions for reuse in the process. For more information, call 201.529.1094, email sales@bionomicind.com, or visit **www.bionomicind.com**.

TRANSDUCERS USA
Tonelight™ Alarm

Transducers USA, a leading supplier of audible signal devices, announces the addition of a plastic warning indicator to its Tonelight™ Series. This panel-mounted device is ideal for use as a warning indicator, which delivers both an audible and visual warning signal, especially helpful when a large amount of ambient noise is present. The unique feature of the TRIP-LB200P Tonelight Model is the independent control of the two indicators. A PLC pulses the flashing LEDs and the beeping frequency of each circuit independently. For more information, visit www.tusainc.com.

EDDYFI TECHNOLOGIES
M2M Capture

Eddyfi Technologies announces the latest release of M2M Capture. Natively embedded on both M2M Gekko and M2M Mantis PAUT flaw detectors, Capture v2.3 offers new advanced features and dedicated tools to improve the user experience and speed up NDT inspection. Released twice a year, Capture software is an evolutive platform combining state-of-the art technologies and highly intuitive interface to answer new market challenges. On this latest upgrade, M2M introduces significant improvements required by customers. For more information, visit www.eddyfitechnologies.com.

GRUNDFOS
TPE3 In-Line Pump

Designed to significantly advance pumping systems for commercial buildings, Grundfos introduces a state-of-the-art TPE3 in-line pump that features best-in-class technologies that deliver greater efficiency for heating and cooling applications. The newest addition to Grundfos's portfolio of intelligent pumping solutions, the TPE3 showcases a permanent magnet motor, leading-edge hydraulic efficiencies, a series of advanced control modes, multi-pump functionality, and easy install, monitoring, and commissioning that boost system efficiency, and deliver overall greater heating and cooling performance. For more information, visit www.grundfos.us.

MIKI PULLEY
CSZ Electromagnetic Clutches

Miki Pulley's CSZ Electromagnetic Clutches have a zero backlash design. They provide an efficient connection between a motor and a load with low inertia, minimal drag, and zero backlash. Miki Pulley CSZ Clutches function utilizing the magnetic force generated by the energized coil providing engagement of input and output members of the clutch. For more information, call Jon Davidson at 800.533.1731 or email jdavidson@mikipulley-us.com.

The Rise of Industrial IoT

F&S's Prem Shanmugam sees predictive inspection models spreading across several industries

Frost & Sullivan's recent analysis, "Global Non-destructive Testing Inspection Services Market: Forecast to 2022," identifies key growth opportunities while detailing the challenges and threats. The report finds growth and revenue opportunities emerge from the advent of new business models, as well as mergers and acquisition activity, and covers the technology segments of ultrasonic, radiography, electromagnetic, visual inspection, and penetrant test. Below, Prem Shanmugam, senior consultant for measurement and instrumentation at Frost & Sullivan, shares some of the insights gained from F&S's latest forecast.

MPT: ***How would you assess the general state of the non-destructive test inspection services market?***

Prem Shanmugam: Rebounding from a two-year slump, the non-destructive test (NDT) inspection services market is undergoing an overall transformation. The convergence of various technologies such as Big Data, predictive analytics, digital twin, cloud computing, and smart factories is enhancing growth opportunities in the market, giving rise to several new business models. Vendors are making concerted efforts to convert Big Data to smart data and shift the market from the traditional time-people business model to more proactive performance-based business models.

MPT: ***What changes has the push toward Big Data brought? Are these transformational technologies?***

Prem Shanmugam: Industrial Internet of Things (IIoT) and Artificial Intelligence (AI)-based NDT capabilities are altering market structures and driving the transformation of traditional business models. Automation companies are increasingly repositioning themselves as service providers, while sensorization and predictive analytics have enabled vendors to develop innovative business models.

This evolving market ecosystem will encourage numerous mergers and acquisitions as NDT inspection service companies look to broaden their capabilities in areas such as online monitoring, robotics, and predictive analytics. The convergence of dimensional metrology with NDT applications will help create a competitive advantage for NDT vendors by allowing them to expand beyond their core capabilities. For instance, technology synergies will enable vendors to use 3D portable laser scanners to scan pipeline corrosion.

MPT: ***Is the rise in smart technologies a response to the "brain drain" in industrial engineering? A demand of the market? Or a bit of both?***

Prem Shanmugam: Another significant benefit of applying technologies such as connectivity, cloud, and advanced analytics is that it mitigates the challenge of a shrinking pool of experienced and qualified NDT technicians. There are also additional revenue opportunities to be gained by leveraging cutting-edge technologies, such as AI-powered industrial robots in inspection and material handling and intelligent algorithms for processing huge amounts of data in real time.

MPT: ***What innovations or new techniques can you foresee becoming more widely adapted?***

Prem Shanmugam: We can also expect drones to inspect components and repair damaged components in the wind energy sector. The results will be automatically analyzed using fuzzy logic and neural networks. Also, mechanical follow-up tools can ensure adherence to the structure of the actual part or new advanced technologies such as CT 3D X-rays. The combined synergies of NDT inspection services with online monitoring solutions will be similar to condition monitoring and other ICT and advanced analytics. ◆

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