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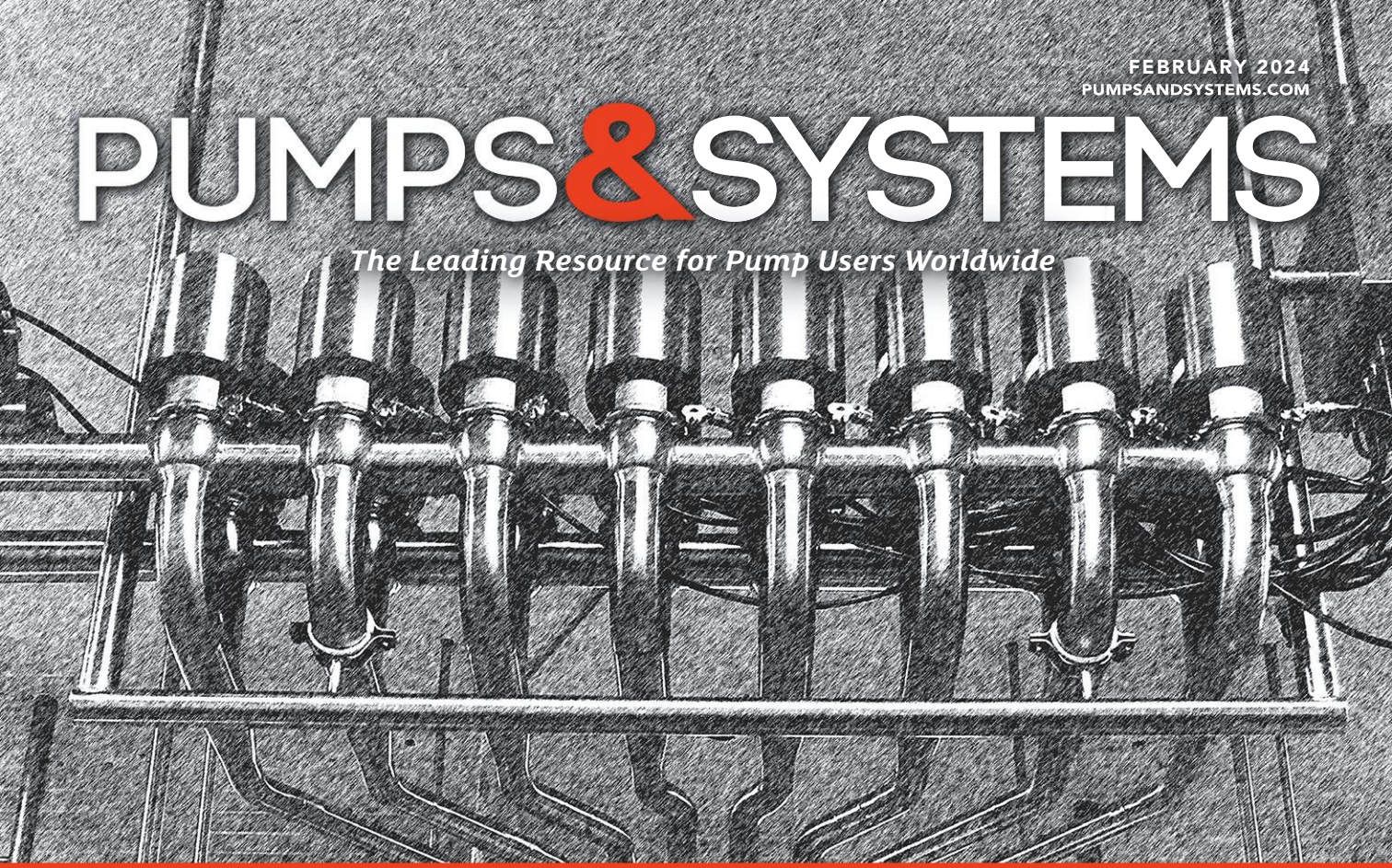

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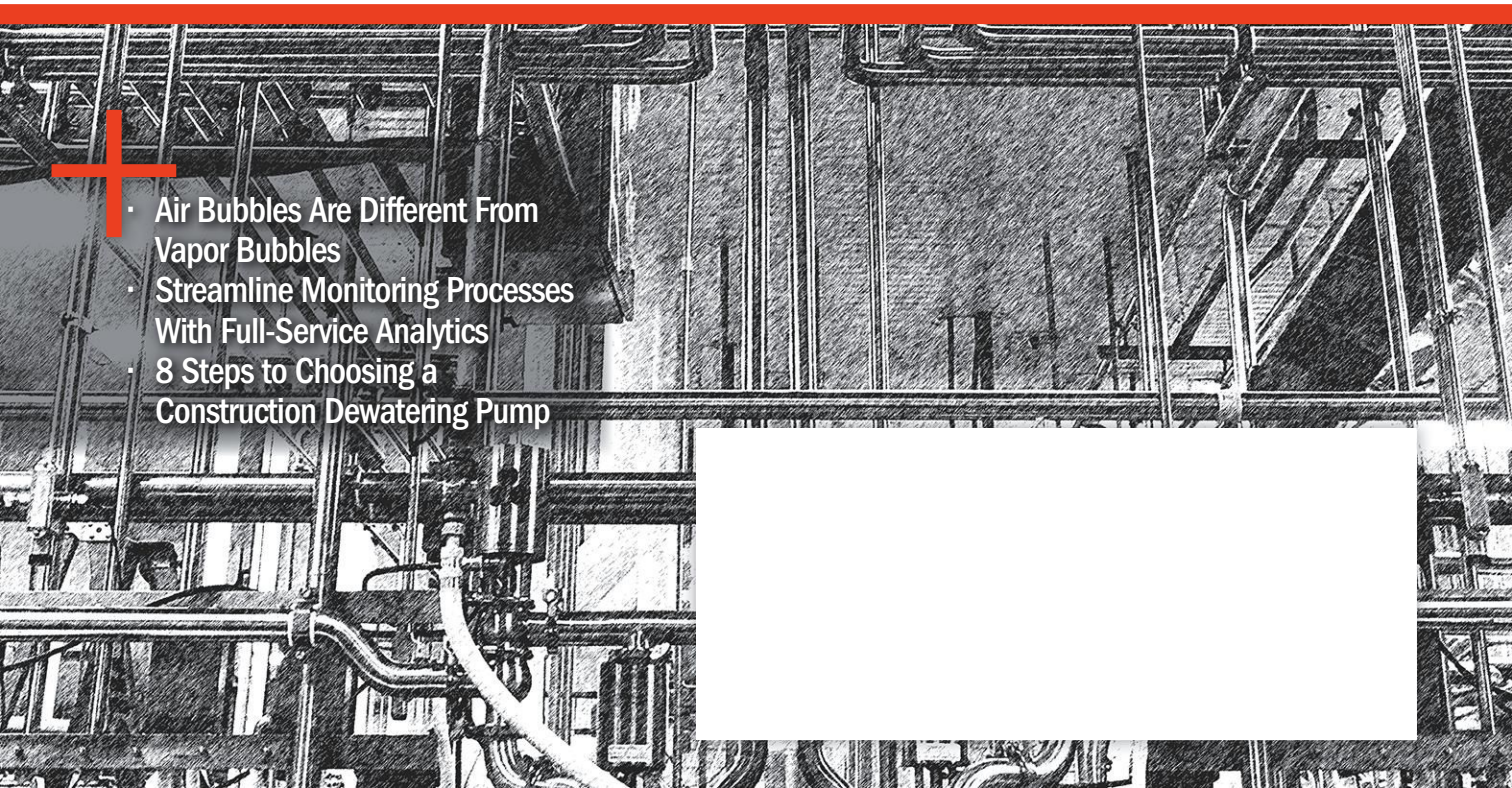

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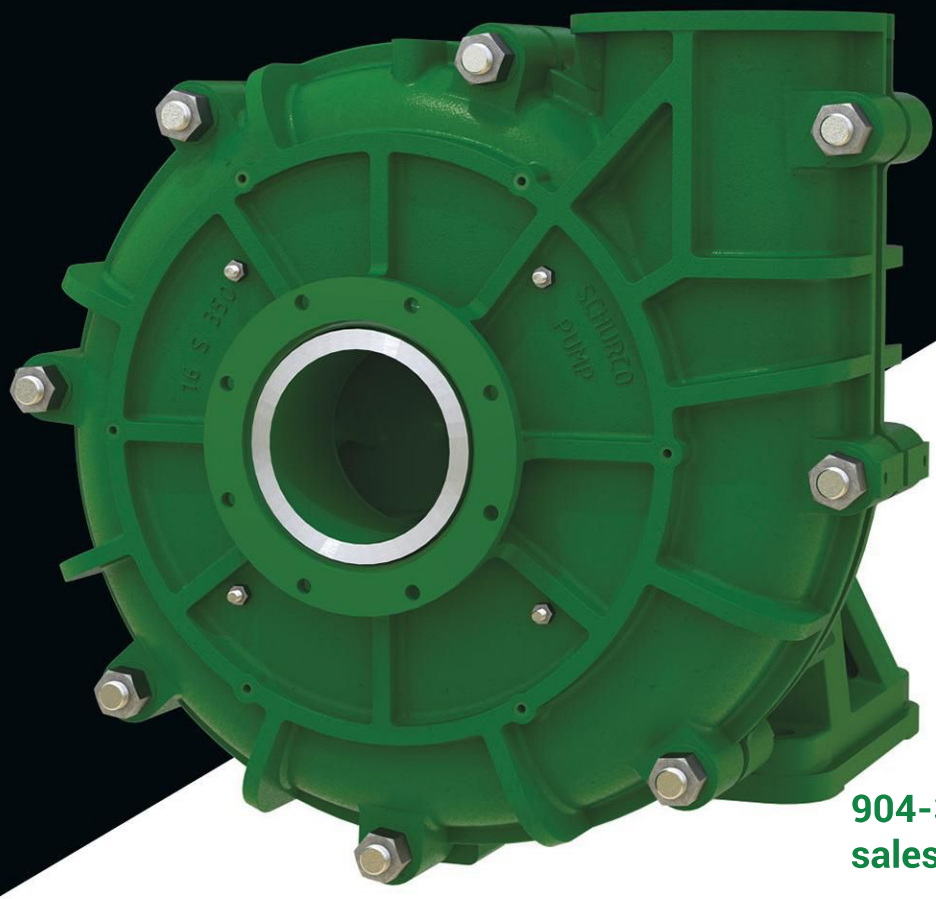

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SCHURCO SLURRY

As consumers, we don't often think about the processes our food and beverages go through before reaching grocery store aisles. However, most of us have an underlying trust that the products we buy were made safely for our consumption.

In December, 2,000 cases of Sprite, Diet Coke and Fanta were recalled across Alabama, Florida and Mississippi due to potential contamination. For the Diet Coke lovers on our team based in Alabama, this news caused a bit of panic as everyone checked to see if the cans they had been drinking were part of the affected batch. When recalls like this do happen, it can impact the trust a consumer has in the company providing their favorite products.

Our cover series this issue—starting on page 22—focuses on the importance of safety and quality assurance in several aspects of the food and beverage industry and how a lack of these critical components can damage a brand's reputation. Read more on how direct steam injection, hydraulic systems and predictive/preventive maintenance in heat exchangers can improve your processes.

Later this month (Feb. 25-29), the Hydraulic Institute Annual Conference will be held in Ponte Vedra Beach, Florida. The event will have over 25 technical committees, a technical tour, an economic update from the ITR firm and more. Editor Amy Hyde and I will be in attendance and look forward to connecting with you there!

Also, be sure to mark your calendars for the SWPA Pumping Systems and Controls Training being held April 16-17 in Chicago, Illinois. It will be revamped with new topics and will feature hands-on training and interactive sessions.

As always, thanks for reading.

Melody Manasco, Managing Editor
mmanasco@cahabamedia.com

ON THE COVER
Image courtesy of Rodem

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2024.otcnet.org

AWWA/ACE 2024
June 10-13
Anaheim Convention Center
Anaheim, Calif.
awwa.org/ace

NFPA 2024
June 17-20
Orange County Convention Center
Orlando, Fla.
nfpa.org/events/conference

EASA 2024
June 24-26
Caesars Forum & Harrah's Las Vegas
Las Vegas, Nev.
easa.com

Mergers & Acquisitions

AFT Acquired by **Datacor**
January 2, 2024

Anderson Process Acquired Tighe-Zeman Equipment LLC
January 2, 2024

Franklin Electric Acquired LCA Pump, LLC
January 3, 2024

Crane Company Announced Acquisition of Vian Enterprises, Inc.
January 4, 2024

DXP Enterprises, Inc. Completed Acquisition of Hennesy Mechanical Sales LLC
January 8, 2024

NEIL WHITE,
RUSCO

BROOKSVILLE, Fla. – Rusco and Vu-Flow announced Neal White as their newly appointed president and chief executive officer (CEO). White's appointment brings extensive water quality experience along with expertise in plumbing, water systems and water quality markets, as well as a long history of consistently delivering exceptional results.

With a proven track record of surpassing sales forecasts, increasing profitability, fostering strategic partnerships and exceeding revenue goals, White solidifies his presence in the water filtration industry.

White's background includes over a decade leading multiple business lines and serving as business unit leader/national sales manager at Pentair and most recently as the sales director for North America at Watts Water Technologies. ■
rusco.com

BHAVNESH PATEL, PAUL GUEDES-PINTO & MIKE DINUCCI,
INFINITUM

AUSTIN, Texas – Infinitum announced the expansion of its leadership team. Bhavnesh Patel has been appointed to chief strategy officer, Paulo Guedes-Pinto has been appointed to chief technology officer and Mike DiNucci joins Infinitum as chief revenue officer.

As chief strategy officer, Patel will oversee Infinitum's long-term strategic planning and initiatives. He joined Infinitum in 2019 as vice president of business development and most recently served as senior vice president of sales and marketing. Patel brings more than 20 years of experience in building and leading teams that deliver revenue growth and user loyalty to his new role as chief strategy officer.

As chief technology officer, Guedes-Pinto will oversee Infinitum's research and development and technical operations. He joined Infinitum in 2019 as vice president of technology and brings more than three decades of engineering leadership experience focused on the design and manufacturing of motors and drives to his new role as chief technology officer.

DiNucci joins Infinitum as chief revenue officer, where he will oversee and drive alignment for all revenue generation activities. DiNucci brings to Infinitum nearly three decades of experience helping hyper-growth companies grow and achieve scale. Prior to Infinitum, DiNucci held senior executive positions with electric mobility companies ChargePoint and Xeal Energy, where he specialized in building high-performance, go-to-market teams. ■
goinfinitum.com

CHRIS CLELAND,
MOTION INDUSTRIES, INC.

BIRMINGHAM, Ala. – Motion Industries, Inc. named Chris Cleland to senior vice president of strategy and markets.

Cleland's career spans over 25 years in consulting, strategy, marketing, branding, e-commerce, business development and transformation. In his previous role as principal consultant at Cummings Creative Group (CCG), he led multiple successful initiatives across several industry verticals, driving growth and innovation for clients—including more than 12 years consulting with Motion on marketing and strategy projects. Prior to his time with CCG, Cleland gained valuable experience as president/owner of LithoSigns and as a sales manager with Citadel Broadcasting.

Cleland will lead the company's strategy development for its business groups, plus the e-commerce and digital teams. He will report to James Howe, Motion's executive vice president–chief commercial officer/chief technology officer. ■
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AROUND THE INDUSTRY

IMAGE 1: The Aquagga team pictured together after their win (Image courtesy of The Water Council)

3 Winners Named for The Water Council's Tech Challenge

MILWAUKEE – The Water Council is pleased to announce the winners of its fall 2023 Tech Challenge, chosen by its leading participating sponsors to help solve real challenges in the water sector.

The Water Council's Tech Challenge connects water innovators with leading water technology companies, facilitating potential partnerships and helping new ideas and technologies gain exposure in the industry. The fall 2023 challenge sought solutions in the areas of per- and polyfluorinated substances (PFAS) detection, PFAS treatment or destruction and non-destructive assessment of pressurized pipes.

Winners were selected from a record number of submissions from eight countries. Two of the winners previously participated in The Water Council's BREW Accelerator programming.

The challenge's sponsors chose the challenge topics and selected the winners to receive $10,000 prizes:

- Aquagga (Washington, USA) was selected for its PFAS destruction technology.
- Searen (Ohio, USA), was selected for its PFAS extraction/concentration technology.
- Pipesonic (based in Canada with a U.S. headquarters in Milwaukee) was selected for its tools that conduct non-invasive assessments of watermains.

Aquagga participated in The Water Council's BREW 2.0 Post-Accelerator in 2022. The program offers virtual and in-person programming for late-stage water technology startups. Pipesonic was launched in June 2023 by alumni of The Water Council's original BREW and BREW 2.0 programs. It recently completed full-scale demonstration projects in Canada and Wisconsin. ■

thewatercouncil.com

DOE Announces Leading Heat Pump Manufacturers Successfully Develop Next-Generation Prototypes to Withstand Subfreezing Weather

WASHINGTON, D.C. – The U.S. Department of Energy (DOE) announced four additional heat pump manufacturers successfully produced heat pump prototypes as part of the Residential Cold Climate Heat Pump (CCHP) Technology Challenge, a DOE initiative to accelerate the deployment of heat pump technologies by supporting innovation and manufacturing.

Launched in 2021, this initiative brings together public and private sector stakeholders to address technical challenges and market barriers to adopting next-generation cold-climate heat pumps—a key clean energy technology that can potentially save households $500 a year or more on their utility bills while also slashing harmful carbon emissions. The challenge specifies prototypes deliver 100% heating capacity without the use of auxiliary heat and with significantly higher efficiencies at 5 F. Through the challenge, the DOE is working together with the industry to accelerate widespread commercialization of efficient cold-climate electric heat pumps, which can provide clean heating and cooling for millions of American families and help meet President Biden's goal of 100% carbon pollution-free electricity by 2035 and a net-zero carbon economy by 2050.

Heating and cooling buildings, homes, offices, schools, hospitals, military bases and other critical facilities contributes to more than 35% of all U.S. energy consumption, driving carbon emissions that fuel climate change, jeopardize public health and pollute local ecosystems. Heat pumps efficiently provide comfortable temperatures for heating and cooling homes and businesses in all climates, especially when homes are well insulated, and can provide more efficient water heating. Unlike heaters that run on natural gas or heating oil, heat pump technology uses only electricity to extract heat from the air to heat and cool buildings and, when compared to gas boilers, heat pumps reduce on-site greenhouse gas emissions by up to 50%.

Bosch, Daikin, Midea and Johnson Controls will join previously announced partners Lennox International, Carrier, Trane Technologies and Rheem in the next phase of the challenge, which is expected to involve the installation and monitoring of more than 23 prototypes in various cold-climate locations throughout the U.S. and Canada over the next year. With eight manufacturing partners successfully passing the laboratory testing stage in the challenge, the DOE is now turning to the nearly 30 state, utility, and other partners that were part of the original challenge commitments to encourage the adoption of CCHPs. The DOE will continue to work with partners to develop programs, incentives, education and outreach campaigns that help consumers better understand the benefits of these new designs. ■

energy.gov

Raghu Kadava

Mechanical Engineer—Pumps and Hydraulics
Black & Veatch

Raghu Kadava is an expert on pumps and hydraulics at Black & Veatch, is a contributing member of the Hydraulic Institute standards committee and has been involved in more than 300 pumping stations in the water, wastewater and stormwater industry in various capacities.

Q | What is your favorite part of the job?

I enjoy solving complex pumping problems. I often feel blessed to be part of a large organization where I have worked on pumping units as large as 17,500 horsepower. I gained a broad range of experience in the water, wastewater and stormwater industry. I have been part of teams that were able to solve several complex water management problems from coast to coast in the United States and several countries overseas.

I also get to travel to pump factories across the world and observe pumps being assembled, inspected and tested.

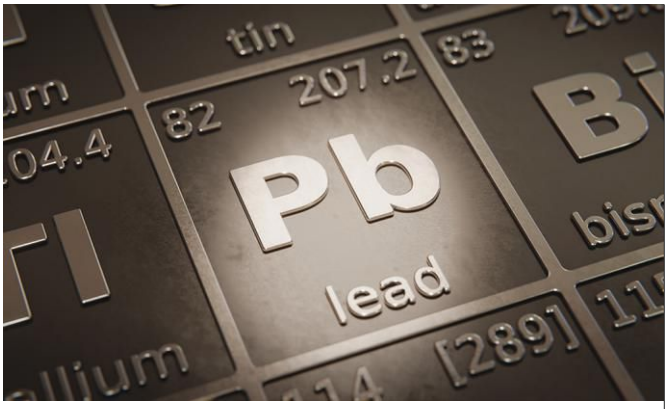
Q | How did you first enter the industry?

My entry into the water and wastewater industry is almost coincidental and only happened because of my wife. At the time (2006), I was working in the automotive industry, and she was an environmental engineer for Black & Veatch working on water treatment projects. Conversations about her projects revealed how passionate she was about her work and inspired me to pursue a career in water treatment.

Fluid mechanics was the primary focus of my master's degree, so I decided to make a career change and took a position as a mechanical engineer for Black & Veatch working on pumping systems. Within my first year, I was exposed to transient analysis, pump station design and surge mitigation systems. I continue to be fascinated with pumping and hydraulics and have enjoyed the same passion for work that my wife had those many years ago.

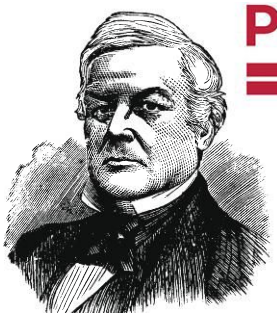
Q | What is your advice to college students or young professionals new to the industry?

Stay curious, ask questions, seek answers and find ways to one-up yourself. Make a difference.



The Environmental Protection Agency (EPA) has announced the Get the Lead Out (GLO) Initiative, funded by the Bipartisan Infrastructure Law, to help ensure safer drinking water. The EPA will partner with 200 underserved communities nationwide to provide assistance needed to identify lead service lines, develop replacement plans and apply for funding to get the lead out.

For the first time in 75 years, the California Department of Fish and Wildlife and the Maidu Summit Consortium released beavers into California waters to aid in ecosystem restoration, with hopes they will lead to increased groundwater recharge and increased seasonal water flow.



PRESIDENT'S DAY FEBRUARY 19

President Millard Fillmore is credited with installing the first flushable toilet in the White House in 1853.

Cardinal Elementary School in Arlington, Virginia, unveiled the completion of a stormwater vault under the school's sports field. The vault system can hold more than 4 million gallons of water and will detain water during rainfall before carrying it slowly out into a drainage area. The vault is part of the county's strategy to mitigate the major impacts of flooding.

**Image courtesy of Arlington County*

Now Is the Winter of My Discontent (Air Bubbles Are Different From Vapor Bubbles)

JIM ELSEY | Summit Pump Inc.

I, like Richard III in Shakespeare's classic of the same name, sit here looking out of my (castle) window at the falling snow and brooding over things that make me unhappy. What is it that is so bothersome, you ask? In the last 12 months I have read at least 10 different articles, media posts and white papers on various platforms that are incorrect, or at the very least misleading, because they conflate the pump problems of air entrainment bubbles with those of vapor bubbles due to cavitation. When I was a young farm kid and things didn't line up the way I thought they should, my grandma used to say that "cats ain't dogs," and now here I am saying "air bubbles ain't vapor bubbles." They are related but not the same thing. This winter, I feel compelled to use my columnist pulpit and attempt to correct this pervasive wrong.

For this column, we will assume the pumped liquid is water at ambient temperature, the water is incompressible and air bubbles are synonymous with gas bubbles. Also a warning that some statements will be repeated for effect.

Air Entrainment Cause & Effect

I have written several columns regarding air entrainment—how it happens, the deleterious effects it has on pump performance and how to avoid the issue. Please see the reference list at the end of the column for more information. Air and non-condensable gas bubbles are both technically gas bubbles, but they are not vapor bubbles. Dissolved air, air bubbles and/or air entrainment will cause a measurable drop in pump performance and at a certain percentage level will cause pump performance issues and damage due to the associated vibrations and mechanical shocks.

Cavitation will also cause an increase in pump noise and vibration, but more importantly a drop in performance, efficiency and impeller erosion—especially as you move right on the pump curve. Not all of the damage from cavitation is metal loss or metal damage. More often the issue is shortened bearing and mechanical seal life due to the unsteady flows and mechanical shock from the resultant surging.

Air Entrainment Disguised

Often, operators believe that a pump problem is cavitation when the real culprit is air entrainment. The opposite problem can also happen. Like diagnosing some diseases in the medical field, the process of eliminating all the other reasons that could be the answer is how the conclusion is formed. If you look at the components that make up the formula for net positive suction head available (NPSHa), you can determine action steps to potentially reduce the effects. For example, if you raise the static suction head or cool the liquid it should reduce the effects, or if you slow the pump down and/or throttle back on the discharge, the symptoms should be reduced. But with air entrainment, all of these checking for cavitation tricks will have almost no effect at all. Refer to my November 2021 column "12 Ways to Mitigate the Cavitation Blues" for more details.

Boiling Water 101

If you boil a pan of water on the stove and observe the initial formation of bubbles, know that these are most likely air bubbles coming out of solution and are comprised of nitrogen, oxygen and perhaps a trace of argon and carbon dioxide. As you continue boiling the water more aggressively, most of those bubbles will be vapor bubbles. A common mistake is to think that vapor bubbles are made of separate hydrogen and oxygen atoms. When water boils, it changes phase, but the bonds between the atoms don't break, so the vapor is water vapor (H2O in the gas state). There may be some oxygen in the bubbles, but it comes from dissolved air that was trapped in the water. There is no oxygen or hydrogen gas produced by splitting water molecules because that process does not occur in this example.

Where Do the Air Bubbles Come From?

The air bubbles are introduced, not created. Air bubbles in the water stream come from the surrounding air introduced further upstream in the suction side of the system/process and are dissolved, entrained and trapped in the liquid (see references for details). The air/gas bubbles were not created within the boundaries of the system; they were externally introduced—granted, some high velocity pipe induced agitation or impeller action may assist in the process. Regardless, the presence of air bubbles is not due to cavitation, and they are not due to a change of state in the liquid (phase change).

I will state that some processes actually introduce air on purpose, but the problems experienced in the field are often from accidental and unintended introduction. Some closed loop systems by their nature

will have air/gas come out of solution, and sometimes chemical additives in the water will exacerbate the issue. For the technical-minded reader, please note it is not my intent to delve into dual phase liquids and subsequent causes of liquid to gas separation. Remember and understand that centrifugal pumps are not designed to be compressors.

Water

Water is a distinctive compound with some unique properties. For example, name another liquid that expands when it freezes and explain why ice will float. The chemical bonds that hold the molecule together are technically covalent but could appear as ionic to the casual observer. To add another complex variable to the energy equation, you can add in the hydrogen bonds and the separate bonds that hold the entire molecule with the others (water molecules often form pairs of four). I mention these bonds that hold the hydrogen and oxygen atoms and molecules together because they are very strong and it takes a lot of energy to break them apart. If you could break the water bonds apart by simply pumping the liquid (you cannot), the commercial costs of producing oxygen and hydrogen gases would be world changing for the gas producers (note the tone of sarcasm).

How Do I Know There Is Air?

Testing for air entrainment is a simple and straightforward process that requires an entrained air gas tester (EGT) and basic sampling procedures. The EGT relies on the basic pressure-volume gas (PV) relationship (Boyle's law) and operator supplied compression to make the calculation. These tests are fairly accurate.

A simple check (go-no-go test) for the presence of air or other non-condensable gases is to use a clear beaker to collect the sample and simply observe for air bubbles. This test will not reveal the actual quantitative percentage of air/gases.

Classic Cavitation

From the perspective of centrifugal pumps, classic cavitation simply defined is the formation of vapor bubbles in the pump inlet, near the eye of the impeller. The vapor bubbles form because the local pressure has dropped below the vapor pressure of the fluid. Less than a fractional second later, as the bubbles transit along the low-pressure side of the impeller vanes, they enter a region of higher pressure and collapse as a result. I refer to this as classic cavitation to differentiate it from other causes of cavitation, such as suction or discharge recirculation that manifests on the other side of the impeller vane. Note there were no air bubbles present; this process is a phase change (liquid to gas).

> When I was a young farm kid and things didn't line up the way I thought they should, my grandma used to say that 'cats ain't dogs,' and now here I am saying 'air bubbles ain't vapor bubbles.'

The Difference In Energy Levels

When an air bubble collapses, there is little to no energy required or released in the process. Cavitation bubbles collapse with a high amount of energy. Cavitation bubbles that break down in the middle of the impeller passageway collapse symmetrically (equally from all directions), and so there is less cause for concern other than potential noise and perhaps some vibration.

However, when the vapor bubbles in a pump impeller collapse adjacent to the metal surface of the vane, there is a much higher potential for damage and concern due to metal loss from the substrate. When the bubble collapses near the vane surface, it will collapse asymmetrically. Because of its proximity to the vane surface, the bubble geometry changes and makes the action more lethal. When the bubble collapses, it is not just the surrounding fluid that rushes in to fill that void.

More importantly, it is that the vapor is changing state from a vapor (back) to a liquid. I repeat for emphasis that the amount of energy transferred for a change of state is very high. You can calculate the energy using enthalpy equations (refer to the heat of vaporization or the enthalpy of vaporization equations). The collapse of a vapor bubble is exponentially more impactful than if it was an air bubble.

I repeat that with vapor bubbles there is a change of state from liquid to vapor and back while an air bubble creation or dissipation does not involve a change of state. Further, when the vapor bubble collapses asymmetrically there is a resulting reentrant micro jet burst that on a local nanoscale level is very powerful (the local scale is 1×10^{-9}, that's 10 to the negative nine exponent or a billionth). Local pressure forces involved in the micro jet burst can have resultant shockwaves higher than 10,000 pounds per square inch gauge (psig). The bubble collapse phenomenon can occur with a high periodicity of 300 times per second, and all of this action happens at the speed of sound. The resultant microburst jet almost always directs itself at the adjacent surface in lieu of the fluid stream. The substrate of the vane material is subjected to a localized surface fatigue failure. The average life span of a vapor bubble from creation to collapse is about 2 to 3 milliseconds.

Not everyone agrees if it is the shockwave or the reentrant micro jet burst that creates the damage—likely it is the combination. Hopefully with this

perspective you begin to understand how cavitation can damage an impeller in short order. On a scientific level, besides the enthalpy equation mentioned earlier, the energy of the bubble collapse is simply a kinetic energy calculation and is a function of the mass and velocity (kinetic energy = 0.5 X mv^2) where m is the mass and v is the velocity.

Vapor bubbles formed in water at ambient temperature are of a much larger size (mass) than if the water temperature was close to and approaching 212 F. The larger the bubble the more energy involved and the more damage incurred. The summary result is that cold water cavitation is much more dangerous than hot water cavitation. Water at 70 F will increase in volume by approximately 54,000 times when vaporized.

Sometimes overlooked in cavitation discussions is the root cause for the vapor bubble evolution, in that pumps do not so much generate heat to make the water flash to vapor, but instead it is the drop in pressure near the impeller eye. Remember you can boil water at 33 F if you can reduce the pressure low enough.

Final Note

Be careful with your choice of words when describing the noise or performance drop of a pump in trouble. Air or gas coming out of solution is totally different than the formation and collapse of vapor bubbles. And cats ain't dogs. ■

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

10 Things Today's Best Practitioners Are Doing to Improve Pump Health

DANIELA GEORGE | Baker Hughes

Over the last 12 months, an energy technology company conducted numerous blind interviews with users. The interviews were done blind for a simple reason: to allow these individuals to speak freely, without the self-censoring that often occurs when a person might say what they think their interviewer wants to hear versus what they need to hear. As such, the professionals being interviewed were given the space to talk at length—up to 60 minutes in most cases—about the problems they were having managing their assets using status quo approaches and what they were already doing (or planning to do) differently.

While there was a diversity of assets, given the diversity of industries, the one asset type that stood out time and again was pumps. Surprisingly, it was not often the most critical pumps in the process that were cumulatively having an impact but rather the garden variety: the ones that could be found by the hundreds or even thousands in many plants. It seems the spotlight is on pumps because there are simply so many of them, and small gains made with each one sum to a substantial cumulative impact—whether good or bad.

Below are ten of the most important insights obtained from these interviews.

1 Turn attention to less critical assets.

The reality is the critical equipment in most plants has been properly instrumented for decades with sophisticated online systems that both protect the asset and allow monitoring of its condition. Gains are not coming through dramatic improvements on this class of assets because most operators are already achieving high levels of reliability. Instead, these operators have turned their attention to less critical assets, namely pumps, realizing there are often thousands of such assets and "many drops create an ocean." A key area for these operators is to look at how much is being spent on maintenance and inspections of less critical assets, examine how many failures are occurring in spite of route-based PDC approaches and go hard after such assets with a different approach. That won't necessarily mean every asset, but it will mean a certain percentage of bad actors and mid-criticality assets.

2 Use—don't lose—your people by deploying them to more fulfilling work.

Strategies that seek to justify expenditures through job elimination rarely succeed. A better strategy is to ask how personnel can be used differently and more efficiently, often through more rewarding tasks. Manually collecting data from every asset in a plant is almost never at the top of anyone's list. Few analysts have the luxury of only examining data, either. They must routinely both collect the data and then interpret it. Many will in turn say the most time-consuming part of the job (aside from collecting the data) is sifting through all of the alarms and constantly optimizing threshold-based alarms for hundreds or thousands of assets. These are areas ripe for digitization and artificial intelligence (AI) to assist people, not replace them. This frees analysts to act on identified issues and focus on legitimate problems to in turn isolate root case.

3 Don't get rid of that portable data collector.

The best companies are using a combination of online and offline for their less critical assets, just as they are using a combination of condition monitoring technologies. Operators are looking across all of their less critical assets and asking which ones can (and should) be converted to online. They are then using the newly freed-up hours to do other things, whether it is collecting data from assets that were previously unaddressed or simply optimizing the condition monitoring program as a whole. The portable data collector can be used to go after assets that were previously too low in priority to balance and align machines and to help diagnose especially difficult problems where supplementary data might be useful. Many of today's providers have platforms that can seamlessly integrate data from multiple sources, including online and offline vibration, while also including things like process data.

4 Use all available technologies.

Vibration is undoubtedly important, but so is lubrication analysis, thermography, motor current analysis, operating deflection shape analysis and motion amplification videography. The best practitioners are embracing all these tools and optimizing their programs to match the technologies to the failure modes and needs of each asset.

5 Leverage digital transformation initiatives.

Converting a program based purely on manual data collection to a program that automates those tasks for a percentage of assets falls squarely into the realm of digital transformation. It is also highly scalable, a key element of digital transformation initiatives looking for enterprise-wide impact.

6 Don't reject the important role of AI.

AI has become a polarizing issue. It is rare to find someone who hasn't had at least one disappointing experience where AI overpromised and underdelivered. Many have a view of AI that assumes it must be extensively trained by mountains of historical data and presided over by data scientists and specialists where constant tuning and adjustment is necessary. While such AI undoubtedly exists, highly effective AI that is forward looking, requires almost no training and is 95% accurate is now the norm when the right provider is chosen.

7 Use AI to empower people, not replace them.

The hype surrounding AI has not helped bring clarity and has instead injected a sense of foreboding with connotations that jobs will be eliminated and humans rendered almost obsolete. The reality is that AI is simply a tool to relieve CM practitioners of tedious tasks, freeing them to focus on less tedious, higher value activities. The best practitioners do not rely exclusively on AI to make machinery decisions. They allow AI to do the grunt work of collecting and analyzing data, flagging anomalies and then delivering those anomalies along with suspected causes and recommended remedies to human specialists who further vet and validate the findings. Then—and only then—do they act on those findings.

8 Convert capital expenditures (capex) to operating expenses (opex) by leveraging subscription-based approaches.

The conventional approach to condition monitoring required the user to own the infrastructure, use the infrastructure and bear all costs associated with it. As a result, this almost always entailed one or more capex projects. The large investments in infrastructure were borne directly by the user, along with substantial risk.

A subscription-based approach circumvents this, and almost everyone interviewed was either actively exploring this or had already done at least a proof-of-concept. This model is highly attractive because it shifts the responsibility for the infrastructure to the provider. It turns large capital outlays into bite-sized opex outlays. It also provides a granularity of expense that is machine-based rather than infrastructure-based, meaning one can think in terms of simply adding another machine at $X per machine—not in terms of sensors, monitors, cables, networks and servers.

9 Use collaborative platforms that enable workflow, not just communication.

If the only goal was communication, email would suffice. But when issues arise, the ability to actually manage workflow becomes important. Is an issue awaiting action from someone? What were the findings? Where is the underlying data? Is the issue urgent or routine? Who has reviewed it and weighed in? Workflow tools provide a proper solution to all of these things, including communication and collaboration across functional boundaries and departments.

10 Keep score to validate initial and ongoing value.

A major issue with many condition monitoring programs is so much time is spent collecting, analyzing and acting that no time is available to keep track of the wins. While it sounds obvious, it is often overlooked, and being unable to show value can jeopardize ongoing viability programs.

Bringing It All Together: The Outcome-Based Model

An outcome-based model embodies many of the insights these user interviews revealed:

- It is a subscription-based approach and turns capex into opex, making the previously unaffordable affordable.
- It puts the burden of infrastructure on the provider, not the user.
- It leverages AI by combining it with human expertise to vet/validate findings before delivering to users to take action.
- It uses online technology to collect data.
- It provides a true workflow environment for notification, communication, collaboration and tracking issues to resolution/closure.
- It shifts the burden of people and skills to the provider.
- It improves the ratio of assets to people.
- It keeps score so management always sees key performance indicators like program return on investment (ROI), number of saves, etc.
- It is highly scalable and lends itself to enterprise-wide implementations, not just single-plant implementations.
- It consistently delivers ROI in excess of 30% and time to value is frequently seven days or less.

Outcome-based models are currently the fastest growing segment of the market. In addition to all of the reasons mentioned, they have the advantage of being both low risk and relatively unobtrusive. Most require nothing more of the user's IT environment than a browser and an internet connection. Sensor installation, network configuration and all other aspects rest with the provider, who is responsible for delivery of validated and vetted machinery insights to the user rather than raw data or even monthly reports. An asset health insight is designed to be actionable by people at site who take the findings, further validate where necessary and work closely with the provider's machinery analyst to address issues. It is not appropriate to think of such offerings as merely condition monitoring as a service, but rather machine health as a service where the deliverable is machine health outcomes—and thus the designation as an outcome-based model. ■

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5 New Year's Resolutions for Your Pumps

AUSTEN SCUDDER | Eaton

Every year, at the stroke of midnight, many of us set in motion our New Year's resolutions. Whether it's getting in better shape, learning something new, getting organized or spending more time with the family, it's natural to think of ourselves. But what about our equipment? While we're taking off for the holidays, our pumps and drives are still hard at work. Let's flip the script and discuss how to apply some classic New Year's resolutions to our drive and pump systems.

1 Eat Healthier

We all know how important a good diet is to our energy and functionality. It's no different if you're chowing down 60 hertz (Hz) of 480 volts (V) for breakfast like many drives do. For them, power quality is going to affect the performance and longevity of your system. You may feel good because you have power reliability and rarely suffer outages; however, voltage sags, phase shifting and harmonics are the processed carbohydrates of the electrical world.

These situations can be difficult to detect, but they are prevalent and destructive to your systems if they go unchecked over time. If you aren't aware of these issues, it may be because you haven't investigated them. Not every issue needs to be resolved, but understanding your power quality environment, risk tolerance and ability to mitigate is part of a healthy electrical diet.

2 Get Organized

Do you know what your installed base of equipment looks like? Do you have a mix of equipment? Are they compatible? Do you have the ability to pull a spare off the shelf in case of failure? Do you know who to call when something goes bump in the night?

Whether it's your on-site maintenance team, a trusted fix-it person or your distributor/supplier's support service, it pays to be prepared. Make sure you have a plan for any critical drive or pump that may fail. You may find you've accumulated a Picasso-like installed base that is impossible to unravel on short notice. If so, consider if it makes sense to standardize over time, keep shelf-spares or talk to your distributor about their preparedness.

3 Be More Productive

Work smarter, not harder. Integrating Internet of Things (IoT) smart solutions should be on your radar. You might think that you must have a premium product, an advanced programmable logic controllers (PLC) system and the support of a controls engineer to tap into the benefits of Industry 4.0. The truth is, there are many opportunities to simply and elegantly incorporate user friendly IoT that enhances productivity. For example, there are mobile apps that will notify you or your team when there are issues, even allowing for troubleshooting halfway across the world. These are often simple, inexpensive, field installable products that save time and drive a productivity mindset.

Additionally, they often collect data that is essential to troubleshooting and speedy resolutions. Being able to look at this data is the first step in a journey to preventative maintenance. Learning what makes your system unique, what it has in common with others and how it behaves in the real world gives you the ability to accelerate and apply productivity enhancements.

4 Spend Less

It's easy to think about system efficiency strictly as the motor-drive rating. Whether you're at IE2, IE3 or IE4, there is only a few percentiles difference in energy usage to be gained. The cost of energy is outpacing these gains, so it's critical to use data to optimize your applications. Product intelligence is consistently underutilized. If you aren't analyzing your systems and leveraging digital tools to monitor and control in real time, you might be paying much more than you realize through your energy provider and missing opportunities to extract additional value from your application. Get savvy with systems and products. Look for providers that can enable you to have access to your data but also offer insights and flexible tools that improve over time.

5 Learn a New Skill

I've worked around drives for over a decade and have seen some pretty harsh applications, as well as a few painful design and component issues. Even more amazing has been how frequently I've seen firmware updates come to the rescue. I know you're thinking, "I don't want to be a test bed," and that's fair. However, there's a difference between being cautious and being outdated. Not only do your products get better, but they'll be more secure as well. Keeping your firmware up to date is a great way to keep your system healthy and secure and even teach an old dog some new tricks.

While I know the average life span of a New Year's resolution is exceptionally short, it's important to remember that it's never too late. Continuous improvement is a challenging and worthy journey to walk. Just like with personal goals, success increases when you share, discuss and even ask for help. Whether it's one of these goals, or something entirely different, take the first and hardest step just by setting one.

Wishing you a happy, healthy and productive new year! ■

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Technology & Reports Help Optimize Operations

Real-time alarms and historical data drive better processes.

CODY P. BANN & DAVID NOLAN |
SmartSights

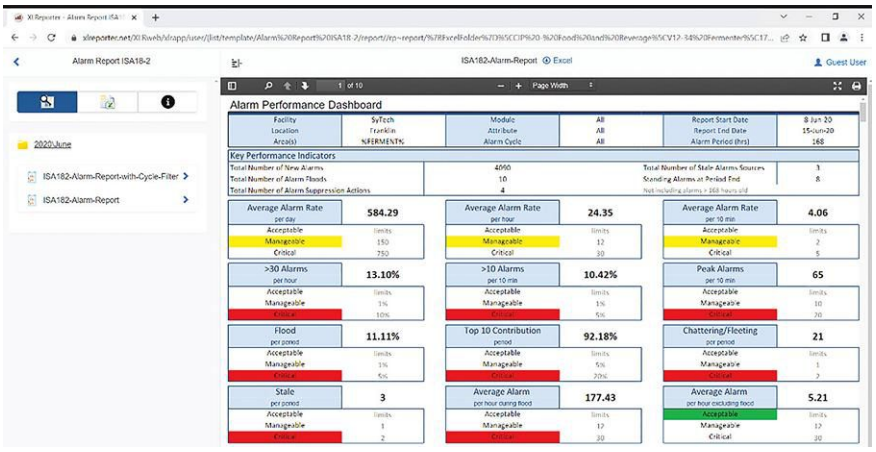

IMAGE 1: Any improvements to an alarm system start by identifying problem areas. Third-party reporting software can provide filters that help reveal the unknown challenges. (Images courtesy of SmartSights)

While digital transformation and industrial Internet of Things (IIoT) may just seem like trending buzz words, the technologies are critical to reducing unplanned downtime and ensuring operations are efficient and competitive. Every industry strives for maximum efficiency, be it manufacturing, oil and gas or water/wastewater. For advanced operations autonomously capturing production data, the days of the clipboard and manual data analysis are gone.

Digital technology and interconnectivity are driving technologies like advanced computing solutions; cloud and remote computing; IoT and connected devices; smart and real-time data sensors; data capture, software analytics and processing; and the adoption of artificial intelligence (AI) and machine learning. To remain competitive—particularly in light of worker shortages—and increase productivity, Industry 4.0 and complementary technology must be embraced.

Operations & Technology

The ultimate goal of adopting modern systems is to have a wholly efficient, possibly even autonomous process that cuts out excess fat, ballooning costs and wasteful operations. Focus should be on end-to-end process improvement, which will, in turn, help shape collaboration within the organization. That means investing in training and education, process automation, related hardware and new tools or software. Continuous operational improvement starts with capturing data from machine assets. This data provides immediate insights for both systems and people, driving automation and enabling better, faster decision making.

Let's take an example of a smart manufacturing plant using data. Characterized by increasing automation and the employment of smart machines and smart factories, informed data helps to produce goods more productively across the value chain. By collecting additional data from the factory floor and combining that with other enterprise operational data, a smart factory can achieve information transparency and make better decisions. Accurate, real-time production data is pivotal to shop floor operations and the effective operation of each machine asset.

Once real-time process information is gathered, the next logical step is to define conditions of concern on those process variables. For example, is an oven too hot or a motor spinning too slowly? Is a tank nearing empty or a pressure too high? Are there issues with the centrifugal pumps drawing liquid? Supervisory control and data acquisition (SCADA) systems provide for such conditions to be defined and tracked, monitoring process variables and surfacing active conditions to human machine interfaces (HMI). These condition-based events and alarms add another level to optimizing the process.

Remote Alarm Notification Software

A key theme of Industry 4.0 and smart operations is greater connectivity—increasing connectivity between devices, industrial networks, physical assets and the cloud. Growing connectivity allows for greater process transparency and the added potential for predictive analytics and sentinel alarm conditions. Smart manufacturing allows potential issues to be addressed before they become problems, but only by extending that connectivity to the people who operate and optimize manufacturing assets. Remote monitoring and alarm management enables operators to take on more proactive, hands-on tasks in the field or on the plant floor without hiring additional staff.

Historization & Analytics

The convergence of advanced technologies and data-driven strategies has ushered in a new era of optimization, where historical data analysis plays a pivotal role in achieving accurate forecasting and scheduling. The ability to harness this data effectively can lead to smarter decision making, improved processes and a competitive edge. Analyzing historical data allows operations management to identify patterns, trends and anomalies that may otherwise go unnoticed. These insights serve as the foundation for creating accurate forecasts and efficient production schedules.

As the past three years have shown,

Metric	Target		As Found	Evaluation
Annunciated alarms per hour per operator console (average)	~6	~12	5.8	Acceptable
Annunciated alarms per 10 minutes per operator console (average)	~1	~2	0.9	Acceptable
Percentage of 10-minute periods containing more than 10 alarms	~<1%		6.20%	Critical
Maximum number of alarms in a 10 minute period	≤10		157	Critical
Percentage of time the alarm system is in a flood condition	~<1%		22.30%	Critical
Percentage contribution of the top 10 most frequent alarms to the overall alarm load	~<1% to 5% maximum		4.70%	Manageable
Quantity of chattering and fleeting alarms	Zero.		132	Critical
Stale alarms	Less than 5 present on any day		2	Acceptable
Annunciated Priority - % of Highest Priority Alarms	~<1%		0.75%	Acceptable
Annunciated Priority - % of High Priority Alarms	~5%		9.19%	Critical
Annunciated Priority - % of Medium Priority Alarms	~15%		15.00%	Manageable
Annunciated Priority - % of Low Priority Alarms	~80%		75.06%	Acceptable

IMAGE 2: Research has shown that a well-managed alarm system results in production efficiency, product quality and operator effectiveness. Alarm prioritization provides a mechanism for placing a qualitative value of importance on an alarm. The priority usually signifies how quickly the operator should respond to an alarm.

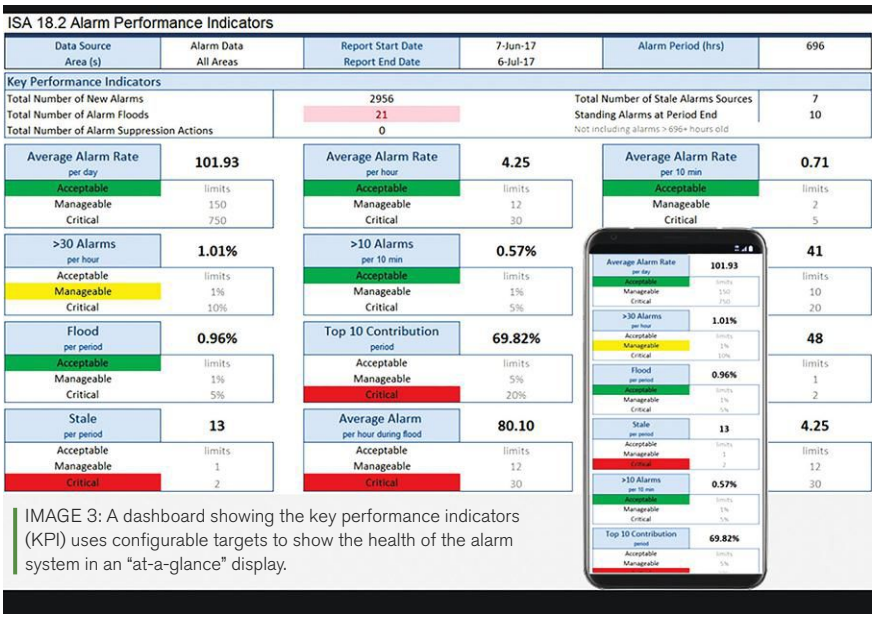

IMAGE 3: A dashboard showing the key performance indicators (KPI) uses configurable targets to show the health of the alarm system in an "at-a-glance" display.

supply chain disruptions and unexpected demand shifts make forecasting more challenging. However, historical data analytics can help plants transition from reactive to proactive planning and keep planning aligned with operations.

Reporting

Reports provide a visualization of this historized process information and correlate related process variables, compute metrics on that data and visually graph such data for easier pattern and anomaly detection. These reports are created through third-party software that seamlessly integrates with programmable logic controllers (PLCs), SCADA and historian systems. Advanced reporting solutions can even pull information from remote alarm notification software, allowing further analysis and optimization of condition response times.

Reporting software enables organizations to turn raw process data into actionable information, thereby increasing efficiency and reducing costs. Furthermore, automated reporting solutions streamline regulatory compliance by collecting data from various sources like SCADA, laboratory information management systems (LIMS), manual entry and others. As the data is collected, it is summarized as key metrics—flow totals or turbidity threshold analysis. The final output is published into a formatted document accepted by regulatory agencies.

Alarm Management

A robust alarm management system enhances operational efficiency and enables timely detection of failures. A comprehensive alarm system provides actionable information to the operator and provides assistance in taking corrective action. Research has shown that a well-managed alarm system results in production efficiency, improved product quality and better operator effectiveness.

Since 1991, alarm management standards have been published, and currently the International Society of Automation (ISA)-18.2 and International Electrotechnical Commission (IEC) 62682 are the most widely accepted. The standards define a seven-step alarm management cycle program from identification to monitoring and assessment. A cloud-connected alarm management system provides access to real-time alarms, even when working remotely, to decrease response times and help reduce unplanned downtime. Alarm audits and reporting provide an efficient means to document and track the history of individual alarms, consequences, response time and the action taken to mitigate the alarms. As this rationalization is performed, continued system-level monitoring and assessment reports validate that these efforts are driving real improvement. ■

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Streamline Monitoring Processes With Full-Service Analytic Solutions

How using a full-service solution can help mitigate risks.

AKSHAT SHARMA | ITT, Inc.

For plants with critical industrial processing machinery like pumps and valves, utilizing a condition monitoring platform has become synonymous with saving money, reducing downtime and keeping operators and the environment safe from corrosive materials and faulty equipment. However, many companies still rely on their reliability or equipment engineers to gather and analyze the vibration data that is collected by these sensors, adding an important and time-consuming task to their list of responsibilities and risking inadequate analyses of information by those who do not have specialized knowledge.

That is where the concept of full-service monitoring comes into play. As innovations make monitoring more precise, more complex and faster in data collection, relying on qualified analysts is more important than ever to mitigate potential risks of disruptions or machinery malfunctions in plants across the oil and gas, chemical processing and power generation industries. Due to this, leading sensing and monitoring service providers are expanding their offerings to include full-service, premium solutions, which include the frequent analysis of data by specialized, highly trained analysts who are able to debrief users on potential issues and solutions before operations are interrupted.

This service is offered as an upgrade when purchasing monitoring sensors, and there are countless benefits of taking advantage of this full-service solution.

Benefits of Opting for Premium Service

The most significant benefit of utilizing a premium service from a sensing and monitoring provider is it allows users to identify an issue and receive counsel on the best solution so it can be swiftly remedied. Better yet, it allows engineers to focus on other, more important responsibilities than keeping track of the data collected by modern day monitoring solutions, which now track data in near real-time.

Another plus to utilizing this service is that, while most sophisticated systems auto-generate recommendations about potential ways to mitigate detections of a machine malfunction, the insight does not compare to the level of detailed investigation users receive from an experienced analyst. Service provider analysts can bring their broader experience across industries and collective knowledge from multiple users to the machine condition monitoring needs of each site.

Due to their exclusive focus on this role, they will automatically stay updated on the latest methodologies and best practices. Analysts regularly comb through data and inform the user on the health of their pumps and systems, including raising concerns about unusual data sequences that should be further investigated and how. While overall site status is typically reviewed in a monthly cadence, analysts are alerted in real-time by sensors when there is an urgent issue, allowing them to act immediately to determine the issue and counsel users on urgent action.

Premium monitoring offerings also include field service needs. In lieu of sending sensors and instructions for setup to the user, engineers and technicians will come on-site to install the full system and make sure it is set up optimally for that location and delivering the data needed to make the most accurate analyses. Any hardware that is not functioning optimally or needs maintenance can be promptly handled by the provider's field service department.

The service team can ensure the proper facility personnel are trained on how to use the system and service while guiding them on how best to utilize the information they are now getting. This will improve facility efficiency and uptime without employees getting overwhelmed or frustrated.

Having access to specialized user care allows support teams to grow, so more in-house engineers will not have to be hired to stay on top of monitoring needs as business expands. Furthermore, in the time it would take an operator to collect and decipher data and identify a machinery malfunction, specialized analysts can review the data, identify the issue and send relevant information directly to the repair/maintenance department to troubleshoot the issue and order replacement parts, significantly reducing overall downtime.

Real-World Risk Mitigation

Many processing plants, especially those that deal with corrosive materials, are already utilizing premium monitoring services to ensure the safety of their employees and the environment. In one notable instance, an oil and gas user had a main pump conducting processing, with a couple of backup pumps available for the application should they be needed. Specialized service analysts were conducting a regular review of the main pump's performance data when they identified a series of high vibrations that were collected by the sensor, which indicated an equipment failure.

Analysts brought it to the user's attention right away, and they determined immediate action should be taken to avoid catastrophic damage to the pump. The analysts swiftly coordinated with their repair shop to have the main pump removed from the service line for repairs, while the user switched to a backup pump in the interim.

Repair professionals determined that part of the pump's impeller had broken off and was still inside the pump, which could have caused the pump to come apart completely had there been further increases in flow or pressure. Because this client had opted for a full-service solution, a potential safety and environmental incident was completely avoided and there was little to no interruption to operations.

The Future of Full-Service Solutions

As premium services are utilized more frequently by industrial users, it is likely the convergence of data will continue to evolve. Right now, monitoring solutions separate vibration and process data into different domains and analyze them individually. In the future, it is likely this data will come together, prompting the use of tools like artificial intelligence (AI) to aid in the processing of large amounts of data more efficiently. This will allow for more flexibility of operations than ever before.

Another potential innovation on the horizon is the creation of one central location to store performance data. This may include the interoperability of systems from one provider or multiple providers to access data in real-time and across several locations. The standardization of tools like wireless networks and gateways will enable users to collect and share data across their plants faster than ever before, potentially allowing for monitoring software to perform centralized analytics and effectively share that data back with the user.

However, in order for data convergence like this to be conducted accurately, suitable infrastructure is required. For that reason, it is likely these capabilities will be available primarily to new plants and users who build their facilities with cutting edge data processing capabilities in mind.

Machinery and data collection continue to become more sophisticated, creating a greater need for oversight by specialized experts to ensure the continued health of industrial equipment. Opting for a premium, full-service monitoring solution allows users to reduce downtime and equipment costs while mitigating issues at the first sign of risk, all without monopolizing time from on-site engineering staff. Asking a monitoring platform provider about full-service options can keep employees and bottom line, as well as the environment, safe from the consequences of costly equipment malfunctions. ■

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Integrity Testing: A Proactive Approach to Maintaining Heat Exchanger Safety & Reliability

Preventative maintenance strategies may benefit brand integrity.

KEVIN TRAUTH | Rodem

Consumer and product safety is a cornerstone of the food and beverage processing industry. Failure to identify contamination hazards can result in costly recalls, damaged brand reputation, and most importantly, it can put consumers at risk. Proactivity through predictive and preventative maintenance of process-critical equipment, like heat exchangers, is an excellent way to ensure consumer safety and protect brand integrity.

Gasketed plate heat exchangers are widely used in dairy, food and beverage processing applications for heating, cooling and pasteurization duties. Their compact nature and efficient design make them ideal for demanding heat transfer solutions. Although resilient and flexible, plate heat exchangers require proper maintenance and repair to maintain accurate performance.

Integrity testing of plate heat exchangers allows processors to identify microscopic cracks and material fatigue before they develop into harmful leaks. This testing method gives processors greater control of their process schedule and maintenance planning with expanded insight and a more detailed understanding of the exact condition of their plates and gaskets.

IMAGE 1: A precision sensor is used to detect the discharge of any gas and to signal damage to the plate or gasket. (Images courtesy of Rodem)

IMAGE 2: The integrity testing precision sensor can identify the type of defect from micro-crack to corrosion, gasket failure and more.

Why Integrity Testing?

Integrity testing offers an innovative way of providing clear awareness about the equipment's status, resulting in increased processing safety and effectiveness. By identifying the smallest of emerging flaws, integrity testing empowers processors to address damaged plates and gaskets before breakdowns happen.

A proactive approach

Early detection of gasketed plate heat exchanger leaks gives processors the luxury of thinking ahead. An undetected leak can not only result in unexpected downtime and unscheduled shutdowns, but can cause excessive waste when a product is damaged beyond recovery or lost, negatively impacting the processor's bottom line.

Knowledge is power

Integrity testing takes the guesswork out of understanding the condition of plates and gaskets in plate heat exchangers. This predictive and preventative maintenance practice gives processors the knowledge they need to schedule repairs on their terms.

Process with confidence

Proactively addressing and planning for process critical maintenance by utilizing integrity testing for gasketed plate heat exchangers gives processors confidence in the reliability of their equipment. This simple, non-disruptive service can have a big impact on overall performance and efficiency.

Detection designed for heat transfer systems

Integrity testing is predictive and preventative maintenance that has been specifically designed for gasketed plate heat exchangers. Years of alternating temperature loads, pulsations, pressure impacts and abrasive cleaning media destroy the thin stainless-steel plates in plate heat exchangers. The result is an above-average extent of fatigue cracks in heat exchangers. Bacteria can migrate through these microscopic plate defects and cracks, causing microbial contamination. Integrity testing uses hydrogen as a test gas method to identify these minute leakage levels.

How integrity testing works

Integrity testing for heat exchangers delivers unmatched convenience, accuracy and safety, but how does it work? First, a nontoxic, nonflammable mix of

IMAGE 3: Alfa Laval Integrity Tester: Integrity testing uses a mix of hydrogen and nitrogen pumped through the gasketed plate heat exchanger to reveal any microscopic cracks, corrosion or material fatigue.

hydrogen and nitrogen is pumped through a gasketed plate heat exchanger, revealing any microscopic cracks, corrosion or material fatigue. Then a precision sensor is used to detect any discharge of gas. The detector can identify the type of defect from microcrack to corrosion, gasket failure and beyond.

Why Hydrogen?

Hydrogen delivers maximum precision

A 5% to 10% hydrogen-nitrogen mix is ideal for testing a gasketed plate heat exchanger's condition. It diffuses quickly and completely uncovers flaws smaller than any liquid inside the unit could penetrate.

Hydrogen minimizes false positives

Compared to other tracer gases, hydrogen has a lower probability of false positives because it has a low parts per million (ppm) in the atmosphere and dissipates rapidly after use. The result is decreased opportunity for error, saving processors time on unneeded repairs and money on unnecessary expenses.

Hydrogen testing yields rapid results

The integrity testing method with hydrogen does not require plate heat exchangers to be opened, making testing convenient and fast. When the gas pumps are connected to a drained unit the results are conclusive within 15 minutes. Disruption to day-to-day processing is minimal, as no cleaning or post-test procedures are required.

Hydrogen is food-industry-approved

The hydrogen mix used for integrity testing is nonflammable, nontoxic and approved for use in the food industry. Additionally, this method will not stress or corrode plates or gaskets, protecting not only consumer products but processors' high-value equipment.

Hydrogen is an eco-friendly option

Hydrogen and nitrogen are non-scarce, sustainable resources that can be utilized without harmful environmental

outcomes. Other methods depend on hard-to-find and nonrenewable helium.

The Integrity Test Advantage

With its ability to identify material fatigue and microscopic cracks before they turn into harmful leaks, integrity testing has a great advantage over other methods of typical heat exchanger testing options used by food and beverage processors.

- Rapid results: 15 minutes per section test time
- Minimally disruptive: No need to open plate packs, clean or perform post-test procedures
- Maximum insight: Hydrogen detects the smallest flaws and flaw types with a low probability of error
- Safe and sustainable: Integrity testing methods will not damage equipment, contaminate consumable products or cause environmental harm

IMAGE 4: Crossroads flavor vats at a processing plant for an ice cream manufacturer

Integrity testing = overall operational value

From tight production schedules to ongoing expansions and modifications to keep up with rapidly evolving consumer trends and an ever-changing supply chain, processors face a variety of challenges each day. Effective predictive and preventative maintenance through gasketed plate heat exchanger integrity testing is an optimal opportunity for processors to add value to their processing organization.

Protect consumer safety

With the identification of microcracks and corrosion before they develop, processors can mitigate the risk of product contamination and ensure greater consumer safety.

Eliminate waste

Early detection and proactive corrective actions in a calculated manner result in decreased product waste and reduced waste handling charges.

Increased efficiency

The elimination of product waste naturally leads to increased throughput. Processes function at a higher efficiency rate, with decreased unexpected downtimes when operating properly thanks to routine maintenance.

Prolonged equipment life span

Regular maintenance like heat exchanger testing annually or biannually significantly improves maintenance planning and ensures equipment is in good working order, resulting in a prolonged heat exchanger life span.

Integrity testing for gasketed plate heat exchangers represents a proactive approach that holds immense value for the food and beverage processing industry. The benefits of this method are clear and compelling. It offers processors the knowledge, confidence and control needed to ensure consumer safety, protect brand integrity and optimize their operations.

By identifying microscopic cracks and material fatigue before they escalate into harmful leaks, integrity testing empowers processors to plan for maintenance on their terms, preventing unscheduled shutdowns and excessive waste. This method, specifically designed for heat exchanger systems, uses hydrogen to deliver rapid, precise and eco-friendly results, making it a safer and more technologically advanced choice compared to other testing methods.

In the competitive landscape of food and beverage processing, where efficiency and safety are paramount, integrity testing stands out as a game-changer. It adds operational value by protecting consumer safety, eliminating waste, increasing efficiency and prolonging equipment life span. Processors who embrace integrity testing are not only safeguarding their brand reputation but also ensuring their long-term success in an industry where safety and reliability are nonnegotiable. ■

Kevin Trauth manages Rodem's engineering and installation team and also serves on its executive leadership team, where he provides strategic insight for managing the company's direction. Prior to Rodem, Trauth served as the plant engineer and assistant plant manager at his family-run business, Louis Trauth Dairy/Dean Foods. For more, visit rodem.com.

The Advantages of Direct Steam Injection in Food Processing

Consistency and safety are of the utmost importance in the food and beverage industry.

ZAC MARTIN | Hydro-Thermal

The food processing industry is a complex and highly regulated field where ensuring consistent quality and safety is paramount. Achieving this level of consistency can be challenging. Still, innovative heating technologies like direct steam injection (DSI) have been an asset to the industry with advantages focusing on versatility and product safety.

DSI: A Revolution in Food Production

DSI is a heating technique that injects steam directly into process liquids, creating precise temperature control and thorough mixing. When modulating direct steam injection, two methods, external and internal modulation, control the mass flow of steam into the process fluid.

External modulation uses a steam control valve on the supply line to vary the steam pressure at the injection point. This affects the steam's density and velocity through the nozzle, controlling the amount of heating. However, external modulation can lead to operational instability, hammering and vibrations, especially with varying steam flow rates. At low steam flow rates, minimal pressure differentials can cause disruptions, while high steam flow rates may result in steam hammering.

In contrast, internal modulation within DSI focuses on controlling the injection area rather than manipulating steam velocity and density to regulate heating. Internally modulated heaters operate at higher steam velocities, which improves mixing and ensures almost instantaneous steam condensation into the process fluid. Comparing DSI to traditional heat exchangers reveals two fundamental types of heat exchange: direct and indirect. Indirect heating, often accomplished through plate and frame or shell and tube heat exchangers, prohibits direct steam and fluid mixing. These heat exchangers transfer heat through a solid barrier, resulting in approximately 83% of heat energy transferred to the process fluid. The remaining energy is discharged as condensate formed by the steam.

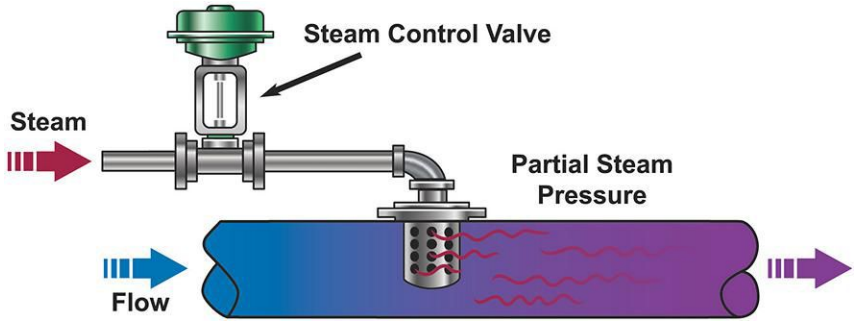

IMAGE 1: External modulation DSI heating systems (Images courtesy of Hydro-Thermal)

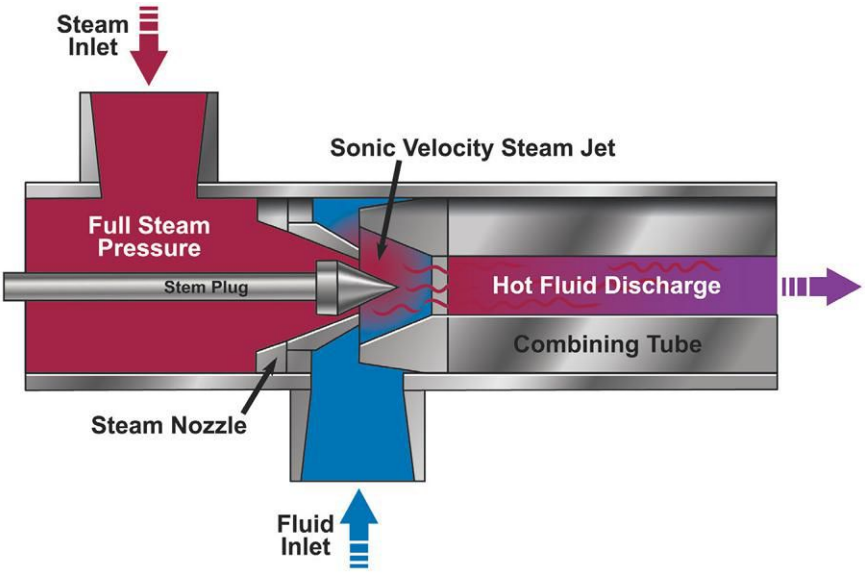

IMAGE 2: Internal modulation DSI heating systems

DSI provides rapid and uniform heating, making it beneficial in processing starches and various food products. It can heat highly viscous fluids and handle challenging-to-heat substances, preventing issues like bake-on and abrasive slurries. Additionally, DSI eliminates problems associated with plugging and fouling on the heat transfer surface.

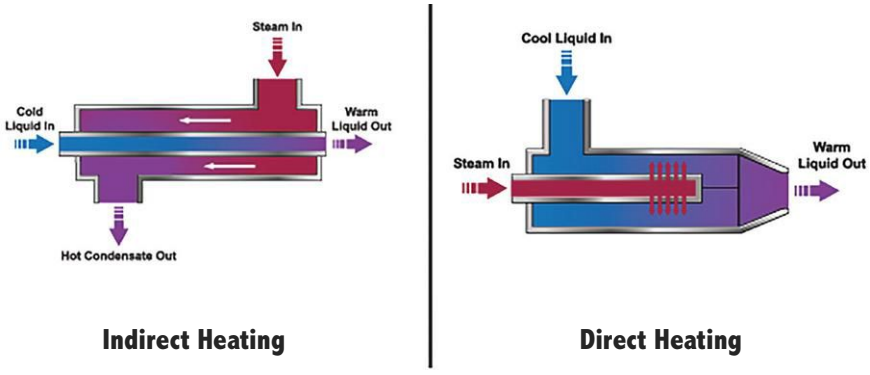

IMAGE 3: Indirect heating and direct heating

In the realm of food processing, the pursuit of product safety and sanitation is an unwavering priority.

Enhanced Product Safety

In the realm of food processing, the pursuit of product safety and sanitation is an unwavering priority. The industry faces the formidable task of ensuring every batch of food produced adheres to stringent safety standards while extending the shelf life of products to meet consumer demands. DSI technology is critical in achieving these goals, offering precise temperature control and consistent heating processes that elevate product safety and extend shelf life.

The critical importance of product safety

Ensuring food products are free from harmful microorganisms and contaminants is not just a regulatory requirement, but a moral obligation for food processors. Consumers trust the products they purchase are safe for consumption, and any lapse in safety measures can have dire consequences, including health hazards, legal ramifications and damage to a company's reputation.

DSI technology enables food processors to consistently achieve and maintain the exact temperatures required for critical processes such as sanitization and pasteurization. These processes are vital for eradicating harmful bacteria, pathogens and contaminants that may be present in raw food materials. Achieving precise temperature control is critical in ensuring every batch is treated effectively, leaving no room for uncertainty.

Extending shelf life

In addition to bolstering product safety, DSI technology offers the advantage of extending the shelf life of food products. Precise temperature control is instrumental in eliminating harmful microorganisms and preserving the quality and freshness of food. By heating products to the exact temperatures required for pasteurization, food processors can destroy spoilage microorganisms and enzymes that can lead to product degradation. This results in products with a longer shelf life, reducing waste and ensuring consumers receive high-quality and safe products.

Consistency and peace of mind

One of the critical benefits of DSI technology is the peace of mind it brings to food processors. Consistency in product safety is not an aspiration but a requirement, and DSI technology's capacity for delivering precise temperature control consistently addresses this need. Food processors can trust that every batch is treated with the same care and precision, minimizing the risk of safety issues and ensuring product uniformity.

Versatility in Food Processing

One of the standout advantages of DSI technology is its versatility. DSI heaters, known for their adaptability, offer flexibility.

Tailored cooking processes

DSI heaters have the capability to be tailored to various cooking and processing needs. This adaptability allows them to excel in food processing, where a one-size-fits-all approach rarely suffices. Food processors can harness the power of DSI heaters to cook products inline, ensuring each batch is consistently and thoroughly heated to perfection. But the true magic lies in the ability of DSI heaters to accommodate specific cooking processes, such as parboiling, immersion cooking or tank heating.

Precision meets consistency

The adaptability of DSI technology empowers food processors to fine-tune their heating processes to meet the exact requirements of each recipe. This precision in temperature control is essential in the food industry, where the subtlest variation can impact product quality and taste. DSI heaters provide the precise temperature control necessary to ensure every batch is cooked to perfection, with minimal room for error.

Combating burn-on and fouling

In addition to its flexibility and precision, DSI technology addresses challenges like burn-on and fouling, common concerns in food processing. Burn-on occurs when food ingredients adhere to the heating surfaces, resulting in undesirable scorching or caramelization. Fouling involves the accumulation of residues that can degrade

product quality and pose sanitation risks. By injecting steam directly into the process liquids, DSI heaters prevent hot spots and scorching, ensuring the product is evenly and thoroughly heated without the risk of sticking to heating surfaces. The instantaneous mixing and condensation of steam into the process fluid prevents the formation of residues that lead to fouling. This means that food processors can maintain consistent product quality, taste and texture while avoiding the common pitfalls associated with burn-on and fouling.

Addressing Water Addition Concerns

One common concern raised by potential users of DSI technology is the addition of water to the recipe, potentially diluting the product. DSI heaters use steam, which condenses back into water during heating. However, this water can be efficiently managed using a flash tank, where the heat is released and the condensate evaporates, generating flash steam while removing excess water. Furthermore, the condensate can be incorporated into the recipe, adding it to the existing water already accounted for in the ingredient statement. Typically, a general rule of thumb is to add 1% water for every 10 degree temperature rise, and this can be easily adjusted using a water addition formula. Steam, being sterile water, does not alter the final product's taste. In many cases, incorporating the steam from the DSI heater into processing systems has improved product quality, texture and flavor.

DSI technology has emerged as a valuable tool in the food processing industry. Its versatility, enhanced product safety and precise recipe control capabilities make it a preferred choice for food processors looking to maintain consistent quality while ensuring product safety and cost savings. ■

Zac Martin holds a degree in mechanical engineering from Marquette University in Wisconsin. He currently serves as an application engineer at Hydro-Thermal, where he specializes in applications in the food and beverage industry. For more information, visit hydro-thermal.com.

The State of Food Plant Hydraulics

Hydraulic fluids for food and beverage plant operations have undergone significant improvements in the last few decades.

ERIC PETER | JAX INC.

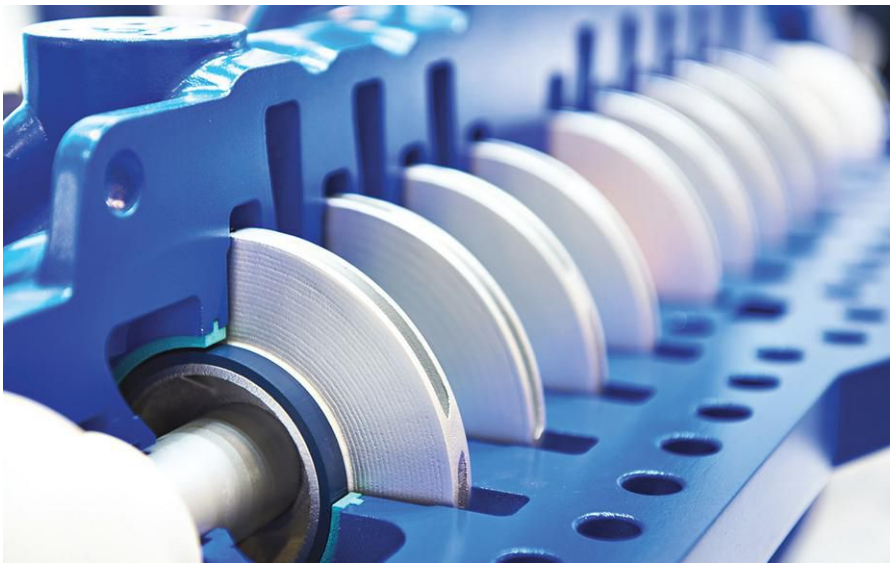

IMAGE 1: Compressor oil seals (Images courtesy of JAX INC.)

Hydraulic systems in food and beverage processing plants are now ubiquitous. How have H1 hydraulic fluids advanced over the years, and what is their current status in these critical food plant systems?

History of Food-Grade Hydraulic Fluids

Hydraulic systems have been common in food processing plants for decades, but it was not until the early 1980s that consideration and development occurred on true anti-wear, "food-grade" hydraulic fluids. The first of these were developed for fully automated corn cutting machinery, which was brand new to the vegetable processing industry and would be run primarily via hydraulic power. The OEM recognized the potential of system leakage which, if undetected, could pose a risk to consumers.

The governing agency then was the United States Department of Agriculture (USDA), which would designate lubricants approved for incidental food contact as USDA H1. These would be listed in the USDA White Book of nonfood compounds allowed for use in federally inspected processing plants. Achieving this designation was accomplished by formulating with Food and Drug Administration (FDA) approved or generally recognized as safe (GRAS) ingredients and then submitting formulation data, samples and labeling information to the USDA for final approval. USDA H1 accepted lubricants had already been in the market since the early 1960s, but they mostly consisted of white oils, greases and chain lubricants. Most were commonly used in the directly USDA inspected meat and poultry industries. Vegetables typically fall under state inspection programs, so the impetus to use H1 lubricants was driven by consumer safety and liability concerns more than federal regulatory oversight.

The first H1 hydraulic fluids were pharmaceutical white oil mineral oils formulated with recently FDA approved additives for anti-wear and rust and oxidation protection. They performed acceptably in bench tests for industry standard pump wear tests, but there were unforeseen issues in some field applications. The purity of these fluids could, in some instances, cause issues with elastomers. Typical industrial hydraulic fluids are formulated with mineral base oils that contain enough aromatic compounds to keep sensitive seals soft and pliable. Since the development of the new H1 hydraulic oils centered so much around matching industrial fluid pump and system wear protection, little thought was given to the fact that seal swell additives would have to be reintroduced to H1 fluids to regain the seal compatibility found in typical industrial products.

Today, all well formulated H1 approved hydraulic fluids should provide good seal compatibility. In addition, modern seal materials have undergone their own evolution over the last 40 years. The applications for H1 hydraulic fluids today can be generally boiled down to three categories with related types in those categories.

General Ambient Plant Systems

These systems are the load carrying gorillas of the typical plant. The hydraulic power packs can be large and numerous, running most of the major hydraulically operated equipment in the plant. The H1 hydraulic fluids used are primarily white mineral oil based with appropriate additive packages to protect components and comply with the guidelines for H1 approvable ingredients. The typical International Standards Organization (ISO) viscosity grades range from ISO 22 to ISO 100, with common applications using ISO VG 46 or 68 grades.

These systems should operate at best practice fluid temperatures between 120 and 130 F. They will handle higher system temperatures, but fluid life will be

shortened as system temperatures rise. Used oil analysis is recommended for all mission critical systems to monitor water content, contaminants, viscosity changes and acid number increases. These are the four primary concerns of fluid condition analysis along with ongoing metals and particle analysis to track hydraulic pump condition.

Low Temperature Ambient Systems

In addition to the considerations given to ambient systems, low temperature systems will face some additional challenges. The main issue will be low temperature fluidity of the H1 fluid. In most of these cases, a mineral oil base solution will be too viscous at startup to run efficiently. There is a risk of pump cavitation and catastrophic failure should the system be starved of fluid while the pumps and motors are running. The solution is to run an H1 synthetic formula, which is usually based upon polyalphaolefin (PAO) synthetic fluids. Although costing three to four times as much, fluids based upon synthetic technology can be paramount in achieving desired cold temp performance.

The designated viscosity grades of these fluids will be typical to the ranges of the mineral based fluids, although synthetic fluids will have pour points 40 to 50 F lower than mineral oil comparable grades. This should be readily observed on the product data sheets in lower pour point temperatures and the higher viscosity index ratings. If there is doubt about the claims made by the lubricant supplier, a comparative pour point analysis done by an independent laboratory is easy and relatively inexpensive.

Properly formulated, these fluids should also provide good elastomer compatibility, but like white oils, PAOs do not contain the aromatic compounds to keep older technology elastomers pliable and must be formulated with performance additives to replace that characteristic.

Fire-Resistant Application Systems

The requirement for these fluids stemmed from past, tragic fires in poultry plants where hot hydraulic fluids acted as accelerants and hampered fire mitigation efforts. Since that time, plant safety and insurance regulations have dictated the need for fire-resistant (FR) fluids. The recognized testing entity for approved fluids is FM Global. Fluids that have achieved an FR rating from FM Global are deemed acceptable for use in these plants.

IMAGE 2: A corn processing machine

The primary ignition hazards in these facilities are cooking processes at elevated temperatures which could, if exposed to the hydraulic fluids, cause an ignition event.

For many years, the only solution was to use a water-based H1 fluid, typically formulated with a blend of propylene or mixed glycols, thickening agents and deionized water. Although these fluids were safe and are still commonly used, they are difficult to maintain in chemical balance and require constant monitoring, testing and chemical adjusting. In addition, water-based fluids are typically deficient in providing good anti-wear protection for pumps and motors.

In the last 10 years, a new class of ester-based FR products has achieved H1 status. These FR fluids have been used in industrial applications for several decades with good known performance in terms of anti-wear, fluid life and system compatibility. With the advent of H1 versions, many plants can take advantage of the reduced maintenance costs provided by using this technology while still satisfying the FM Global fire-resistant requirements.

Although not compatible with the water glycol solutions, in many instances, the cost of a drain and flush procedure to change to H1 FR ester fluid technology will more than make up for itself in equipment and maintenance costs. A side benefit to most ester-based H1 FR fluids is that many are also classified as readily biodegradable, enhancing sustainability and adhering to environmental safety programs. As in the case of the other fluid classes covered in this article, care must be taken to operate hydraulic systems in optimum sump temperature conditions of 120 to 130 F. All fluids will suffer with shortened fluid life as their operating temperatures increase above this range. Routine laboratory fluid analysis for critical systems is a maintenance manager's best ally in alerting their team to any impending issues with their systems.

Additional Information

In most cases, the color of these fluids is water white. This can make leak detection and level sensing more difficult, as the fluid is difficult to see. Some OEMs offer FDA compliant dye solutions, which can either add color or ultraviolet (UV) detection capabilities. These are typically added at the user site. ■

Eric J. Peter is an experienced industrial lubrication technologist with a deep understanding of the machinery and processes used in the food and beverage industry. With a career that spans decades, Peter has been involved in numerous advances in food-grade lubricant technology. He served as the president of JAX INC. and continues to contribute to the company as a director. For more information, visit jax.com.

Creating New Replacement Parts for Old Equipment

Utilizing modern methods to solve an age-old problem.

CHAD HIBNER & ALEX RAY | Sulzer

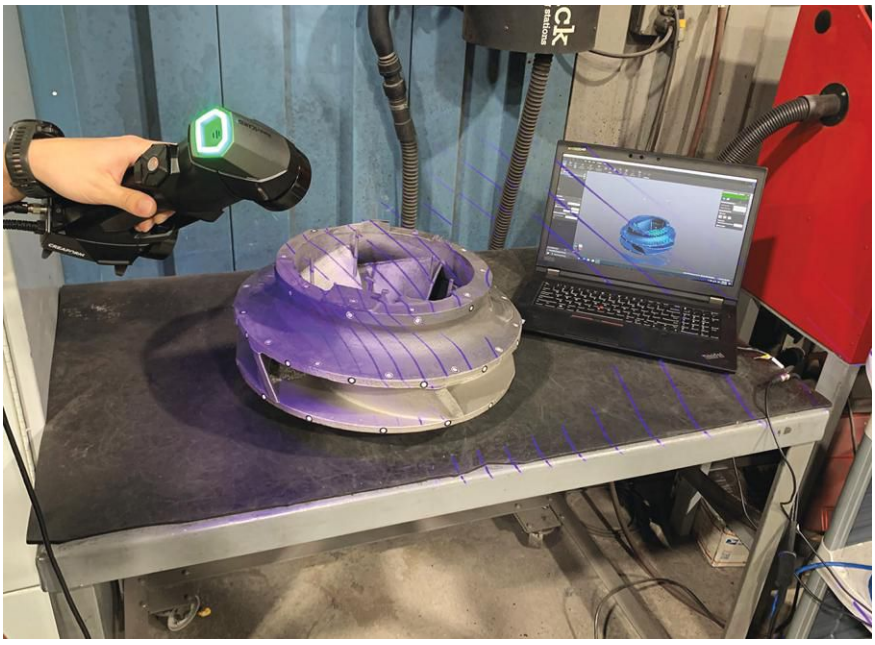

IMAGE 1: Precision data acquisition allows dimensions to be repeated within 0.001 inch. (0.025 millimeter) (Images courtesy of Sulzer)

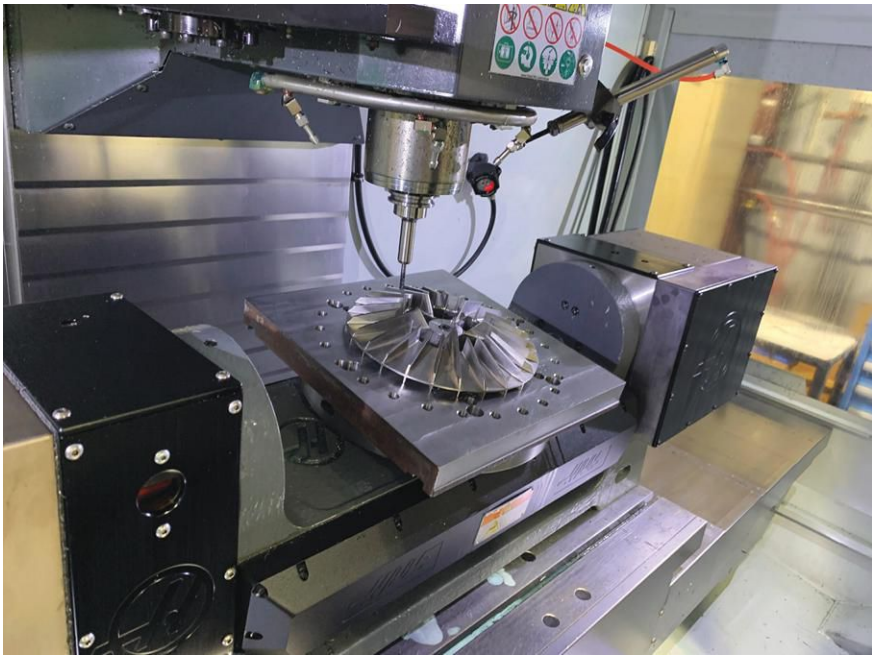

IMAGE 2: High precision machining on multi-axis computer numerical control (CNC) equipment

Repairing critical pieces of equipment can be a time-consuming task, especially if they have been in service for a long time and original parts are difficult to source. One solution for a fast repair is to give the challenge to a specialist parts manufacturer, which can reengineer new parts for a wide range of rotating equipment. OEMs will always do their best to provide a comprehensive array of spare parts for their products. However, after decades in service, it may not be possible to deliver this level of support. The manufacturer may have been acquired by another entity or ceased trading altogether.

Whatever the cause, the requirement for replacement parts remains, and when larger pieces of equipment are involved, their role is often more critical.

The Latest Technology

When creating new parts for crucial pieces of equipment, speed is of the essence to avoid costly downtime. Using the latest generation of laser scanner enables engineers to gather 1.3 million points of data every second, and 11 intersecting laser lines ensure even the most complex geometry is captured accurately. This type of scanner outputs a high-definition mesh geometry that can be imported into 3D computer-aided design (CAD) software.

Fine-Tuning the Design

Having acquired the basic dimensional data for a project, engineers can fine-tune the design of the new component. Adjusting machine stock, integrating wear rings and upgrading hydraulics to make pumps more efficient are a few changes that can be made. In this way, it is possible to make alterations to the original design to account for changes in the application.

After scanning is complete and the 3D models are created, these components are stored in a digital inventory. This allows engineers to have a database of digital artifacts that can be referenced at any time. With this digital stock-holding, various avenues may be pursued using different additive manufacturing techniques.

IMAGE 3: Creating new components using a 3D sand printing process

IMAGE 4: An in-house foundry is central to creating new parts and pouring numerous different alloys for castings.

IMAGE 5: Specialist cleaning and polishing equipment

Modern Casting Methods

Traditionally, casting a new component involved creating a wooden pattern of the original and putting it into a sand-casting box. This is a lengthy process and subject to considerable inaccuracies, especially if the wooden molds are stored for any length of time and become distorted. As part of the modern process to create a digital mold, the first step is for design engineers to create a rigging and gating system to adequately sustain the initial flow of molten metal all the way to the final solidification of the part. The design is based on numerous calculations that allow the engineers to create these complex systems.

From here, an analysis is performed to predict the flow and solidification of the molten metal within the designed system. The design engineers then have an expected outcome and can deem the system acceptable or not, based on their acceptance criteria. The next step is to create the mold using 3D CAD software. The rigging and gating system will be derived out of the cope and drag to get the proper replication of the designed systems. From there, the individual pieces of the molds are exported for further processing.

Exported files are then sent to a 3D sand printer that uses the data to gradually build a mold of the new component. Using layers of sand and adhesive, the 3D printer creates a mold that can withstand the high temperatures of the molten metal that will form the new component.

Retrieving the Data

A foundry is central to creating new parts and pouring numerous different alloys for castings. The exact make-up of the metal alloy is determined by the component and its application.

Having been poured, the cast component is then returned to the engineering group, where a 3D scanner is used to retrieve data from the casting. It is overlayed with the original 3D model to verify there is enough stock to create the final machined product. Once this verification step is completed, the part is returned to production for final processing. ■

Chad Hibner is a project engineer at Sulzer Pumps, specializing in elevating OEM capabilities through 3D scanning and modeling under its OEM-X Brand. Hibner has over a decade of experience in reverse engineering pump equipment, and he holds a degree in manual and CNC machining. Hibner also holds degrees in engineering design and manufacturing engineering through Marshall University's partnership with Mountwest Community & Technical College. In 2018, Hibner received an honorable mention for Sulzer's Global Innovation Award.

Alex Ray, a project engineer at Sulzer Pumps (WVPMC), began his career as an intern in the summer of 2019, concurrently pursuing his studies at Marshall University. By spring 2021, Alex had earned his bachelor's degree in mechanical engineering and transitioned into a full-time role at Sulzer. For more information, visit sulzer.com.

Evolving Performance of UVC LED-Based POE Systems

The market for UV disinfection in POE systems is growing.

PATRICK AIGELDINGER | Crystal IS

The use of ultraviolet (UV) mercury lamps in point-of-entry (POE) water treatment has provided homeowners with microbially safe water throughout their homes. However, as concerns loom around bans on mercury lamps, either from the Minamata Convention or consumer sentiments, more OEMs have been investigating UVC light-emitting diodes (LEDs) as a potential way to access the UV spectrum for their products.

In addition, the industry is adapting to regulations around forever chemicals, often categorized as per- and polyfluoroalkyl substances (PFAS), which focus on both production and abatement to reduce exposure to these materials. Treatment of incoming or feed water in residential, commercial and public buildings is meant to ensure both compliance with these regulations and safety of the water supply.

Traditional POE treatment methods include reverse osmosis (RO) and granular activated carbon (GAC). While these methods remove the trace PFAS chemicals present in the incoming water, they also remove some of the protective chemicals, like chlorine, that ensure the potability of the water throughout the home. Removing chlorine increases the risk for opportunistic property piping pathogens (OPPP) and biofilm growth.

This global regulatory environment around potential mercury bans and PFAS regulations is increasing the interest in applications that include UVC LEDs at the POE, particularly as their performance improves to meet the application needs.

	Low Pressure Mercury Lamp	UVC LED
Heavy Metals	Mercury (20–200 milligrams [mg])	None
Warm Up Time	1-15 minutes	Instantaneous
Wavelength	254 nanometers (nm)	250 nm – 280 nm (can tailor to application)
Voltage	110 – 240 volts (V) alternating current (AC)	6 – 12 V direct current (DC)
Current	0.5 – 2.0 amperes (A)	0.02 – 0.5 A
Lifetime	8,000 hours	> 10,000 hours

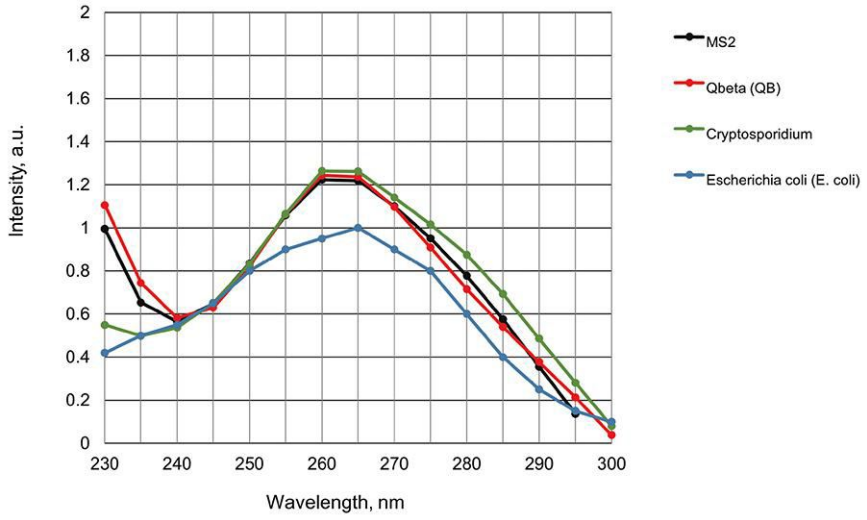

IMAGE 1: Absorption curves for common target microbes (Images courtesy of Crystal IS)

Improvement in UVC LED Performance

In the point-of-use space, UVC LEDs have several advantages over traditional UV lamps. They make the system more energy-efficient, have a longer life span and are less likely to break or malfunction. In addition, they can help to protect people from waterborne illnesses while having no adverse effect on the temperature or odor and taste of the treated water. Their compact size enables more design flexibility and provides a more optimal output for disinfection.

UVC LEDs offer a tremendous benefit in UV efficiency primarily due to the wavelength emission. In UV disinfection, short wavelength ultraviolet (UVC) light in the range of 250 to 280 nm disrupts the DNA of microorganisms, rendering them unable to reproduce. The action spectrum for bacteria is commonly reported and shown as a response from 200 to 300 nm with a peak between 265 to 267 nm wavelengths, with some variation across species (Image 1). Low-pressure mercury lamps emit a discrete wavelength at 254 nm whereas UVC LEDs can be tuned by the manufacturer to emit in a specific wavelength range.

When calculating system needs, it is important to understand the target microbe, or biodosimer, that is being used to design the system and its spectral response. A biodosimer is a surrogate microbe used to measure the performance of a system to ensure it delivers the disinfection efficacy required for the application. These are often defined by industry standards, such as the National Sanitation Foundation (NSF), or regional regulatory standards like the Environmental Protection Agency (EPA). However, some manufacturers may prefer to use a specific microbe based on their own application requirements.

Once the target microbe is selected, one can consider the dosage—or energy required to reach a specific log reduction of a target microbe. For example, with NSF 55 Class B, the disinfection target is 2.0 log reduction value (LRV) at the beginning of product life for the surrogate Q-Beta—which according to Table 1, requires a dose 22 millijoule (mJ)/centimeter (cm)2 within the system.

Status of POE Systems

Generally, POE UV treatment systems can vary greatly in flow rate from 5 to 30 gallons per minute (gpm). The disinfection dosage performance can also vary from 16 mJ/cm^2 to 40 mJ/cm^2 with the dosage requirement often increasing as the flow rate decreases. Typically, UV lamp systems will employ a 35-watt low pressure mercury

Microbe	1 LRV	2 LRV	3 LRV	4 LRV
MS2	16 mJ/cm^2	34 mJ/cm^2	54 mJ/cm^2	78 mJ/cm^2
Q Beta	11 mJ/cm^2	**22 mJ/cm^2**	34 mJ/cm^2	46 mJ/cm^2
Cryptosporidum	4 mJ/cm^2	9 mJ/cm^2	13 mJ/cm^2	17 mJ/cm^2

IMAGE 2: UV dose response based on 254 nm
Source: scholar.colorado.edu/downloads/rn301175t

lamp for 9 gpm flow rate. This provides 11.5 watts of UVC energy at 254 nm for a dosage of 30 mJ/cm^2.

UVC LEDs are available in a range of peak wavelengths, with those in the 260 to 270 nm range providing a more consistent performance across multiple microbes (Image 1). While a lamp will emit the total energy across the entire length of the light source, LEDs provide more intense UVC energy that reactor designers can focus within the system (Image 2). They also emit as a point source, meaning the output intensity is focused and can be more easily directed within the system. This, coupled with the more optimal wavelength for disinfection, means that when moving from a mercury-based system to an LED-based system, less UVC energy is required for the same performance level. Understanding this, we can then consider an example POE system operating at 9 gpm and requiring a 3 log reduction of Q Beta.

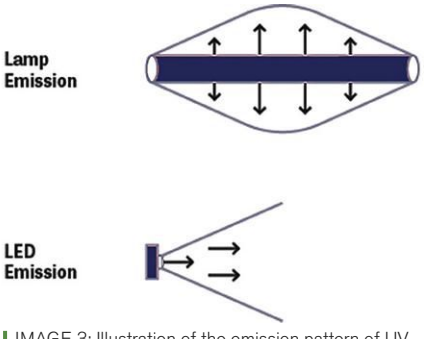

IMAGE 3: Illustration of the emission pattern of UV light sources

According to Table 1, the dosage required to achieve a 3 log reduction of Q Beta is 34 mj/cm^2 at 254 nm. Thus, using the absorption curve, the required dosage at 265 nm to be 28 mj/cm^2 can be calculated. A 35-watt mercury lamp will provide nearly the amount of UVC energy required to meet the disinfection requirement at 11.5 watts of UVC for a dosage of 30 mj/cm^2. However, using an LED emitting in the peak germicidal wavelength from 260 nm to 270 nm, the system would require approximately 9.5 watts from the LEDs.

These calculations assume a basic design with moderately reflective surfaces within the reactors. Reactor design can be further optimized to balance the specifications of the existing technology with the disinfection performance and economic goals of the application.

Historically, there have been a few niche players that specialized in designing and building LED-based reactors. However, as adoption has increased, there are now more mainstream companies that can provide varied sophistication in design to meet the performance and economic goals of a system. In the point-of-use space, the performance of UVC LEDs is now at a point where the reactor designer can use less expensive materials and simpler designs to meet economic goals around the total system.

In larger flow cases like POE, the experience and expertise of designing systems with UVC LEDs in water reactors is paramount. Broadly, commercially available UVC LEDs meet the need for point-of-use markets, making reactor design easier to achieve. They also meet the entry conditions for applications in POE, and relying on companies that specialize in LED-based reactor design allows OEMs to leverage the full benefits of the UVC LED platform across their product lines. As the market need for UV disinfection in POE systems grows, it is anticipated that more OEMs will to turn to UVC LEDs as their platform technology as both the performance of discrete devices and overall system design improves. ■

> While a lamp will emit the total energy across the entire length of the light source, LEDs provide more intense UVC energy that reactor designers can focus within the system.

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Patrick Aigeldinger is a director of product management responsible for global product and business development activities at Crystal IS, an Asahi Kasei company and a U.S.-based manufacturer of high-performance UVC LEDs. He holds a degree from Millersville University of Pennsylvania in industrial engineering and completed his MBA at Villanova University. For more, visit cisuvc.com.

The Process Behind Valve & Piping System Automation

An in-depth look at the interactions that take place between a SCADA system and PLC.

KEN BLYSTONE | Asahi/America, Inc.

When designing a process valve and piping system, it is necessary to both choose the right valve configuration and appropriately select the automation configuration. There are various types of valves, which sparks the following questions: Should they be manual or automated? If they are manual valves, are they out of reach or easily accessible? If they are automated valves, what type of automation is necessary? Is a supervisory control and data acquisition system (SCADA) required for the automation? Are any automated valves going to be modulating? Are there any critical automated valves that will require a failsafe option in case of a system failure, power loss or other natural catastrophe? All these questions must be considered when designing the process piping system.

IMAGE 1: A butterfly valve with an added chain wheel option to the gear operator (left) and powder-coated stem extension with an electric actuator (right). (Images courtesy of Asahi/America, Inc.)

Valve Selection

One of the first steps of the process design is selecting the appropriate valve type. A resilient seated butterfly valve would be an acceptable selection for media that may have suspended particles and/or higher flow rates, such as in filtration. A butterfly valve with a non-wetted body is an excellent solution for corrosion resistance.

Weir-type diaphragm valves would be a suitable solution for a slurry or a throttling application, such as pressure sensing or flow metering. The linear flow characteristic allows for manageable flow rates and precision flow control for the most precise applications.

A ball valve would be an acceptable selection for clean filtered media with no suspended particles. When used in a sodium hypochlorite application, an isopropyl alcohol application or any application where off-gassing may occur, using a ball valve with a vented hole designed specifically for these applications should be considered.

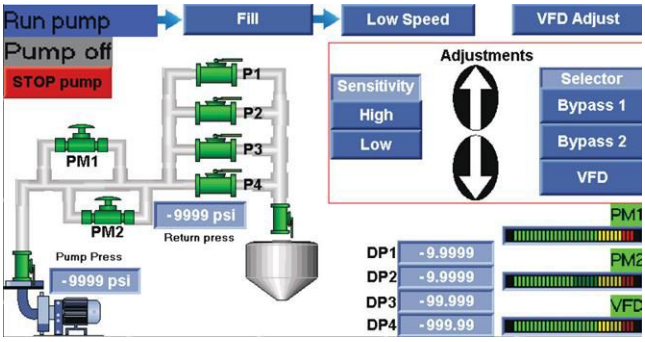

IMAGE 2: An example of an HMI on a PLC

Valve Considerations

Selecting the correct valve for an application involves many considerations to ensure the valve will meet the application requirements, such as thermoplastic material, chemical compatibility, pressure and temperature ratings, size and connection type, flow rate and pressure drop and regulatory compliances.

- Thermoplastic material: Different thermoplastic materials, such as polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), polyvinylidene fluoride (PVDF) or polytetrafluoroethylene (PTFE), have varying degrees of temperature tolerance, chemical resistance and

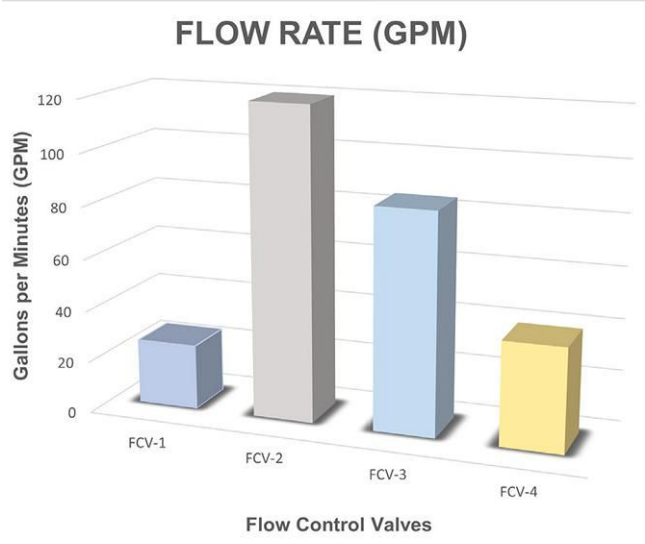

IMAGE 3: Flow rate chart

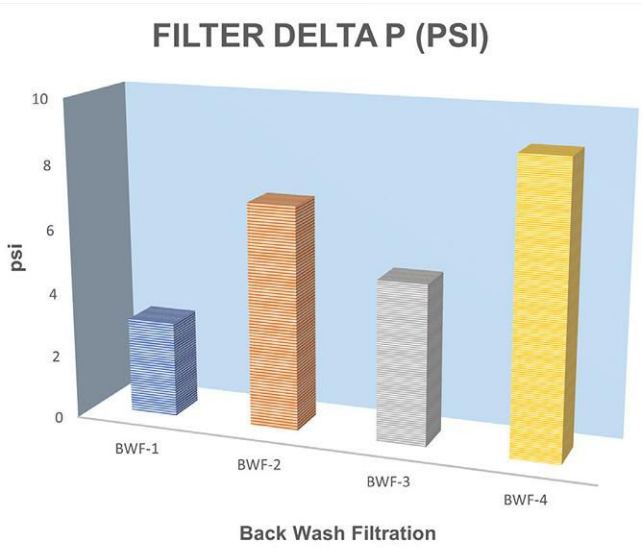

IMAGE 4: Filter Delta P chart

strength. It is critical to choose a valve material that is compatible with the process flow media and the operating conditions of the system.

- Chemical compatibility: Verify the chosen thermoplastic material is resistant to the chemicals, acids and bases present in the system to prevent degradation and corrosion of the valve. Always check the chemical compatibility chart provided by manufacturers to make an informed selection.
- Pressure and temperature ratings: Confirm the operating pressure and temperature range of the system to ensure the selected thermoplastic valve meets the requirements. Making the correct selection will prevent failures and deformation of the valve.
- Size and connection type: Ensure the valve size matches the pipeline dimensions, the connection type (flanged, threaded, solvent cement) and aligns with the piping system to facilitate proper installation.
- Flow rate and pressure drop: Ensure the flow characteristics of the valve and its effect on pressure drop within the system do not negatively impact the process. Ensure the valve's flow (Cv) meets the system's flow rate requirements.
- Regulatory compliance: Confirm the selected thermoplastic valve complies with industry standards and regulations. Examples would include the National Sanitation Foundation (NSF), American Society for Testing and Materials (ASTM) and Food and Drug Administration (FDA).

After the proper valve is selected, added accessories and options are available based on the specific requirements of the application. A system designer might ask the following questions: Is the valve below grade, and does it require a stem extension? Is it overhead, and does it require a chain operator? Is it a safety interlock? Should it be automated?

Automation Selection

There are many considerations in automation selection. The first major question a system designer might ask is if the installation requires electric or pneumatic automation. In either selection, a system designer needs to make careful calculations based on the system requirements.

A suitable power source must be available to handle all of the system power requirements. This would include, but not be limited to, a programmable logic controller (PLC), system-wide flow meters/transducers, pH/oxidation reduction potential (ORP) probes, flow meters, level sensors and pumps.

If the system requires pneumatic automation, solenoid valves and compressors must be included in the calculations. Electric actuation would include electrical wiring in the calculations.

Another consideration would be the use of a SCADA system. This complexity could include a sophisticated setup involving a master PLC overseeing the entire plant, with numerous secondary PLCs managing daily processes. Alternatively, it could be as straightforward as a single PLC operating a compact skid filtration system.

The PLC, otherwise known as the "brain" of the system, receives input from all of the instrumentation, processes it, then sends outputs to the process systems. It recognizes when the pump is running, the flow rate, the pressure, the level of the tanks, the Delta P of the filters and the position the valves are in and commands the valves to open, close or modulate. Previously, this was all accomplished with relay logic, but modern PLCs make this

much more user friendly with touchscreen Human-Machine Interfaces (HMIs).

System Operation

The PLC activates the pump, generating system pressure and flow. It needs to ensure the main valve is open to prevent the pump from deadheading against the valve. The SCADA system will check the valve position and open it prior to starting the pump. The flow meters transmit the flow rate to the PLC. The pressure sensors transmit the pressure to the PLC. Valves are in varying states of position, directing the media through the appropriate piping sections. Media runs through the filters, and the Delta P is reported to the PLC. Tanks begin to fill and the tank level is reported to the PLC. If the pressure becomes too high, a pressure relief valve might open and divert some system pressure and flow to bring the pressure back down to the designed operating pressure. The PLC might also command an automated valve to open, diverting the flow and bringing the system pressure back down to the designed operating range. This could be a modulating valve used to maintain a constant pressure within the system. A modulating valve would react to a 4-20 milliamp (mA) signal or a 3-15 pounds per square inch (psi) signal, depending on if it were electrically or pneumatically actuated. The low number of the signal represents closed, and the high number of the signal represents open. If the valve needs to be 50% open, the PLC would send the appropriate command signal (12 mA for electric or 9 psi for pneumatic), and the valve would react and go to that position. The position is dependent on the designed pressure and the actual pressure. The PLC makes this computation and sends the proper control signal to the valve. Another application for a modulating valve could be to maintain a consistent flow rate. Flow meters would report the media flow rate to the PLC, which would compare that to the desired flow rate setting, then send a signal to open or close the valve to slightly alter the flow.

The PLC will consider the Delta P of the filters, and when it gets too high, it will cycle the valves and put the filters into backwash mode. The PLC understands when the filters are clean by the low Delta P, which will command the valves to reverse their cycle and put the filters back online. As the process continues and the tank level rises, the PLC might command the fill valve to close to maintain the proper tank level. Should this valve fail, there would be a high-level dump valve so the tank does not overflow. The PLC would command this valve to open in this case. During the process, the tank level may drop to its low level. The PLC will command the fill valve to open and allow the tank level to rise up to its designed level.

There is always a potential for a full system operation downtime due to a blackout or lack of a power source. In this scenario, failsafe valves drive to their fail open or fail closed positions. It is possible the valve on the discharge side of the pump would close, relieving pressure and diverting the media flow, or the tank valves close, which locks out the tanks. The back-and-forth communication between the PLC and SCADA means the system is working as expected.

While every process valve and piping system is different with variable requirements, this is just a general representation of the various items used within a process system. This article aimed to show some of the intricacies involved in a valve and piping process system. There are manual valves of various types, automated valves of various types, flow meters, pressure sensors, pumps, pH/ORP probes, air compressors, air dryers and pneumatic and electric actuators with different options. ■

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8 Steps to Choosing a Construction Dewatering Pump

For reliable, cost-effective results, match the pump and system design to the application.

TIM CREECH | United Rentals

IMAGE 1: Most construction projects that involve excavation require the removal of groundwater or surface water. (Images courtesy of United Rentals)

Most construction projects that involve excavation require the removal of groundwater or surface water. Without proper dewatering, the subgrade could become unstable, making it difficult to install a solid foundation or causing damage to work already performed. Wet or muddy ground can pose a slipping hazard, threaten the integrity of building materials such as lumber and cause equipment and metal tools to rust. Areas of flooding can limit crew access or halt work altogether. Contractors who know how to efficiently remove water from a jobsite have a higher likelihood of keeping a project on schedule and budget.

Avoiding dewatering problems begins with understanding the characteristics of the site and choosing the most appropriate pump type and size. There are many pumps available that can handle the large-scale movement of liquids, and no one-size-fits-all solutions. Following these eight steps can help ensure the selection of an effective dewatering system design.

1 Consider the Water Source

The pump needed to dewater a site that gets 2 or 3 inches of standing water after a heavy rain is likely to be different in type and size from the one required when water is constantly seeping into an excavation or running along the ground due to a high water table. A more powerful pump designed for long-term use may be required for continual operation.

IMAGE 2: When it comes to construction site dewatering, there is a lot riding on proper pump selection.

2 Check the Solids Content

The water on a construction site will never be completely clear, but the type and amount of debris and solids it carries will vary greatly from location to location.

The solids content influences the type of pump needed. For example, a trash pump, or solids handling pump, can generally move liquids with a solids concentration of 3% to 5%, with solids up to 3 inches in diameter. A sludge pump is designed to move liquids with a solids concentration of up to 6% to 7%. Using the wrong pump to move water with a heavy concentration of sludge or other materials will likely result in system failure.

3 Determine the Flow Rate Required

The maximum flow rate needed is one of the critical pieces of data necessary to properly size a pump. The gallons per minute or cubic meters per minute of water entering the site will determine the required flow rate and pump capacity.

When it comes to maintaining the outward flow of water, the closer a pump can be located to the water source, the better. If the distance between pump and water is greater than 100 feet, the dewatering system may require larger piping or conduit.

4 Measure the pH

One factor often overlooked in dewatering pump selection is the pH of the water. Water that is acidic or basic can damage pumps and cause project delays. Many factors can affect the pH of groundwater and surface runoff. Groundwater may contain dissolved minerals from rocks or contaminants in the surface layers of soil. Rainwater can pick up airborne contaminants from nearby industries.

When the pH is outside the normal range, pumps made with corrosion-resistant materials are the ideal choice. They are less likely to break down as a result of issues such as seal failure and will perform better long term.

5 Measure the Pumping Distance

Pumping over large distances typically requires a pump with more horsepower, as well as larger hoses or pipes to reduce friction losses. Depending on the distance, multiple pumps may be necessary.

6 Calculate the NPSH

The net positive suction head (NPSH) also influences the required pump size, but contractors sometimes fail to factor it in.

NPSH is the difference between the pressure available at the suction port of the pump (NPSHa) and the pressure required to keep the pump operating properly (NPSHr). The NPSH calculation factors in the temperature and vapor pressure of the water being moved, the atmospheric pressure and friction losses. Using a pump with insufficient NPSH can lead to cavitation and pump breakdown.

7 Calculate the Required Static Suction Lift

The vertical lift from the lowest point of the water being pumped to the center or eye of the impeller is known as the static suction lift. The greater the suction lift, the lower the pump flow capacity.

A good rule of thumb is that at sea level, a properly operating vacuum-assisted priming pump can perform a static lift of 28 feet to the eye of the impeller. For every 1,000 feet of elevation, deduct one foot of priming capability.

A typical 6-inch, diesel-powered vacuum-assisted pump is designed to lift fluid 28 vertical feet to the impeller. If the required suction lift is greater than 25 feet, a different type of pump, such as a submersible pump, may be needed.

8 Rely on Expert Advice

When it comes to construction site dewatering, there is a lot riding on proper pump selection. If the dewatering system fails or a pump breaks down, water can start collecting on the site, slowing operations or bringing them to a stop.

Pump selection is more complicated than it may seem. A temporary equipment vendor with deep knowledge of pumps and experience in designing dewatering systems for a variety of jobsites can help contractors perform the necessary measurements and calculations, choose an appropriate pump and design a system that does the job efficiently and at the lowest cost. If the pump will need to handle both high and low flows, for example, the vendor may suggest using two pumps instead of one, with the second pump kicking in only when the flow is high, instead of oversizing the pump, which wastes energy and increases costs. ■

Tim Creech is a dewatering specialist at United Rentals. For more information, visit unitedrentals.com.

The Fundamentals of Mechanical Seals, Part 2

How this equipment seals and what features to consider when making a selection.

ALAN EVANS | A.W. Chesterton Company

In last month's article, we discussed the four basic components found in every mechanical seal, as well as reviewed the different configurations seals typically are available in. This month's article will look more closely at how a mechanical seal functions, and it will also identify some features to consider when selecting or being offered a seal from a supplier. First, we will look at how a mechanical seal "seals."

The first misconception many seal users have is that a mechanical seal is leak free while in normal operation; this is not correct. As described in last month's article, mechanical seals are precision, dynamic devices. The primary sealing interface, where the rotating face contacts the stationary seal face (Image 1), must be lubricated and cooled or significant heat and wear will occur quickly, resulting in catastrophic failure.

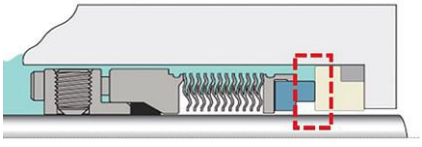

IMAGE 1: Primary sealing interface (Images courtesy of A.W. Chesterton Company)

The reality is there is a small gap formed between the seal faces in which fluid under pressure and temperature will act to cool and lubricate the face pair. In aqueous fluid, this gap can be as small as 0.3 micrometers (µm). As the fluid migrates through the gap, its pressure will drop and the temperature will increase until it typically vaporizes and is not visible to the human eye. However, in some cases with higher viscosity fluids like oils, the fluid may not vaporize and the faces may appear wetted or even have a small drop occurring over time. In both cases, the mechanical seal is operating fine. Image 2 shows this process underway in an operating seal. Therefore, all seals must leak in order to operate properly.

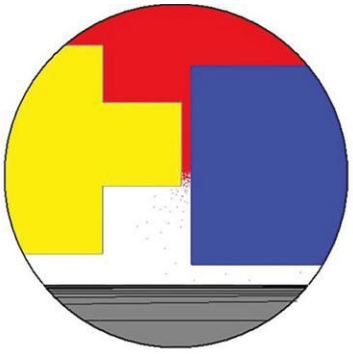

IMAGE 2: Fluid (red) progression through the sealing interface

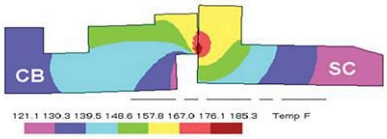

IMAGE 3: FEA showing positive "coning" of a seal face pair in operation

The seal faces do not run completely parallel as shown in Image 2, but due to the various stresses encountered in operation, there is always a level of distortion that is occurring. The art of mechanical seal design is to try to balance these various distortions so that at the design operating parameters, the faces are operating as close to parallel as possible and as close together as possible to limit the amount of leakage that occurs. Image 3 shows the results of a finite element analysis (FEA) model, showing the distortion occurring due to pressure and thermal stresses in an operating seal face pair.

It is critical to remember that if the sealed fluid does not offer the seal faces the proper amount of cooling and lubrication required, an external liquid or gas will need to be provided through what is called an environmental control/seal support system. The American Petroleum Institute (API) 682 Standard "Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps" offers a complete list with diagrams for the various piping plans that can be used. Most mechanical seal manufacturers have API piping plan details on their websites as well.

If there are particulates in either the process stream or fluid being used to provide cooling and lubrication to the seal, additional action may need to be taken to limit or remove these particulates, as they can both clog the seal from operating properly or interfere with the cooling and lubrication the seal faces need.

Now that we know how a mechanical seal "seals," it is important to understand what makes a mechanical seal successful in a given application. This starts with looking at what the goals are for the seal designer. This is fundamentally simple, but significantly more difficult to achieve in real life:

- To keep the seal face pair as flat and parallel as possible
- To keep the seal face pair as close together as possible to limit the amount of leakage occurring

There are several approaches to this goal that different seal designers (manufacturers) will use. Here are five key features that should be focused on.

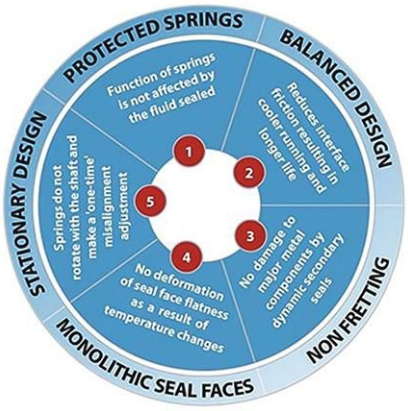

IMAGE 4: Five key features to consider when selecting a mechanical seal for an application

1 Protected Springs

Many early seal designs position the spring(s) on the rotating portion of the seal. This is known as a rotary seal design (Image 5). As can be seen in Image 5, the spring(s) are exposed to the process fluid where they have the potential for chemical attack or clogging.

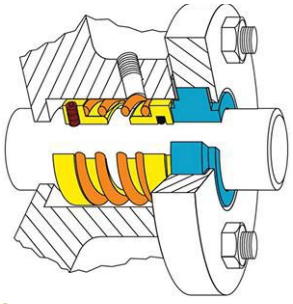

IMAGE 5: Rotary seal design with the springs exposed to the process fluid

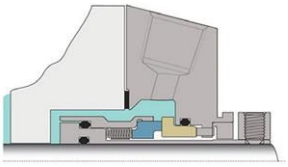

IMAGE 6: Seal design with the springs isolated from the process fluid

Recognizing these potential issues, seal designers developed a design that protects the springs by isolating them from the process fluid as shown in Image 6.

2 Balanced Design

Mechanical seal balance is a topic that could consume this entire article on its own. To simplify, seal balance describes the amount of hydraulic force (load) being applied to the seal faces. The higher the face loads, the greater the distortion and heat that is generated in the sealing interface, which works in direct opposition to the stated design goals above and also defines the operating capabilities of the mechanical seal. An unbalanced seal will have lower performance limits than a balanced seal design. An unbalanced seal design is one in which the full stuffing box pressure is impacting the loading on the seal faces as shown in Image 6.

A balanced seal design is one in which only a portion of the sealing interface is exposed to the stuffing box pressure as shown in Image 7. By reducing the hydraulic loading on the sealing interface, the seal can operate at higher pressures, temperatures and speeds more reliably.

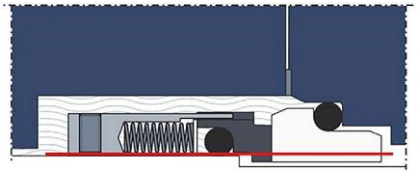

IMAGE 7: "Balanced" seal design in which only a portion of the sealing interface is impacted by the stuffing box pressure

A mechanical seal's balance is defined by what is known as its balance ratio, which is a calculation of the ratio between the closing forces imposed on the sealing interface versus the countering opening forces. A seal is considered unbalanced if this ratio is greater than 1.0. A standard balanced seal design will have a balance ratio between 0.65 and 0.85. However, for specific applications, a seal design can utilize different ratios to optimize the design.

3 Non-Fretting Design

Image 8 shows a pump shaft sleeve with a small groove worn in the area where the seal's dynamic elastomer is located. This occurs in rotary seal designs because nothing is perfectly aligned and concentric, so the rotary seal face will move relative to the stationary seal face. This very small movement results in the dynamic elastomer (O-ring, boot or bellows) rocking back and forth, causing the wear shown. If this continues for a period of time, the groove can become deep enough to inhibit the dynamic tracking required to maintain a small gap between the faces during operation, resulting in increased leakage. Image 9 shows this process.

IMAGE 8: Groove worn into a pump shaft sleeve from the dynamic elastomer moving back and forth during operation

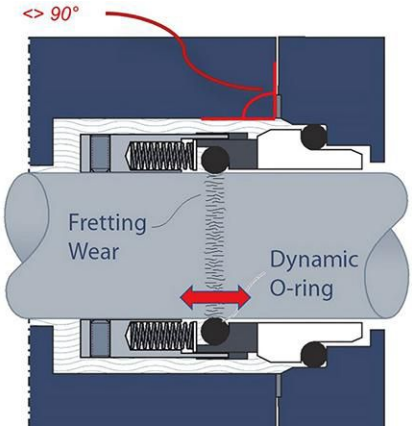

IMAGE 9: Relative motion between the seal's dynamic elastomer and the pump shaft sleeve, resulting in wear

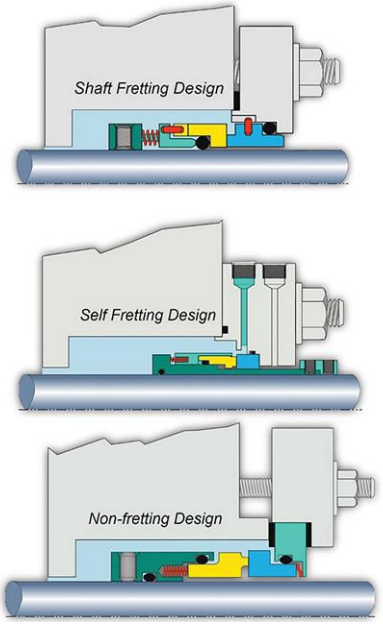

IMAGE 10: Dynamic elastomer locations, two of which will result in fretting over time

Seal designers have three options regarding the placement of the dynamic elastomer shown in Image 10. Originally, the dynamic elastomer was positioned

directly on the pump's sleeve or directly on the shaft, which resulted in the damage shown above. To combat this, seal designers can move the dynamic elastomer into the mechanical seal itself, but this just moves the wear internally to a metallic surface in the seal where it will still create problems. Alternatively, the seal designer can place the dynamic elastomer in a place where it does not contact any metallic surfaces, resulting in a non-fretting design.

4 Monolithic Seal Faces

Many first- and second-generation seal designs incorporated what is called

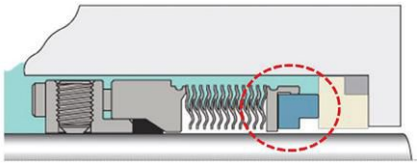

IMAGE 11: Seal material (blue) inserted into a metal holder

composite seal face technology. This is defined as a sealing material inserted or embedded into a metal holder, typically stainless steel, or the alloy the seal metal parts are made of. Image 11 shows a seal design with a composite seal face.

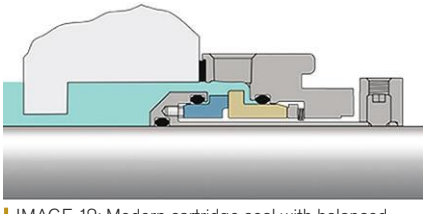

IMAGE 12: Modern cartridge seal with balanced, monolithic seal faces

In the 1990s, the third generation of seal design was introduced, including the use of monolithic seal face technologies. This means the entire seal face is made of one material like carbon/graphite, silicon carbide or tungsten carbide. Image 12 shows a monolithic seal face.

The major advantage of a monolithic seal face design relates to thermal growth. In the composite face design, there are two different materials which have different coefficients of expansion. In hotter processes, the materials will grow at different rates, resulting in additional face distortions which can limit the seals' ability to provide adequate leakage control

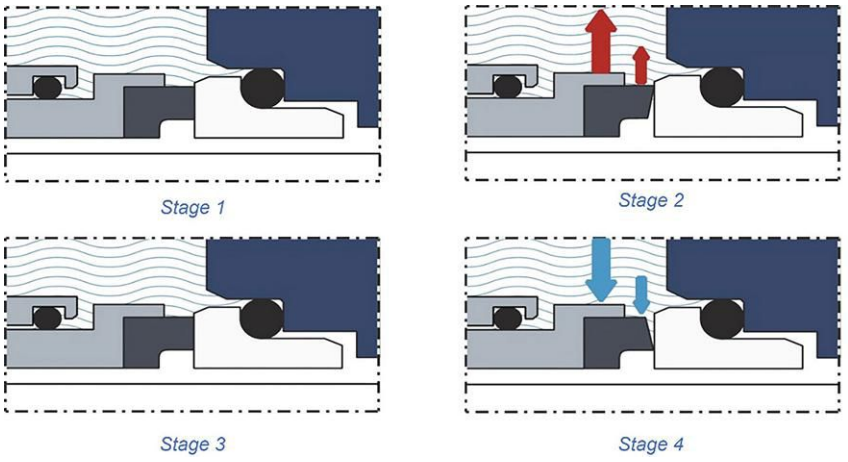

IMAGE 13: Stages of distortion a composite (inserted) face goes through during normal operation

both during and after operation. Image 13 shows the distortions a composite face goes through in normal operation.

Stage 1 represents the seal installed in the pump before operation begins. As the seal begins to rotate (Stage 2), temperature begins to increase and the various materials begin to expand at different rates, resulting in face distortion. As the system reaches equilibrium, the seal face will stabilize as well, including wearing in (Stage 3). When the pump is shut down (Stage 4), all the components begin to cool off, resulting in the components returning to their original shape except for the seal face, which can lead to an increase in seal leakage. Unlike a composite face design, a monolithic seal face will return to its original shape, offering greater reliability and leakage control.

5 Stationary Seal Design

A stationary seal design is one where the springs are mounted in the stationary side of the mechanical seal as shown in Image 14. The advantage a stationary seal

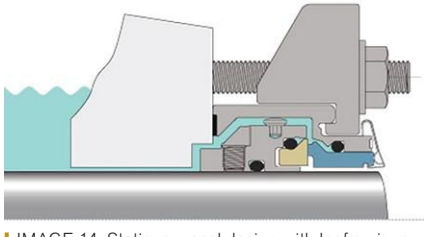

IMAGE 14: Stationary seal design with leaf springs mounted outside of the seal

design offers is that when there is any static misalignment, the stationary springs must move once to align the stationary face to the rotary face.

Conversely, in a rotary seal design, the spring must actuate twice for every shaft rotation to maintain dynamic tracking. Therefore, if the pump is operating at a nominal 1,800 rotations per minute (rpm), the rotary springs and face are moving 3,600 times per minute. For a nominal 3,600 rpm application, the rotary components are moving 7,200 times per minute. If anything interrupts this motion, there will be a momentary opening of the seal faces, causing increased leakage. If there are particles present, offering the possibility of trapping particles between the faces causes increased leakage, face wear and damage.

Given this amount of internal motion, there is an opportunity for something to interrupt the dynamic tracking, resulting in a momentary "opening" of the sealing interface and resulting in increased leakage. This also offers an opportunity for dirt or other debris to lodge between the faces, resulting in increased wear and damage. ■

Alan Evans is the global director of product line management for the A.W. Chesterton Company's mechanical seal business. Evans offers over 40 years of experience working with industrial systems and equipment, including rotating and stationary equipment in a multitude of industries. For the past 30 years, he has been working with pumps and sealing systems with a focus on improving reliability and reducing the total cost of ownership for the plants he has worked with globally. Evans holds a bachelor's in mechanical engineering and an MBA in high technology management. He is also a classically trained reliability engineer. Prior to working with Chesterton, Evans was a maintenance reliability engineer working in the chemical and minerals processing industries. For more, visit chesterton.com.

Lessons From the Space Shuttle Challenger Disaster, Part I

The importance of valve packing loading precision.

RON FRISARD |
Fluid Sealing Association member

IMAGE 1: Space shuttle Challenger takeoff (Images courtesy of Fluid Sealing Association)

On Monday, January 27, 1986, the anticipation was palpable as the crew of the space shuttle Challenger readied themselves for a historic launch. Poised atop the multibillion dollar spacecraft, all systems signaled a resounding "go for launch" on that warm Floridian day at Cape Canaveral. However, as technicians diligently sealed the cockpit door, an unexpected glitch emerged. The handle steadfastly refused to budge after a 90-degree rotation. No amount of pulling or pushing could dislodge it, prompting Lockheed Space Operations engineers to request power tools for assistance.

The unfolding drama captured global attention, with live TV broadcasting the escalating tension. Battery-operated drills and cutting blades were deployed, only to discover the batteries were running low, exacerbating the predicament. A seemingly inconspicuous bolt, responsible for securing the handle to the shuttle, had seized, casting an unforeseen shadow over the imminent launch of seven astronauts into space. Faced with escalating embarrassment and the ticking clock, a pivotal decision was made—to cut the handle with a hacksaw.

A maintenance worker, propelled into action from a nearby service building, entered the fray, President Reagan observing the unfolding events from the Oval Office on live TV. After overcoming security hurdles, the worker ascended the colossal 184 feet of the space shuttle using an elevator. The team diligently wielded their tools until the handle finally broke off, tumbling down between the gangway and the shuttle. Simultaneously, a weather front tracked by NASA swept into Cape Canaveral, with winds surpassing the shuttle's "return to launch site emergency constraints" threshold. NASA, confronting the unpredictable forces of nature, chose to abort the launch, rescheduling it for the following day.

Yet, hidden beneath the dramatic tale of this hatch bolt seizure lies a narrative rarely discussed—the incident that transpired on the eve of the space shuttle Challenger disaster. In the aftermath, discussions predominantly focused on the sealing of the O-ring in the booster rockets as the primary culprit behind the catastrophic setback that reverberated through NASA's space program. However, it is crucial to acknowledge that bolting, exemplified by the seized bolt, played a contributory role in this tragic accident. Beyond the space mission context, the challenges associated with bolting extend to plant operations, generating safety hazards and operational headaches, particularly in the domain of tightening valve glands.

At the core of industrial discourse lies a significant debate on how to precisely apply bolt load to valve packing. When overtightened, valve packing can wreak havoc, causing substantial damage to the valve and disrupting overall operations. On the flip side, insufficient load jeopardizes the valve packing's ability to maintain a reliable seal, culminating in costly leakage.

In times past, installation instructions for valve packing would often invoke the nebulous concept of "the skill of the craft" when it came to tightening. This approach relied on institutional knowledge, lacking precision. Older valve packing designs featured loose cores of fibers, a potential trigger for blowout failure modes when subjected to load loss. This perilous scenario resulted in injuries to maintenance workers, prompting efforts to preempt accidents by applying extra load to valve packing. This extra load typically took the form of using a pipe or cheater bar to extend the length of the wrench tightening the gland follower bolts, creating extreme gland forces that wreaked havoc with the valve's operation.

Excessive gland load on valve packing bolts gives rise to three primary issues. Learn more about these challenges and how to prevent them in Part 2. ■

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

Ron Frisard is packing and gasketing global product line director for AW Chesterton and chair of the gasketing division of the Fluid Sealing Association. and past chair of the packing division.

Pump Curves When Pumps Are Operated in Parallel & Applications That Utilize Pumps Operating in Series

HYDRAULIC INSTITUTE

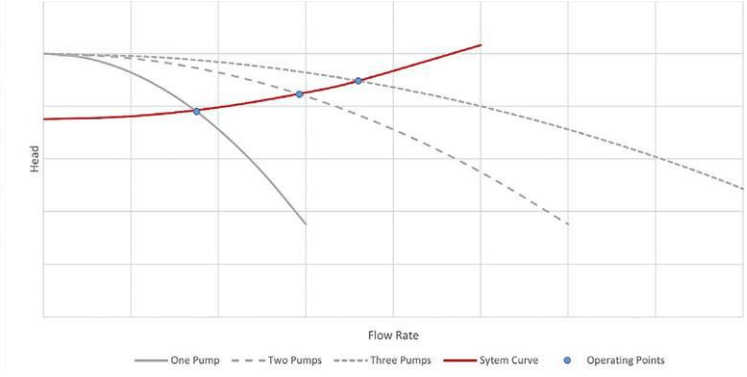


IMAGE 1: Three identical pumps operating in parallel with individual and parallel curves (Images courtesy of Hydraulic Institute)

Q | How does the pump curve change when pumps are operated in parallel?

Operating pumps in parallel means multiple pumps take suction (inlet) from and discharge (outlet) to a common header, meaning the suction and discharge pressures will be nearly identical. The idea is that each pump will share the flow requirement while operating at the same differential pressure or total head. The parallel pump curve is derived from the individual pump curves by adding the flow rate at the common head. Image 1 shows three identical pumps operating in parallel. The "Two Pumps" curve was derived by doubling the individual flow rate, and the "Three Pumps" curve was derived by tripling the individual flow rate while maintaining a constant total head. There are three operating points noted where the red system curve intersects the "One Pump," "Two Pumps" and "Three Pumps" curves. This is a reminder the actual system flow rate will not double or triple, so there should be an evaluation of the pump curves and system curves to understand how the total and individual pump flow rates will change when operating pumps in parallel.

For additional information on pump curves and varying the system operating point, refer to the Hydraulic Institute's Free Engineering Data Library at edl.pumps.org.

Q | What applications utilize pumps operating in series?

Series pumping is when the outlet of one pump supplies the inlet of another pump. This is much like the concept of multistage pumps, where within a single pump the outlet of one impeller supplies the inlet of the next. In series pumping, each pump will operate at the same flow rate unless some flow is directed elsewhere prior to the next pump. It is important to size series pumps to have nearly identical best efficiency point flow rates. Additionally, it is important to consider that each subsequent pump (if at the same location) will have higher inlet pressure, so the subsequent pumps may need to be designed to operate at a higher working pressure. Image 2 shows that operating three identical pumps in series triples the total head at a constant flow rate.

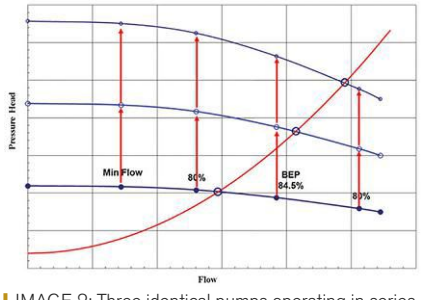


IMAGE 2: Three identical pumps operating in series with individual and parallel curves

The two main reasons for series pumps are booster pumping to increase the inlet pressure of a second pump or when there are system high head requirements that cannot be accommodated by a single pump.

Some applications require an initial booster pump designed with lower net positive suction head requirements (NPSHr), which then boosts the pressure to a second pump. A common application for this occurs in the electric power plant steam cycle, where high energy pumps may be used that require high NPSH margin for reliable operation.

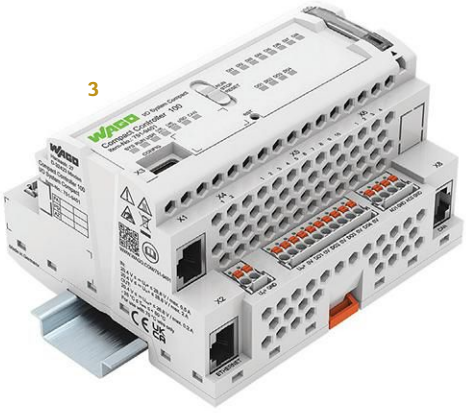
Some applications have high system head requirements along with high volumetric flow rates. An example of this is oil and gas pipeline applications that pump large volumes over thousands of miles. It is common to have four double suction between bearing pumps that operate in series to overcome the high friction head loss in the long pipe line. The first pump may be designed to operate at a lower speed (with lower NPSHr), which also acts as a booster pump for the subsequent pumps that operate at higher rotational speeds. ■

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

HYDRAULIC INSTITUTE

NEW & NOTABLE TECHNOLOGY

Selected by the *Pumps & Systems* editors



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1 STAINLESS STEEL

SIMFLO's line of 316 stainless steel pumps are durable, corrosion resistant and highly adaptable for use in the harshest environments. The high-quality bowls and impellers are designed for a wide variety of applications, including water and wastewater treatment and distribution, industrial processing, petroleum production, mining, agriculture and more. SIMFLO's stainless steel castings, from 5 to 16 inches and 50 to 50,000 gpm, feature Vesconite bearings.

■ *simflo.com*

2 INTELLIGENT ACTUATOR

The **ROTORK** IQ3 Pro is a range of intelligent electric valve actuators that offer a combination of performance, reliability and connectivity with the integrated Rotork app. The Rotork app provides intelligent control and communication capabilities for the IQ3 Pro electric actuator. The app introduces smart features, including a virtual setting tool and a valve configuration setup wizard. Data logs from the actuator can be extracted via the app and exported to Rotork Insight 2 software or sent to Rotork's cloud-based intelligent asset management (iAM) system.

■ *rotork.com*

3 CONTROLLER

A new member has been added to **WAGO**'s Compact Controller 100 family. The 750-9401 Controller has a dual core processor with a mix of 18 digital and analog onboard I/O channels. It also comes with an RS-485 serial port, dual Ethernet ports, a USB-C port for direct configuration connection as well as a CANopen communication port. The CANopen port makes it easier for the expansion of applications where more digital I/O may be needed, or connecting to other devices such as sensors or J1939 enabled devices. This compact unit is programmed with CODESYS 3.5 software that is free of charge or can be used with Docker containers for running opensource applications.

■ *wago.com*

4 MICROPUMP

PSG BIOTECH, a provider of pump, flow-sensor and flow-measurement technologies for use in life science and biopharmaceutical process applications, and a brand of PSG, is pleased to announce the availability of the new Quattroflow QB2-Standard (QB2-SD) single-use precision micropump. The Quattroflow pump family is expanding with the launch of its first QB Series micropump, the QB2-SD. This model is the smallest size in the family of single-use, lightweight and compact rotary microdosing pumps designed for precision and can be used to transfer delicate biologics. The QB2-SD has a minimum resolution of 25 µl and flow rates up to 2.7 liters per hour (91.3 fluid ounces per hour), which makes the QB2-SD pump ideal for liquid-handling operations requiring precise and delicate dosing of products that can be found in cell and gene therapy, laboratory and small-scale upstream and downstream applications.

■ *psgdover.com/biotech*

5 SELF-PRIMING PUMP

TITAN MANUFACTURING INC. now provides ANSI 4796 self-priming pumps. They're designed for chemical processing, oil and gas, petroleum transfer, industrial sumps, and water and wastewater applications. Power frame parts are interchangeable with ANSI 4196 models. ANSI 4796 pumps have an effective lift of 20 feet for sump applications. Flange options class #150 and class #300 available. The one-piece casing is designed to purge air from the casing and retain enough liquid for future priming.

■ *titanpumpsinc.com*

6 VERTICAL HOLLOSHAFT MOTORS

The **U.S. MOTORS** brand line of vertical HOLLOSHAFT motors has been setting a standard for the vertical turbine pump industry since 1922. Their innovative, performance-focused design keeps farming, turf, municipal and industrial pumps running strong, even in the harshest conditions. Available in a wide range of power, speed and enclosures, U.S. MOTORS brand vertical motors drive an optimal ROI by offering peak energy efficiency and reliability.

■ *usmotors.com*

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PRODUCTS

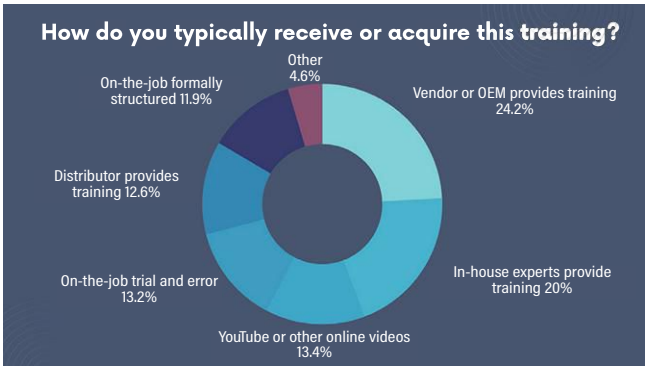
Workforce Survey: Training

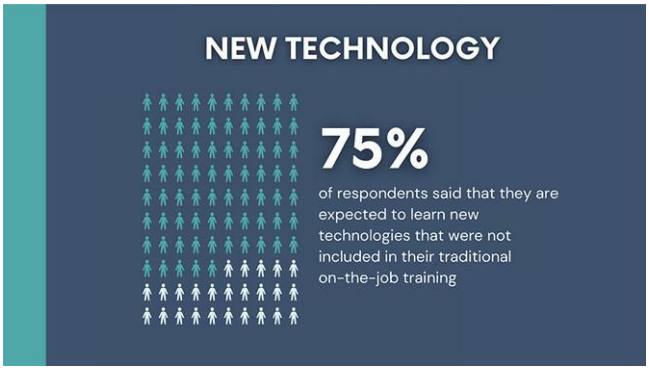
Pumps & Systems partnered with the Hydraulic Institute to provide more insight on training across the industry.

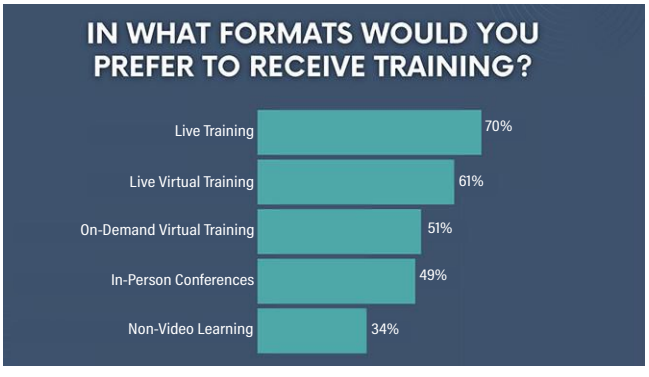
Looking for Market Analysis? It's on hiatus this month, but while you wait, here are some stats about the current state of training in the industry and where those in the workforce would like to see training improve.

This workforce survey was deployed at the end of September 2023 in partnership with the Hydraulic Institute. The majority of respondents work in water/wastewater treatment (59%) and have 21 years or more of experience in the industry (62%). Those taking the survey were asked to characterize their job. 49% said engineering, with maintenance (13.5%), other (11%), executive/administration (9%) and operations/technicians (8.5%) following behind.

Here are some of their answers about the industries need for training and how they wish to receive it. ■







Virtual training opportunities: | **Live and on-demand webinars: pumpsandsystems.com/webinars Podcasts: The Pumps & Systems** **Podcast, available on podcast apps or in video format on YouTube (youtube.com/@pumpsandsystemsmag)** **Courses, assesment prep and other tools via the Hydraulic Institute: training.pumps.org**

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