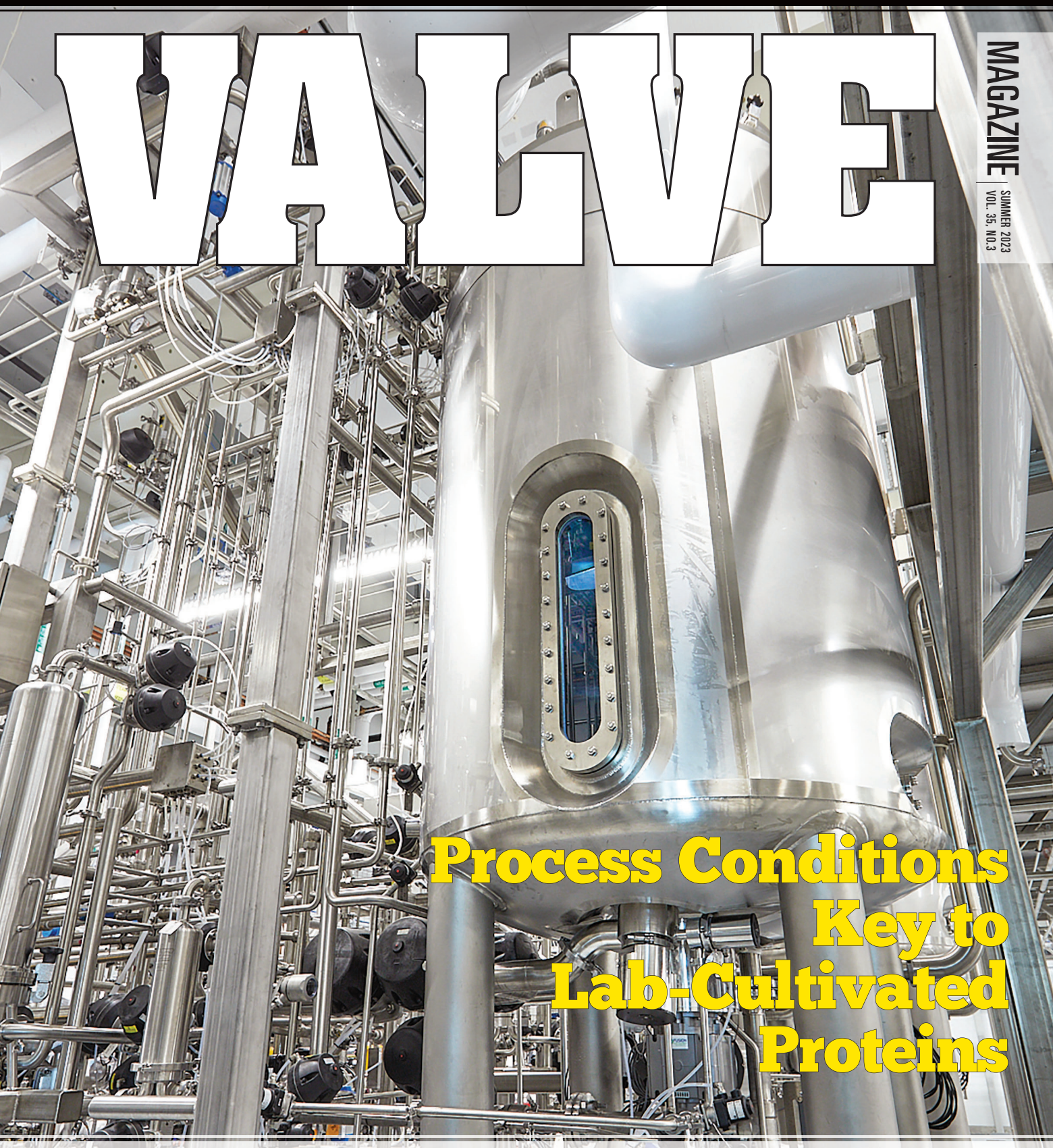
HYDROGEN VALVE SUMMIT COMING IN SPRING 2024

# VALVE

MAGAZINE
SUMMER 2023
VOL. 35, NO.3



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- CHECK VALVE INSTALLATION
- SRV TESTING & MONITORING
- A PRIMER ON PRESSURE SEAL VALVES

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VMA MAGAZINE
SUMMER 2023 | VOL. 35, NO. 3

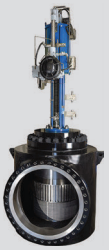
14

# Sustainable Protein Products: What's Ahead for Manufacturers

As climate change forces us to look at different ways to grow, raise and cultivate our food, fermentation to create "meat" that is sustainable is on the rise. BY DIANE JACOBER

COVER PHOTO COURTESY OF UPSIDE FOODS





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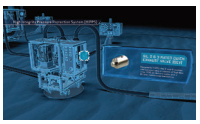
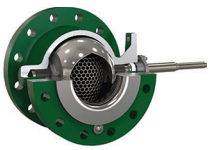


Advances in Offshore Safety



Metal Additive Manufacturing: The Evolving Road to Adoption & Standardization

Testing of Hydrogen Valves


Predictive Maintenance with Retrofitted Electraulic Actuation

VALVE MAGAZINE

www.VALVEmagazine.com



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VMA VALVE MANUFACTURERS ASSOCIATION OF AMERICA

www.vma.org

# Unlocking the Future: VMA's Annual Meeting and Beyond Tackle Key Trends

This time of year, I'm spending time planning VMA's Annual Meeting, and a significant part of that is working with our member leaders to discuss and understand what's on their minds, and how that translates into topics to cover at the Annual Meeting. It also provides a time to reflect on how the issues and activities VMA is working on help our member companies in their businesses. In looking at this issue of *Valve Magazine*, there are certainly overlaps in what is covered here and what we'll delve deeper into at the 85th VMA Annual Meeting early this fall and throughout the coming year.

First and foremost, hydrogen. Close behind are carbon capture, energy transition and energy security — all very important topics for our industry. The Annual Meeting will address these topics, and on page 18, we take a look at control valves in hydrogen applications, focusing on the importance of material selection and sizing, as well as setting up for diagnostics to prevent fugitive emissions and other issues once installed. I'm also excited to announce that VMA will be holding our first **Hydrogen Valve Summit** — open to anyone in the industry — next spring. This is the first event for the industrial valve industry solely focused on hydrogen and carbon capture opportunities. It is one day prior to the Valve Forum, and I hope to see you there!

A market segment that we haven't covered in the magazine for a while is food and beverage. This issue's feature article (page 14) takes a look at some of the unique processing and valve needs in the industry, and even if your company isn't a part of the industry — the article is an interesting read!

Other articles get back to basics by exploring important safety considerations and a case study with valves used in the nuclear industry, as well as articles on check valves and pressure seal valves.

Also in this issue of *Valve*, the VMA News section discusses the PFAS chemicals activities we are working on to support our members and the industry at large. With the potential to have detrimental effects on the environment, health, the economy and more, it is of paramount importance to all of us. I am also happy to announce two new VMA members.

Thank you for reading *Valve Magazine*, and as always, if your company isn't a member and would like more information, please contact me at hrhoderick@vma.org.

Heather

**Heather Rhoderick, CAE**
*President*

# OEM Support Services

United Valve offers a unique package of services for the valve manufacturer. Our machining and welding capabilities allow us to perform any type of modification or after-market upgrade. A 104,000 sq. ft. shop with 40-ton overhead crane lifting capacity and 35 ft. hook height make easy work out of large valve handling. Valve repair is handled by a team of experienced valve technicians, ready to apply their skills on all types of valves either in-house or in the field.

CAD-CAM capabilities on six CNC machine tools, along with many manual machines enable us to manufacture virtually any production or replacement valve part. We can manufacture complete components for metal-seated ball valves up through 12", including ball lapping and polishing.

Our engineering testing department is staffed with experienced valve engineers. This group provides engineering testing services including fugitive emissions testing, cryogenic testing, API RP591 evaluation, valve forensic analysis, plus many other valve inspections and examinations.

The United Valve team is ready to partner with your company to provide products and services that are either beyond your daily scope of operations or not cost effective for you to perform.

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- *Bore work*
- *All types of modifications*

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- *Manual Milling machines & Lathes*
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## Fire Testing
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- *API 6FA*

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- *All valve sizes and types*
- *ISO, MSS or customer specifications*
- *Helium or Methane*

## API RP591 Testing
- *Gate, globe, check & ball valves*
- *Manufacturer evaluation*
- *Subcontractor evaluation*

## Cryogenic Testing
- *All sizes and valve types*
- *Testing at -320°F, -150°F & -50°F*

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## COMPANY TRANSITIONS TO EMPLOYEE OWNERSHIP AND THRIVES

Doug Beck first learned of employee ownership when his bank recommended it to him as a method of succession for his family company. "I first realized that employee ownership was what I was going to do as I planned for retirement because I don't have any children to take over the business," Beck says. "I also wanted to retain the culture and success of the company moving forward without having to worry that a sale to a competitor or other strategic buyer would result in relocating the business, laying off workers or reducing benefits."

Founded by Beck's grandfather, Harold Beck & Sons began in Philadelphia with the initial goal of improving temperature control of industrial furnaces and the belief that their automation method could prove more effective than other companies. The business grew exponentially during the 1940s as World War II surged and continued to grow from there. In 1996, Doug Beck joined the company as president and began placing an emphasis on international expansion. Today, the company has 135 employees. Beck electric actuators are used in more than 70 countries and in more than a dozen industries to precisely position valves and dampers.

Harold Beck & Sons became employee-owned through an Employee Stock Ownership Plan (ESOP) at the end of 2021.

Since transitioning to the ESOP at the end of 2021, Beck says he has already noticed increased growth, excitement and engagement within the company. "People really began to take real ownership in the company and have more enthusiasm," Beck says.

## EXXONMOBIL TO ACQUIRE DENBURY INC.

ExxonMobil Corporation (NYSE: XOM) has entered into a definitive agreement to acquire Denbury Inc. (NYSE: DEN), an experienced developer of carbon capture, utilization and storage (CCS) solutions and enhanced oil recovery. The acquisition is an all-stock transaction valued at $4.9 billion, or $89.45 per share based on ExxonMobil's closing price on July 12, 2023. Under the terms of the agreement, Denbury shareholders will receive 0.84 shares of ExxonMobil for each Denbury share.

- Combined assets and capabilities further accelerate ExxonMobil's Low Carbon Solutions business and create an even more compelling customer decarbonization proposition
- Leading CCS network underpins ExxonMobil's commitment to low carbon value chains including CCS, hydrogen, ammonia, biofuels and direct air capture
- Transaction synergies expected to enable more than 100 MTA of emissions reductions over time, driving strong growth and returns

The transaction synergies are expected to drive strong growth and returns for ExxonMobil. The acquisition of Denbury provides ExxonMobil with the largest owned and operated $CO_2$ pipeline network in the U.S. at 1,300 miles.

## CHEVRON ANNOUNCES AGREEMENT TO ACQUIRE PDC ENERGY

Chevron Corporation has entered into a definitive agreement with PDC Energy, Inc. to acquire all of the outstanding shares of PDC in an all-stock transaction valued at $6.3 billion, or $72 per share. Based on Chevron's closing price on May 19, 2023, and under the terms of the agreement, PDC shareholders will receive 0.4638 shares of Chevron for each PDC share. The total enterprise value — including debt — of the transaction is $7.6 billion.

The acquisition of PDC provides Chevron with high-quality assets expected to deliver higher returns in lower carbon intensity basins in the United States. PDC brings strong free cash flow, low breakeven production and development opportunities adjacent to Chevron's position in the Denver-Julesburg (DJ) Basin, as well as additional acreage to Chevron's leading position in the Permian Basin.

"PDC's attractive and complementary assets strengthen Chevron's position in key U.S. production basins," says Chevron Chairman and CEO, Mike Wirth. "This transaction is accretive to all important financial measures and enhances Chevron's objective to safely deliver higher returns and lower carbon. We look forward to welcoming PDC's team and shareholders to Chevron and continuing both companies' focus on safe and reliable operations."

"The combination with Chevron is a great opportunity for PDC to maximize value for our shareholders. It provides a global portfolio of best-in-class assets," says Bart Brookman, PDC President and CEO. "I look forward to blending our highly complementary organizations, and I'm excited that PDC's assets will help propel Chevron toward our shared goal for a lower carbon energy future."

## CIRCOR INTERNATIONAL ENTERS ACQUISITION DEAL WITH KKR

Circor International Inc. (Circor), a provider of mission-critical flow control products and services for the industrial, aerospace and defense markets, has entered into a definitive agreement to be acquired by investment funds managed by KKR, a global investment firm, in an all-cash transaction valued at approximately $1.6 billion, including the assumption of debt.

Under the terms of the agreement, KKR acquires all outstanding shares of Circor common stock for $49 per

share in cash, representing a 55% premium to the company's closing stock price.

KKR is making its investment in Circor through its North America Fund XIII. The investment builds on KKR's experience investing in flow control technologies and aerospace and defense industry suppliers globally, including Ingersoll Rand (formerly known as Gardner Denver), Flow Control Group, Hensoldt and Novaria Group.

The board of directors of Circor has unanimously approved the transaction and recommends that Circor shareholders vote in favor of the transaction. The transaction is expected to close in the fourth quarter of 2023, subject to the receipt of approval from the company's shareholders and certain required regulatory approvals, as well as the satisfaction of other customary closing conditions. The board has the right to terminate the merger agreement to enter into a superior proposal, subject to the terms and conditions of the merger agreement.

Following the close of the transaction, KKR will support Circor in expanding its equity ownership program to allow all employees to have the opportunity to participate in the benefits of ownership of the company. This strategy is based on the belief that employee engagement is a key driver in building stronger companies. Once the transaction is complete, Circor will be a privately held company wholly owned by KKR's investment funds and will no longer have its common stock listed on any public market.

## CURTISS-WRIGHT SELECTED BY NEI TO DEVELOP NEXT-GEN PADS

Curtiss-Wright's Nuclear division announced that it has been awarded a contract by the Nuclear Energy Institute (NEI) to develop the Next Generation Personnel Access Data System (Next Gen. PADS). First introduced in 1988, NEI's PADS software is used by U.S. commercial nuclear licensee members to share access authorization, fitness-for-duty, training and radiation protection information.

Curtiss-Wright will collaborate with NEI and its industry steering committee in the design, testing and implementation of the Next Generation PADS software. The company's In-Processing and Access Authorization (IPAA) suite is comprised of three software applications designed to optimize nuclear in-processing, access authorization, and fitness-for-duty activities. Over 65% of U.S. nuclear power utilities use IPAA applications.

Curtiss-Wright is performing the work at its Idaho Falls, Idaho, facility within its Nuclear division in the Naval & Power segment. The project commenced in Q2 2023 and is scheduled for completion by the end of 2024.

## AMERICA MAKES AND ANSI PUBLISH ROADMAP FOR ADDITIVE MANUFACTURING V3.0

America Makes and the American National Standards Institute (ANSI) announced the publication of the Standardization Roadmap for Additive Manufacturing, Version 3.0, developed by the America Makes and ANSI Additive Manufacturing Standardization Collaborative (AMSC). The roadmap describes the current and desired future standardization landscape for additive manufacturing (AM) and focuses on industrial market sectors using AM technologies. A total of 141 standardization gaps (including 60 new gaps) are identified with corresponding recommendations across the AM lifecycle areas of design; precursor materials; process control; post-processing; finished material properties; qualification and certification; nondestructive evaluation; maintenance and repair; and data. The hope is that the roadmap will be broadly adopted by the user community to facilitate a more coordinated approach to the future development of AM standards.

The AMSC is a cross-sector coordinating body that works to accelerate the development of industry-wide AM standards.

## NEW PARTNERSHIP FORMED TO TREAT AND DESTROY PFAS FROM MUNICIPAL WATER SYSTEMS

Ovivo Inc. ("Ovivo"), a global provider of water and wastewater treatment equipment, technologies and systems, announced a new strategic partnership with E2metrix Inc. ("E2metrix" and together with Ovivo, the "Partners") to develop and commercialize a complete integrated solution to treat and destroy perfluoroalkyl and polyfluoroalkyl substances ("PFAS"), commonly called the forever chemicals, and other emerging contaminants present in water and wastewater. The solution will permanently safeguard public health and provide a viable onsite PFAS

**SEPTEMBER**

**27-29**
**VMA/VRC Annual Meeting**
*(VMA Members only)*
*Savannah, GA*
**Vma.org/AnnualMeeting**

**OCTOBER**
**VMA Webinar: Hydrogen & Carbon Capture**

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**Valve Basics**
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## 2024

**APRIL**

**9**
**Hydrogen Valve Summit**
*Houston, TX*

**10-11**
**Valve Forum: Conference & Exhibits**
*Houston, TX*
**VMA.org**

**OTHER VMA EVENTS**
Please visit vma.org for additional programs as they are scheduled.

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

VALVE MAGAZINE

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destruction option to their customers.

Since December 2021, Ovivo and E2metrix have been exclusively collaborating to develop an onsite, commercially viable treatment system to remove and destroy PFAS present in municipal drinking water utilizing an electrochemical oxidation technology at the heart of the integrated solution. The partners are currently piloting a solution in Alabama that has delivered impressive results with up to 99% reduction of PFOS and PFOA and over 85% reduction of total detectable PFAS in the water treated. The integrated solution is not only removing PFAS, but is mineralizing these forever chemicals into their elemental parts of carbon and fluorine, returning safe water back to the environment at a full-scale facility.

## PEOPLE IN THE NEWS

### THREE NEW SENIOR APPOINTMENTS AT VAL-MATIC

Val-Matic Valve & Mfg. Corp. CEO Rob McDonald announced the appointment of Suhas Mahadik to the position of president, and the promotion of Jason Maciejewski to the position of senior VP of sales. The company also welcomed Sandra Diaz as director of planning and forecasting.

Mahadik has been with parent company A.Y. McDonald Industries since July 2022 as director of automation. Maciejewski has been with Val-Matic nearly 13 years and has held a variety of sales roles with increasing responsibility. Diaz began her career in customer service and switched to inventory and supply chain. She has worked in the PPE industry, and gained responsibility with each role.


Suhas Mahadik


Jason Maciejewski


Sandra Diaz

### EASTERN CONTROLS ANNOUNCES LEADERSHIP UPDATES

Eastern Controls, Inc. (ECI), a leading provider of process measurement and control equipment and services, announced the promotion of Kevin Lavelle to general manager and Ted Johnson to vice president of sales. Lavelle assumes overall responsibility for the strategic direction, growth and operational excellence of Eastern Control. He has extensive experience in sales and leadership, and a deep understanding of the industry. Johnson has spent more than 40 years in the process industry and has developed strong relationships throughout his career.


Stefan Gesing

### VDMA VALVES ASSOCIATION ELECTS NEW VICE CHAIR; COMMITTEE CHAIR

In early July, the board of directors of the Building Valves Division elected Stefan Gesing, CEO of Dornbracht AG & Co KG, as its new chairman. He also assumes the role of vice chairman of the VDMA Valves Association. Gesing has been CEO at Dornbracht since 2020. Previously, he served as CFO and member of the executive board at Grohe AG and as CFO at Thyssenkrupp Industrial Solutions.

# Forward together – Neles is now part of Valmet



Neles was merged into Valmet on April 1, 2022 and is now Valmet's Flow Control business line. Valmet now offers an extensive flow control portfolio of industry-leading valves, valve automation solutions and related services, including the renowned Neles, Neles Easyflow, Jamesbury, Stonel, Valvcon and Flowrox solutions.

Valmet is now an even stronger, globally leading company with a unique and competitive offering of process technologies, services, automation systems and flow control solutions for process industries.

Our global team of around 17,000 professionals is committed to moving your performance forward — every day.

For more information, visit **valmet.com/flowcontrol**

Valmet FORWARD

# PFAS Task Group Formed; Comments Submitted on Draft PFAS Legislation

VMA's PFAS Task Group, formed earlier this year, is working to raise awareness of the implications that a full ban on all PFAS materials could have on the industry, the customers it serves, the environment, health, energy, the economy and much more. For a number of years, the governments in the European Union, the U.S. and Canada have been increasing activities that would lead to a ban on all PFAS materials — having far-reaching and what we believe are broad negative implications to society.

While VMA supports eliminating harmful PFOAs and PFOS, we believe the many other PFAS chemicals, including fluoropolymers, create low concerns and need to continue to be used. In our industry, fluoropolymers are used due to their properties in effective sealing, creating barriers for emissions, reducing energy use and providing a safe and reliable production process. There are no available substitutions that provide similar and extensive benefits in many critical applications. Additionally, removing the ability to use these PFAS would negate decades of success in providing clean air as these products drastically reduce fugitive emissions.

Earlier this month, VMA submitted comments in support of the Senate's Committee on Environment and Public Works' draft legislation on per- and poly-fluoroalkyl substances (PFAS). This draft legislation differentiates different types of PFAS substances, which VMA supports. VMA continues to work with other national and global associations on this issue and to support our members and industry with governmental and other leaders as needed.

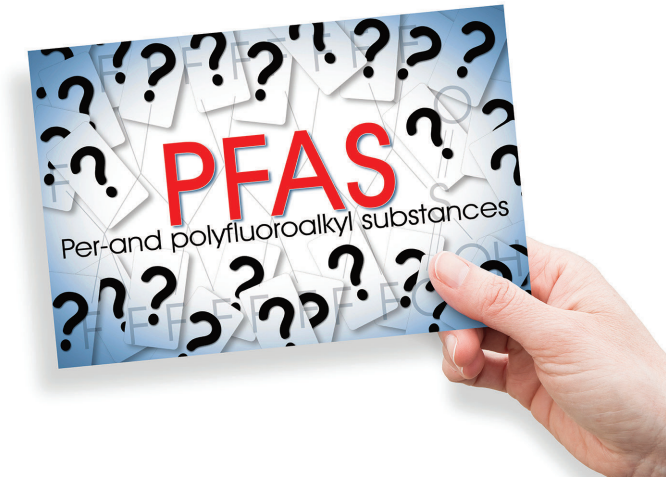



PHOTO CREDIT: GETTY IMAGES

For more information on PFAS used in our industry, see the *Valve Magazine* article in the Winter 2022 issue.

# Hydrogen Valve Summit Announced; New Location for Valve Forum 2024

It is hard to ignore the focus on and opportunities for hydrogen solutions and carbon capture technology — both in mainstream news and in technical journals from many industries. The industrial valve industry is essential to help bring the benefits and potential opportunities of both mainstream. VMA is excited to announce a new Hydrogen Valve Summit to help our industry understand many of the issues and hear perspectives from key players. The Hydrogen Valve Summit will provide an overview of the landscape; government/academia perspectives; end-user applications and perspectives; and testing, qualifications, materials, standards and other topics.


"This is the first industry event that truly focuses just on these two technologies and the role that valves have in helping the world meet new environmental and energy challenges. I'm excited to help VMA offer this Summit to the industry next year," says Heather Rhoderick, president of VMA. The Summit will be held the day prior to the 2024 Valve Forum, on April 9, 2024, in Houston.

The Valve Forum: Conference & Exhibits will be held April 10-11, 2024, in Houston. The forum offers exhibits, product demonstrations, hands-on opportunities and plenty of educational sessions and networking. Introductory and advanced technical topics on valves, actuators and controls — including applications and standards — will be covered, as well as manufacturing, marketing and business topics. More information will be available this fall, and those who are interested can sign up to receive the information first at **www.vma.org/valveforum**.

# VMA Welcomes New Members

VMA welcomes **ARI-Armaturen** as a new manufacturer member! ARI-Armaturen can look back on a tradition of more than 60 years as a specialist for valves and components. In 2002, ARI-Armaturen USA was established in Houston to provide a growing North American customer base with localized support and inventory.

From industrial processes and chemicals through shipbuilding to building management, whether standard constructions or custom-made, the company offers a broad product portfolio of industrial valves and services linked to control, isolation, safety and steam trapping. Product development, manufacturing and rigorous testing are done with state-of-the-art technologies and quality control processes.

VMA welcomes **Carbide Technologies Inc. (CTI)** as a supplier member! Carbide Technologies specializes in rotating equipment and valve repairs and manufacturing. Utilizing thermal spray coatings, precision grinding and seat lapping, CTI is able to repair any type of ball for ball valves ranging from 2" to 42". Not restricted to ball valves, CTI can also coat and grind plug and gate-type valves. Family-owned and operated, Carbide Technologies Inc. is located in Houston.

CARBIDE TECHNOLOGIES, INC.

# Excitement Builds for 85th Annual Meeting

VMA is holding its 85th Annual Meeting this year back on the east coast for the first time in four years, and in a new city, Savannah, Ga. The Annual Meeting — open to VMA and VRC member companies — delivers unparalleled networking, discussion and analysis of the most important external and internal issues being faced, and how they affect the industrial valve and flow control industry. This year, topics on the agenda include traditional and new energy sources, sustainability/ESG, government regulatory and legislative implications including PFAS updates and implications, trade and geopolitical issues, industry technical innovations and more. Hotel rooms are filling up fast, and registration rates increase September 5. VMA and VRC members can register and learn more at **www.vma.org/annualmeeting**, and for those interested in VMA membership, contact Heather Rhoderick at hrhoderick@vma.org.


# Nominate a Deserving Individual for a VMA Membership Award

Each year, VMA honors and recognizes individuals who have contributed significantly to the industry and VMA. All VMA members are encouraged to provide nominations for individuals who are deserving via the link on **vma.org/awards**.

Two awards are presented at the annual meeting — the Person of the Year Award and the Service Award. The Person of the Year Award is VMA's highest honor and is given to one individual each year. The winner should possess a passion for the industry and for sharing their knowledge with others to help advance VMA and the industry at large.

VMA's Service Award recognizes individuals who have provided outstanding service, expertise and guidance while participating on a committee, or to VMA in some other way. A list of past recipients of both awards can be found at **vma.org/awards**.



# VMA's Office is Moving!

Early this fall, VMA will move its offices to Alexandria, Va. The new office provides a modern layout and flexibility to meet the changing needs of staff and the way in which work is conducted today. It will have space available for VMA committee meetings and also offers members a home base if they are in the D.C. area for business. A small display area will be filled with examples of our industry products — past and present — as well as an area to facilitate video content.

"With its location close to many other organizations which VMA routinely works with, as well as to transportation, the new office space provides VMA with the opportunity to showcase the industry and our Association to members and partners," says Heather Rhoderick, president of VMA. Effective October 1, 2023, the new office address is 209 Madison St., Ste. 303, Alexandria, VA, 22314. All email addresses and phone numbers will remain the same.

# Valve Repair Seminar Provides Focus on Key Industry Issues

After a five-year hiatus, the Valve Repair Seminar, produced by the Valve Repair Council, an affiliate of VMA, took place in early June outside of Houston, Tx. The Seminar provided the perfect opportunity for learning and networking through the sharing of best practices, tours of a local facility and demonstrations of new technology.

Day one included a tour of the Setpoint IS facility nearby, where safety programs were highlighted as well as the overall facility operational flow and various pods of work centered on specific valve types.

Speaker R. Roth

The next day kicked off at the Houston Area Safety Council with presentations on various repair issues and management topics. The day was moderated by Chris Jones, Valve Repair Council board member and director of asset reliability Services at Midwest Valve Services. Kyle Burdine, lead speaker and sales engineer at Digitize Designs, provided attendees with AI applications for the repair industry, mostly around possibilities with 3D scanning technology and how that could be utilized in the valve repair process.

Other topics that generated a lot of discussion — both presented by Setpoint employees — included a discussion on hiring and why it's important to find the right team and individuals who support and reflect the organization culture and goals, and safety considerations when bringing valves back to the shop to repair. A discussion on the industry implications and current activity around PFAS chemicals also took place. Remaining sessions focused on core repair issues — from pipeline valves, MOV, fugitive emissions and more.

Thank you to Carbide Technologies, EFCO USA, ENGIS and EGC for providing tabletop displays during the closing reception. With over 40 people in attendance, the event was a great way for targeted networking! The next seminar will take place in two years. In the meantime, repair topics will be presented at the Valve Forum next spring in Houston.

# Sustainable Protein Products: What's Ahead for Manufacturers?


Photo courtesy of Getty Images

## As alternatives to conventional meat products are being introduced to relieve environmental and ethical implications of farming, process engineers are presented with both challenges and opportunities.

BY DIANE JACOBER

In recent years, people worldwide have grown increasingly concerned about the environmental and ethical implications of raising livestock on a densely populated planet. As a result, alternatives to conventional meat products are being introduced and adopted rapidly, presenting both challenges and opportunities for process engineers as they work to design manufacturing practices to deliver these foods at reasonable cost and with the most efficient use of resources.

### BIOMASS FERMENTATION AND MYCELIUM PLANT MEAT

A family of products called fermented proteins are one field that is growing in popularity. While fermentation has been used in food preparation for years, recent technology is using fermentation for alternative protein production. The Good Foods Institute (GFI) defines "biomass fermentation" as "using high-protein content and rapid growth of microorganisms to efficiently make large amounts of protein-rich food."

Also called fungi-based food, mycelium forms a filamentous, dense structure that mimics meat with excellent protein content and digestibility.

Biomass fermentation takes place in a bioreactor where environmental conditions key to the growth of the mycelium are closely monitored and controlled. Engineers are optimizing bioreactor design, but the process is already considered to be an efficient method of food preparation. Products made with this technique, such as Quorn, are widely available today in supermarkets.

### CULTIVATED MEAT

Also referred to as cell-based meat, cultivated meat is a new, innovative cellular agriculture process with the potential to feed more people using fewer resources than conventionally raised livestock. Unlike plant-based meat alternatives that only mimic the taste and texture of meat, cultivated meat is a real meat protein grown from animal cells in a bioreactor.

By leveraging the biotechnology already being used to

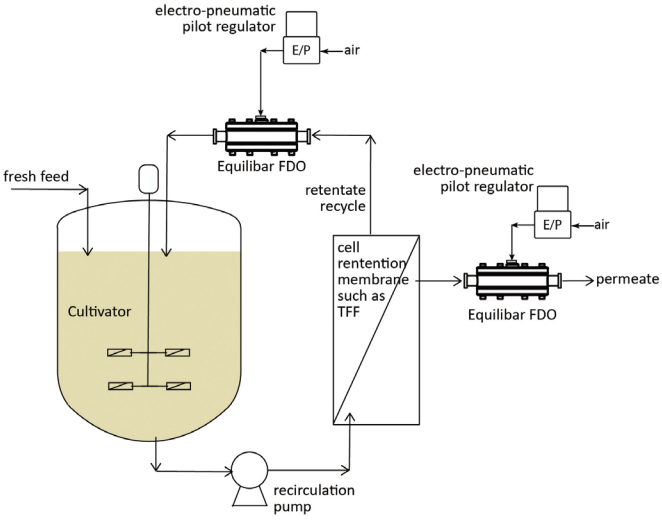
produce medicines, cellular-based food technology can be utilized to produce beef, chicken or fish while improving food safety and security — all without harming any animals.

The cultivation process begins by harmlessly harvesting cells from an animal. The cells are grown in a stainless-steel bioreactor, similar to a brewery fermenter, where the biological process that happens inside an animal takes place in the bioreactor. The bioreactor, sometimes called "cultivator" in this process, is supplied with the necessary elements for building muscle, such as water, glucose, amino acids, vitamins, minerals, and growth factors. During the process, parameters such as pH, temperature, oxygen, and pressure are tightly controlled. Further refinement of the meat structure takes place after harvesting the cells, often using plant-based scaffolding to encourage the meat to grow in a certain form.

Cultivated meat is in its infant stages and the process has some significant design hurdles to overcome before it can be price competitive with conventional farmed meat. To produce cost-effective products that meet the market demand, cultivating meat requires high throughput, affordable input ingredients and minimized process costs.

### CHALLENGES & OPPORTUNITIES

To be competitive with the cost of conventional farmed meat, the process of cultivating meat will have to be done on a very large scale. Industry leaders are using bioreactor technology know-how from the life sciences companies, but the scale required for producing medicine is much smaller than that needed for meat. Ideal parameters for best quality final product are also being studied. Process conditions such as levels of pH, dissolved oxygen and glucose must be optimized for healthy and efficient cell growth. Automation around those parameters will also be a challenge as scientists learn how to best measure and control them.




**Schematic of general perfusion process with direct-sealing diaphragm back pressure regulators maintaining transmembrane pressure.**

Photo Credit: Equilibar

## So How's It Made?

Created from animal cells instead of from the farming and slaughter of animals, cultivated meat is cellularly the same product as the traditional farmed meat you are used to eating. But, compared to conventional production, it is less resource-intensive with decreased methane emissions (that occur in large amounts from cattle production), uses less water and is less polluting, and removes some of the issues with antibiotic resistance and foodborne illnesses. One study from CE Delft in Europe found that compared with farming animals, cultivated meat could cut the climate impact by up to 92%, reduce air pollution by up to 94% and use up to 90% less land.

In 2020, Singapore was the first country to allow the sale of cultivated meat. In the U.S., the FDA and USDA Food Safety and Inspection Service (USDA-FSIS) are working together under a joint agreement to oversee the industry. The FDA oversees cell collection, cell banks and cell growth, while the USDA-FSIS oversees production and labeling of the products. Any cultured food that is imported must meet the same legal requirements as domestically produced foods and food safety regulations, and the manufacturers must undergo additional equivalence process and adhere to labeling requirements. At this time, the USDA-FSIS has not found equivalence with any country, so the import of cultured meat and poultry products for commercial consumption is currently not allowed.

In March 2023, the USDA cleared cultured chicken cell material made by Good Meat company as safe for human consumption, and in May 2023, both Good Meat and Upside Foods got approval from the US Department of Agriculture to sell their products in the U.S.

Bar Crenn, owned by Chef Dominique Crenn, is planning to sell the Upside product. And Chef José Andrés is going to sell the Good Meat product in one of his Washington, D.C. restaurants. Crenn is the only female chef in the U.S. with three Michelin stars, and Andrés is a world-renowned chef who has also made humanitarian work a key tenet of his work, taking his World Central Kitchen concept to disaster areas and even war zones in Ukraine to provide meals for residents and workers while they recover and rebuild. With two of the most renowned chefs in the U.S. offering these products at their restaurants, production facilities are being built. As the adoption curve by foodie consumers will likely accelerate the demand for these products, expect to see them in grocery cases in the near future. What do you think, will you buy cultivated meat products or do you already? Send me an email and let me know your thoughts.

*—Heather Gaynor, Editor-in-Chief, Valve Magazine*
*hgaynor@gardnerweb.com*

To produce cost-effective products and meet market demand, cultivating meat requires high throughput and minimized process costs. Processes where valves are used create opportunities for the valve industry to contribute to cultured meat optimization.

## PERFUSION REACTOR FOR CULTURED MEAT

Cultivated meat manufacturers are developing best practices for scaled up bioreactor design including batch, continuous and perfusion used in bioprocessing. Perfusion reactors offer key benefits over standard batch-style processes for the cultivated meat cell growth process due to the lengthy time it will take for the cells to grow, and the volume of meat required to maintain reasonable cost. The long processing time requires filtering out waste during cell growth and recirculating the good cells back into the reactor. Filtering methods, such as tangential flow filtration (TFF), are well suited for this application and are commonly used.

In a typical perfusion process, fresh media is added to the tank while spent media is circulated through a filter and removed. Transmembrane pressure (TMP) is a critical variable during filtration and must be precisely maintained at a specific setpoint for the most efficient separation process. If pressure drifts, the healthy cells may not all be recirculated back to the reactor, or the waste may not be properly removed. In these cases, the filtration process will take longer or reduce yield and result in higher cost.

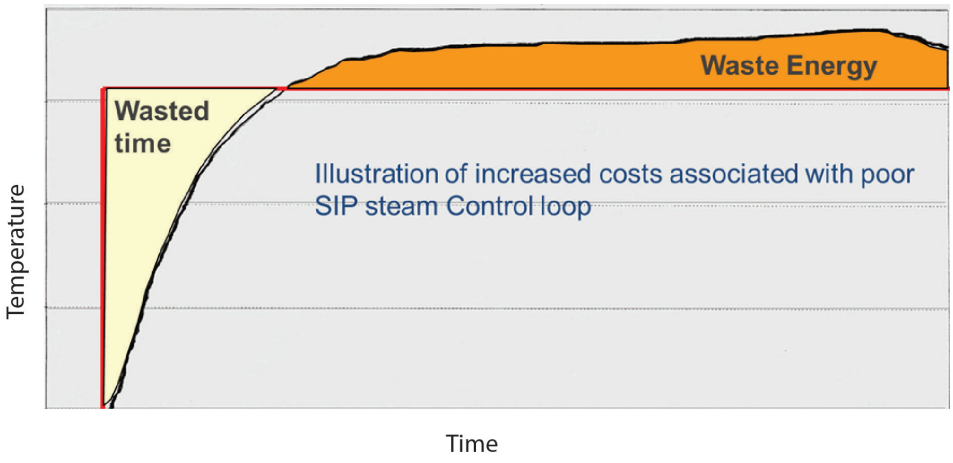
Valve selection for TFF can be an important decision for cost reduction. Multiple-orifice direct-sealing diaphragm valves, for instance, have been proven to provide superior filtration pressure control in TFF applications for perfusion in biopharmaceutical processes. A responsive and precise sanitary back pressure regulator will be beneficial in the role of maintaining TMP to optimize yield.

## CLEANING AND STERILIZING CULTIVATED MEAT PROCESSING EQUIPMENT

Bioreactor growth tanks or cultivator tanks and associated process lines are cleaned and sterilized before the cultivated meat growth process begins. Sanitary food processes use clean-in-place (CIP) and steam-in-place (SIP) methods to eliminate food contamination and cross-product contamination.

One of the largest expenses for cultivated meat plants will be the cost of utilities, primarily used for cleaning and sterilizing. Insufficient steam control can be a costly waste of steam and energy.

In the graph below of a standard SIP process, there are *two main causes of waste*: The first occurs during heat up, where the longer it takes to reach temperature, the more steam is required to continue filling the vessel and more time is wasted delaying the start of the next batch. The second occurs when the steam temperature overshoots due to improper control, resulting in wasted energy.



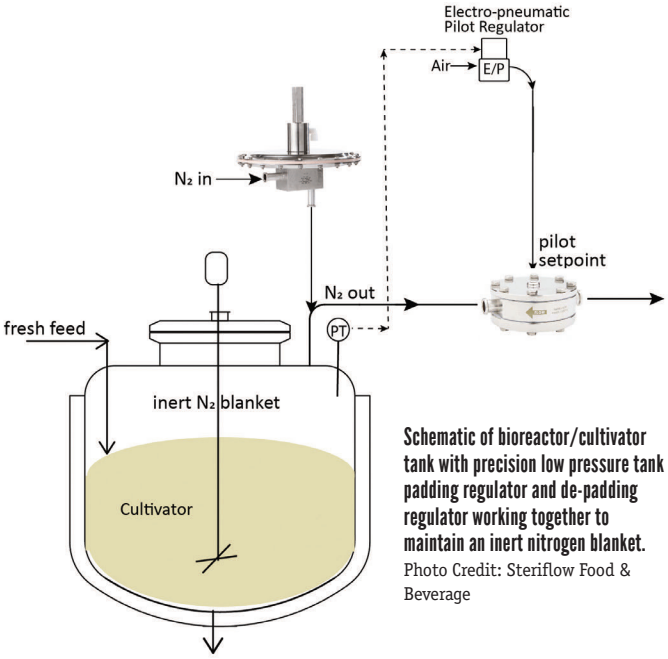

**Graph of steam heat up and control during SIP showing where time and energy can potentially be wasted.**
Photo Credit: Steriflow Valve

Higher steam temperature equates to high energy costs. By choosing a high-performing steam pressure control valve to accurately control SIP with minimal droop, process engineers can avoid wasted time and energy.

## TANK BLANKETING FOR MEAT CULTIVATOR TANKS

Once the cultivator tank is sterilized, the growth process occurs under positive pressure to avoid contamination from adventitious agents. Bioreactors benefit from an inert gas protective layer, such as nitrogen ($N_2$), above the contents inside the tank to keep the environment sterile. The same

Photo Credit: UPSIDE Foods




**Schematic of bioreactor/cultivator tank with precision low pressure tank padding regulator and de-padding regulator working together to maintain an inert nitrogen blanket.** Photo Credit: Steriflow Food & Beverage

setup can be used in cultivated meat growth tanks so the growth environment is carefully controlled to ensure the meat will grow healthy muscle and fat cells. Precise and responsive tank blanket valves can reduce cost by ensuring an optimum $N_2$ pressure.

The example above shows how a tank padding regulator (pressure reducing valve or PRV) and a tank de-padding regulator (back pressure regulating valve or BPRV) can work together to keep an $N_2$ blanket in the cultivator tank. Here, a sanitary tank blanketing regulator (a low-pressure PRV) is used to add nitrogen gas to the cultivator growth tank at the start of the growth process or as pressure decreases during growth. As pressure conditions change during growth, the BPRV opens to relieve excess pressure and the PRV opens to add $N_2$ to increase the pressure. These valves work in tandem to keep the $N_2$ padding (blanketing) at the desired setpoint.

The PRV and BPRV of choice for this process should be able to maintain very low pressure.

## LOOKING AHEAD

The cultivated meat industry is an exciting new development and needs more optimization before becoming a viable alternative to traditional farmed meat. The examples here illustrate just a few ways that proper valve selection can contribute toward the industry's success. Working together, leaders in the industry can tackle the challenges ahead. VM

**Diane Jacober**, MSME, is a technical marketing manager for Equilibar, and content creator for Richards Industrials, Equilibar's parent company. She has worked as a process engineer, project engineer and technical marketing specialist for several companies in a variety of fields.


# Control Valves for Hydrogen Applications

## Proper sizing, material selection and monitoring are as important as ever.

BY KEVIN JACKSON

Hydrogen has a long history in the energy market — from powering the first internal combustion engines over 200 years ago to becoming an integral part of the modern refining industry. When we think about hydrogen applications, most people think of hydrogen used in refineries to either remove sulfur from gasoline, diesel fuel and other refined products, as a catalyst to stimulate chemical reaction, or as a fuel for furnaces that generate steam for several refining processes. It is important to note that hydrogen is a gas that must be treated with respect, particularly when it comes to material selection. If not, the safety risk associated with using improper materials can be catastrophic and pose a long-term safety hazard.

As we move to a greener world, hydrogen is becoming an increasingly common fuel and is expected to be used in various applications. These applications include the blending, in different percentages, of hydrogen with natural gas commonly 20%/80%, to produce a gas for gas-fired power generation that reduces $CO_2$ output by approximately 6-7%, or in transportation either as drop-in fuels, hydrogen gas cells, or in liquid form for vehicles that require longer range.

Hydrogen can be produced in four basic ways. In the refinery, hydrogen is traditionally produced from natural gas, oil or coal by steam methane reforming or by gasification, with approximately 96% of today's hydrogen produced using this process. Electrolysis is the fourth method, and today represents about 4% of total hydrogen produced globally.

When it comes to sizing and configuring control valves for hydrogen gas and liquid applications, control valve engineers must exercise caution. This is especially true now, as hydrogen is being generated and transported in large quantities around the world in various forms including hydrogen gas, hydrogen pure liquids and organic compounds that either absorb hydrogen or mix it with nitrogen to produce ammonia. All these forms of hydrogen require proper pressure and temperature control to make them viable as pure hydrogen or as a carrier to move it to areas where hydrogen cannot be manufactured locally in sufficient quantity to meet the local demand.

There are five key areas to consider when determining the size and configuration of a control valve for use in hydrogen, as well as when configuring isolation and safety valves.

### MATERIAL SELECTION

Hydrogen embrittlement (HE), also known as hydrogen-assisted cracking or hydrogen-induced cracking (HIC), is a complex process involving several distinct contributing micro-mechanisms, familiar to anyone who has worked in the upstream sector. However, in more recent years, it has become widely accepted that HE is a complex issue that can be a result of improper material selection and environmental conditions, metal hydride formation, phase transformations of the hydrogen and a variety of other factors without always being able to identify a single cause. The result of HE is a reduction in ductility due to the absorption of the very small hydrogen atoms.

Steels with a tensile strength of less than approximately 145 ksi (1000 MPa), or with a Rockwell hardness of less than

HRC 32, are the alloys that are not generally susceptible to hydrogen embrittlement. Temperature must also be considered because HE is maximized around room temperature in steels, but most metals are relatively immune to hydrogen embrittlement at temperatures above 150°C (302°F). Pressure should also be considered, as the hydrogen partial pressure at which maximum embrittlement occurs is estimated to be between 300 and 1500 psi (20 and 100 bar).

It should be noted that hydrogen embrittlement occurs in steels and similar metals at relatively low hydrogen concentrations, depending on the temperature and pressures. Generally acceptable materials for hydrogen service include austenitic stainless steels, aluminum alloys, copper and copper alloys. Nickel and most nickel alloys should not be used since they are subject to severe hydrogen embrittlement. Gray, ductile and malleable cast irons should also not be used for hydrogen service.

Tests such as ASTM F1624 can be used to rank alloys and coatings during materials selection to ensure that the threshold of cracking is below the threshold for hydrogen-assisted stress-corrosion cracking. Tests should be conducted during quality control to qualify materials being produced in a rapid and comparable manner. Standards such as NACE MR-0175 for upstream exploration and production, and NACE MR-0103 for refinery environments, can help define and specify control valve requirements for hydrogen gases.

When considering materials, also consider materials used for diaphragms and sealing. While research and testing are ongoing, the knowledge of hydrogen compatibility with polymers continues to undergo extensive field tests. Users understand the principles of explosive decompression from gases, but hydrogen adds another layer of complexity, especially for diaphragms. Packing materials for control valves may seem straightforward in terms of selection, spiral wound, PTFE or graphite, but special attention to temperature and pressure must be considered for hydrogen applications.

## FUGITIVE EMISSIONS

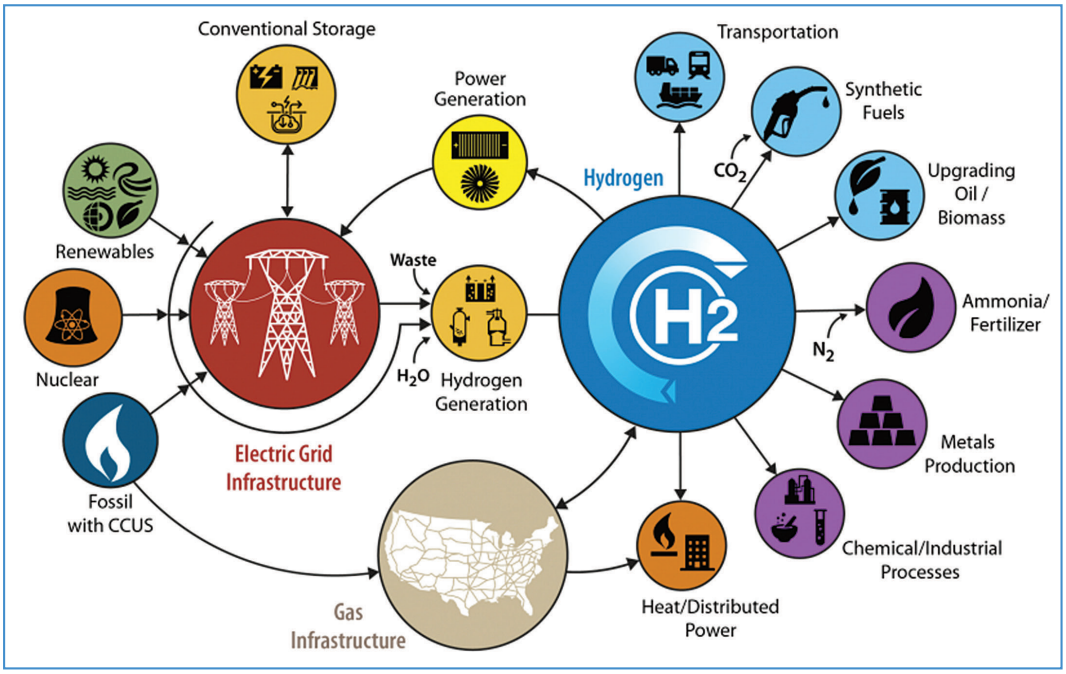
A fugitive emission is defined as the unintentional and/or undesirable emission, leakage or discharge of gases or vapors from pressure-containing equipment like faulty or incorrectly applied valves.

There are two main types of emissions that impact the environment, air quality and human health: greenhouse gas emissions (GHG) and air pollutant emissions. For valves, we are concerned with greenhouse gas emissions.

Fugitive emission testing is an umbrella term for a wide variety of differing test procedures and methods used to test and evaluate the integrity of the external leakage of valve stem seals/packings and body joints of control valves — globe, rotary and regulators.

The test needs to be a direct reflection of the actual service conditions, from cryogenic to ambient and extreme high temperatures and pressures. The most common test standards used for control valves are ISO-15848-1 and 2, ANSI/ISA S93.00.01, ANSI/FCI 91-1, TA-Luft/VDI 2440, API-622, API-624 and API-641. Some companies have their own test procedures, for example, Shell SPE 77/300 and Shell SPE 77/312. When specifying, configuring or purchasing control valves, the appropriate standard should be used with proof of third-party witnessing certificates that covers the correct stem diameters, materials and test gas. It should be noted that any witnessed test should not only include the steam packing, but all body joints as well through the cycle and temperature variations.

Approximately 60% of fugitive emissions come from valves, and as much as 80% of the leakage per valve originates from its stem packing. Other sources from the valve are bleed or exhaust ports from solenoid valves, positioners, and other control accessories. To avoid the development of leaks, regular testing and maintenance go a long way in preventing fugitive emissions. For gaseous fugitive emissions, regular use of gas detection devices is useful as it helps detect the source of such emissions.




**The ecosystem of the hydrogen economy continues to expand.**

Image Credit: U.S. Dept. of Energy

## PERFORMANCE AND RELIABILITY

The performance of a valve's safety features

is measured in terms of the Probability of Failure on Demand (PFD). Through this calculation, you get a Safety Integrity Level (SIL) as an indication of system reliability and integrity, and it's measured on a scale of 1 to 4 (4 being the safest and most unlikely to fail, but rarely used). This is not a requirement to have when selecting a valve type or manufacturer, however, it does provide a level of confidence that the supplier is reputable, and a measure of performance and safety based on international industry standards.

However, if the failure of the control valve does not place a demand on the Safety Instrumented System (SIF), for which it is a part, but could place a demand on any other associated SIF, additional analysis will be required.

## CONTROL VALVE SIZING

The process of control valve sizing is a procedure where the fluid dynamics of the system are matched to the performance characteristics of the valve. This selects a control valve of an appropriate size and type that best meets the needs of managing flow within the process system. Each control valve manufacturer, together with some independent software companies, has developed its own platforms for valve sizing based on the ANSI/ISA-75.01.01 and IEC 60534-2-1 standards.

Obviously, all control valves are slightly different from each other in terms of their unique design characteristics. Although they all use these industry standards, each manufacturer has certain nuances because of the unique design profile of certain components of the valve that can affect the outcome of the valve sizing evaluation. Each sizing should be accompanied by the manufacturer's sizing data sheets. Independent sizing software can give the ideal size and performance data, but it is generic.

Reputable control valve manufacturers carry out verification tests to ensure that the calculated performance stated with their valves will match, within a minimal acceptable tolerance, the actual valve performance when it is installed. Additional tests to verify precise flow rates, noise generated, capacity and pressure drop can be carried out by request.

Along with the above, when sizing and selecting control valves for use on hydrogen, the sizing is affected by several factors:

- While hydrogen is a pure element ($H_2$), methane is a compound made up of carbon and hydrogen ($CH_4$). The absence of carbon in hydrogen is the major driver behind the differences when compared to natural gas.
- The periodic table of elements is ordered by molecular weight. Hydrogen ($H_2$), as the first element on the periodic table, is a very light molecule. Methane ($CH_4$) is a compound made up of carbon and hydrogen and is much heavier, with a molecular weight of eight times the weight of hydrogen. This means hydrogen is a smaller molecule, which increases the potential for leakage in packings and joints as well as valve size.
- Flammability is another concern that affects valve selection, especially packings and joints. Hydrogen will combust with both higher and lower concentrations of air present, making combustion more likely if there are leaks.

Great care needs to be taken when selecting control valves. Always look for a manufacturer who can provide evidence and examples of true understanding of the nuances of hydrogen applications for the safest and best results.

## VALVE DIAGNOSTICS IN HYDROGEN

As the world moves forward in IIoT and smart systems, control valve diagnostics is now a key part of monitoring and managing control valves in the new era. This involves using the positioner to monitor the valve's health and gather data about its position, conditions and performance to improve plant efficiency and process uptime.

Understanding changes in the valves operating conditions and performance is critical to acting before a breakdown occurs. If you are not measuring and tracking a system, you are only guessing and missing your optimal performance.

Any online valve diagnostics should consist of key performance indicators (KPIs) which are continuously monitored while the valve is in service, providing real insights into actual operating performance of the valve system without the need to take a process offline.

To get the most out of your system and processes, it is ideal to be brand agnostic and have a valve asset management system that can track assets from all manufacturers throughout the entire lifecycle of all the valves in the plant.

## CONCLUSION

Hydrogen is light, storable, energy-dense and produces no direct greenhouse gases. But for hydrogen to make a significant contribution to a clean energy transition, it needs to be adopted by all industries. As the industry continues to grow, it is imperative that valves used in hydrogen applications are properly sized and are constructed of the proper materials for the applications where they will be used.

There are still many hurdles to overcome including safety, regulatory, scalability and lowering costs. Consider hydrogen compared with where LNG (liquified natural gas) was 20 years ago and the transformation that has taken place in production, transporting and offloading. Certainly, the challenges are different and currently not all the processes and equipment exist to take full advantage of hydrogen and its new role in the world, but the future of hydrogen seems secure as a major fuel source. VM

**Kevin Jackson** is a control & isolation valve expert with more than 40 years' experience and design and applied engineering. He is currently on the New Energy team at Baker Hughes.

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# Check Valve Installation Considerations to Maximize Process Performance

## Key considerations in successful check valve performance.

BY LEA CLAUSON

Check valves are critical in backflow prevention. They protect pumps and compressors in a process system and prevent wet wells from flooding. Proper check valve selection and installation will prevent premature wear of the valve and an unscheduled shutdown. The keys to successful check valve performance are valve selection, size, pipeline installation and cost of ownership. Time spent evaluating these key considerations will maximize check valve operational performance.

### EVALUATION BEFORE VALVE SELECTION

The design of the pumping system should be evaluated before selecting a check valve. First, consider whether the pump system design has potential surge issues. If surge issues are a concern, then a surge investigation should be performed by a valve manufacturer. The surge investigation may determine whether a pump control valve is better suited for the application than a check valve.

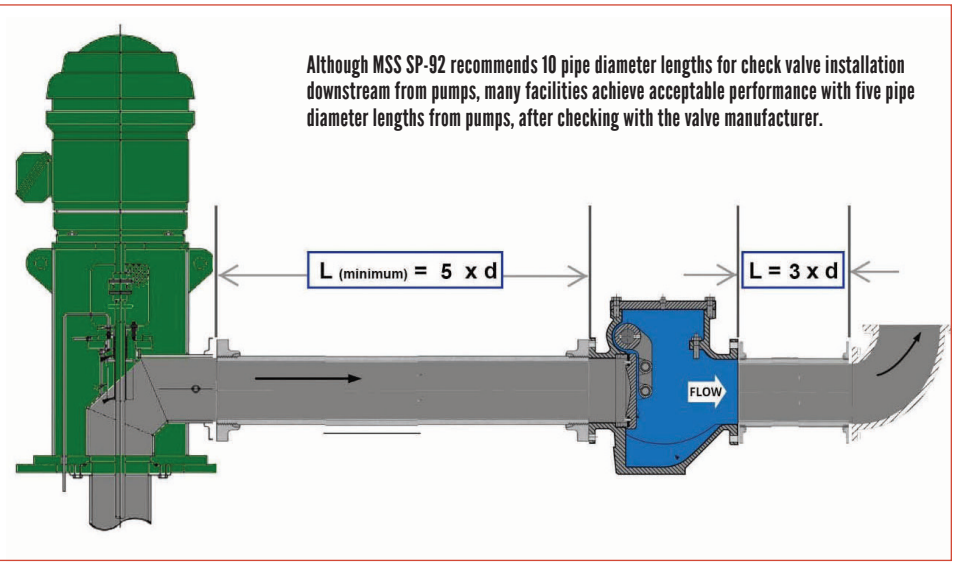
### KEY CHECK VALVE CONSIDERATIONS

**Valve Style:** Selecting the appropriate style check valve starts with understanding the process media. The type of media — whether it is clean, abrasive, corrosive or slurry — determines what style of check valve should be selected.

60-inch swing check valve for critical backflow prevention.

All images courtesy of DeZURIK, Inc.

For clean service, check valve styles such as slanting disc, double door and silent are most common for low head loss, large pipe or quick closure requirements. Although rubber flapper and swing check valves can be used in clean service, they are typically used in wastewater service. These valves are more suitable for abrasive/corrosive/dirty applications and rapid flow reversal. Swing check valves are commonly used for pump discharge applications due to control options that accommodate varying forward and reverse flow conditions.



Although MSS SP-92 recommends 10 pipe diameter lengths for check valve installation downstream from pumps, many facilities achieve acceptable performance with five pipe diameter lengths from pumps, after checking with the valve manufacturer.

**Valve Size:** Correct valve size is important to valve performance and may or may not be the same as the pipeline size. For best valve performance, sizing calculations for minimum, normal and maximum flow conditions are necessary to optimize valve life and minimize valve maintenance. The American Water Works Association standard (AWWA C508) for swing check valves states: "Valves may be subjected to excessive wear if there is insufficient flow to open the valve."

Rubber flapper valves are typically sized to be fully closed or fully open with sufficient flow. Conversely, full waterway swing check valves are not typically sized for full open but are sized for the lowest acceptable head loss per the design. If the valve is sized too large and normally operates nearly closed, the disc connection can be worn. Premature wear can occur on the disc connection through vibration, oscillation and force until the metal connection is ground away and no longer allows the disc to seat properly in the valve body.

**Valve Installation:** Valve installation in the pipeline is a critical consideration to the success of the check valve. The recommendation by Manufacturers Standardization Society of the Valve and Fittings Industry (MSS SP-92) is to install a check valve at a minimum of 10 pipe diameters of straight pipe on the downstream side from tees, fittings, increasers or pumps and five pipe diameters from elbows to ensure laminar flow with minimum turbulence to minimize disc movement and premature wear. However, many facilities with smaller footprints have achieved acceptable performance in systems with the check valve installed five pipe diameter lengths of straight pipe from the downstream side of tees, fittings, increasers or pumps and three pipe diameters lengths from elbows, as shown in the illustration above. Consult the valve manufacturer for design pipe distances less than the recommendation by MSS.

**Cost of Ownership:** When selecting the proper check valve, it is important to consider the cost of ownership. The cost of ownership includes initial cost, operating cost and maintenance cost. An inexpensive check valve may end up costing less at startup but may cost more in the long run with unscheduled maintenance and downtime than a valve that is better suited for the application. The more suitable valve will perform better, require less maintenance, and provide system longevity.

**Design Goal:** The goal of design planning is to minimize

## Case Study 1

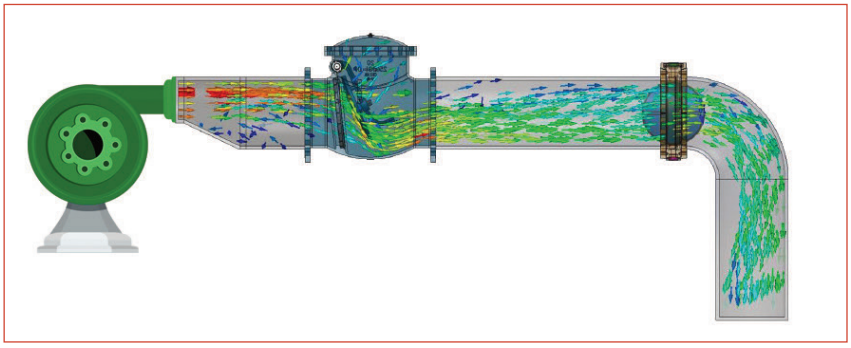
In one installation, a swing check valve was oversized because they planned for future growth. The low flow rate of the valve resulted in the valve only being open 17 degrees. The near-vertical disc was subjected to high-velocity water flow near the top of the disc and low-velocity swirling water at the bottom of the disc. The unbalanced dynamic forces on the disc caused the disc to wobble and wear the connecting parts. The pin and connections were worn down and the center hole in the disc was worn out, not allowing the disc to close properly. In time, the disc became loose and failed to close.

## Case Study 2

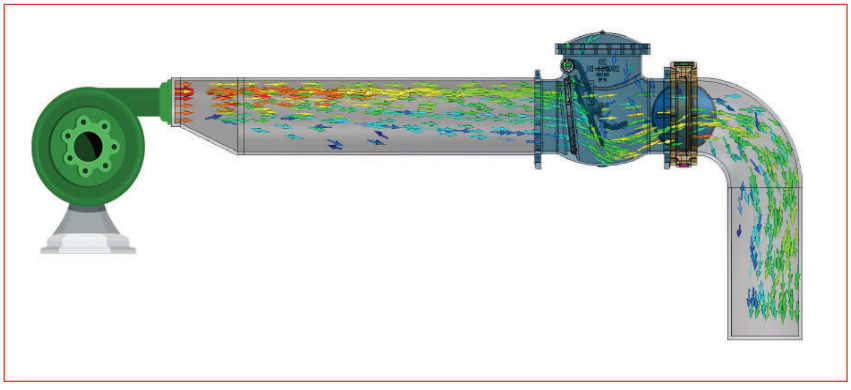
In another installation, because of the facility's extremely compact footprint, the check valve was installed immediately after the pump and increaser with little pipe length distance between the check valve and pump. The high-velocity pump discharge focused a jet of water directly at the check valve disc and pin connections, prematurely wearing out the valve components and causing improper seating of the disc.

the facility footprint without compromising equipment performance. Equipment will last longer under laminar flow and with no sudden changes in flow velocity. Sudden changes in flow velocity occur during a sudden pump shutdown when the flow reverses and is stopped by the closing of the check valve. This sudden stop in fluid flow or flow velocity change instantly reduces the pressure below the vapor pressure and may cause momentary column separation. The vacuum created by the column separation draws the two columns together violently. When the columns rejoin it creates a high-pressure shockwave, also known as water hammer. Water hammer creates a loud banging sound which is disruptive and the accompanying pressure surge could be destructive if left untreated.

AWWA C508 states: "Conditions of water hammer, hydraulic pulsation, and excessive operating noise are results of system design rather than valve design and are beyond the scope of this standard and require special design and construction considerations."



Unbalanced dynamic forces on the check valve disc caused the disc to wobble and wear.



Moving the check valve further from the increaser decreased turbulence and allowed flow to become more laminar.

Pump station design with silent check valve installed five pipe diameter lengths from pump discharge.

**Flow Characteristics:** Shown on the left is Computational Fluid Dynamics (CFD) analysis of a check valve near an increaser. Eddies formed at the bottom of the increaser and created turbulent flow through the check valve. Moving the check valve away from the increaser removed the eddies and created a more laminar flow through the check valve, as shown in the second CFD image.

**Increaser:** Another way to ensure more laminar flow is to limit the size of the increaser between the pump and check valve so it is not greater than two pipe sizes. For example, if the pump discharge is 12 in. it would be acceptable to use an increaser to a 14- or 16-in. check valve size, but any larger would be too extreme.

## FIELD EXPERIENCE

**Issues:** Failing check valves are often caused by installations too close to pumps and increasers. In addition, there is a tendency in design planning to oversize discharge pipes for future expansion which then require extreme reducers to fit the pump size. Both these issues create turbulent flow that can wear the disc and pin connections and cause premature check valve failure.

**Solutions:** Ideally, the pipe distance between the pump and check valve should be calculated during the design phase of the project. For existing facilities, one solution is to move the check valve further away from the pump to achieve a more laminar flow, preferably five pipe diameters. If there are space limitations and moving the valve is not an option, then consider another style of check valve. Another solution is verifying the check valve is properly sized for the process conditions and, if possible, avoid utilizing extreme increasers.

**Keys to Successful Check Valve Performance:** The role of the check valve is to prevent backflow from damaging pumps in the process system. Check valves play a vital role in the successful operation of a facility. When designing a pumping system, it is beneficial to request a surge investigation from the valve manufacturer to determine whether the process conditions require a check valve or a pump control valve. If a check valve is required, then valve selection, size, installation and cost of ownership should be considered before specifying the valve. These key considerations will extend the life of the check valve, ensure proper protection of process equipment, and prevent an unplanned shutdown. VM

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Basics

# A Primer on Pressure Seal Valves

## High pressure, high-temperature applications require a safe, leak-free pressure-containing boundary.

### INTRODUCTION

When I look back at the original article, *Pressure Seal Valves: Simple Designs, Demanding Applications* (published previously by VMA in *Valve* and included in *Back to Basics,* originally published in 2009), I am struck with how much has remained constant from a design and applications standpoint in the realm of large diameter (4-inch and greater), high pressure/temperature pressure seal gates, globes and checks. Whereas metal seated ball valves have displaced pressure seal gates and globes in a number of applications, plant designers still choose pressure seal, parallel slide gate valves for main steam isolation (stops) in combined cycle power plants and in other similar applications. Where steam throttling is required, pressure seal globes are specified, and where reverse flow protection is necessary in high-energy piping systems, pressure seal check valves are installed.

Design Advantages: I always like to kid valve designers that we valve guys are not overly creative in our nomenclature. The term "pressure seal" is no exception. These valves use system "pressure" to "seal" that pressure from the environment. In the case of a standard 150-600# bolted bonnet gate/globe/check valve, having a flanged body-bonnet joint sealed by a gasket; as system pressure increases, so does the potential for leakage. In the pressure seal design, as system pressure increases, the potential for leakage decreases. Besides having this advantage, most pressure seal designs weigh less than their bolted bonnet counterparts as a function of the combined incremental weight of the body and bonnet flanges, as well as the connecting nuts and bolts.

### WHAT HAS CHANGED?

Although many of the design considerations have remained fairly constant, there are several advances that have driven change to the pressure seal valve.

- The pressure seal gasket effectively seals system pressure from the atmosphere. Although originally made from soft steel and silver plated for optimum sealing, this type of pressure seal gasket, beginning in the early 90s, has evolved to a design incorporating a graphite gasket with the leading edges capped to prevent extrusion. This improvement provides for a much more forgiving seal.
- Power plant designers continue to push the pressure/temperature envelopes trying to eke out every possible megawatt of power from their respective design platforms. Material manufacturers have been tasked with facilitating that goal with special alloys that can "take the heat." Creep Strength Enhanced Ferritic (CSEF) materials became increasingly popular during the combined cycle boom in the 1990s. Much was learned about the metallurgy and weldability of Type 91 (available in forging, casting and pipe forms), in terms of chemical composition, optimal preheat, interpass temperature and the maximum soak temperature during PWHT. Many utilities developed unique material specifications and imposed restrictions on welding this material. A working group was formed by ASME to study the issues, resulting in changes to the SA182-F91 material specification. Welding and stress relieving Type 91 material remains a key consideration in the construction of power plants.
- Many valves used in high-pressure/temperature applications incorporate cobalt-based hardfacing materials (CoCr-A) welded onto the valve seating surfaces to extend the service life and sealing integrity of the valve. In the early 2000s, a failure mode was identified where the hardfacing material would flake off the base metal. In some instances, whole sections were reported to detach from the base metal. Valve manufacturers and organizations such as the Electric Power Research Institute (EPRI) launched studies to determine the root cause and actions to prevent recurrence. EPRI has published reports identifying this phenomenon and proposed solutions.
- Prior to the turn of the century, many manufacturers of pressure seal valves utilized castings for the body and bonnet of the valve. Over the years, the advantages of forgings over castings, particularly in high-pressure/temperature applications, coupled

with improvements in forging capabilities and technology, have spurred manufacturers to develop forged pressure seal valves in lieu of their cast predecessors.

- Of course, manufacturing technology has also continued to make improvements to the machining and welding of pressure seal valves. Advances in the tooling and controls of CNC machines make for faster run times and tighter adherence to tolerances. The development of advanced waveform welding equipment improves both filler metal deposition rates and overall weld quality.

These advancements work together to provide manufacturers with the tools to create better quality pressure seal valves quicker. Whether in a power plant, a refinery, a chemical plant, an aircraft carrier or a pulp and paper mill, pressure seal valves installed in high-ressure/temperature applications continue to provide excellent service for their owners.

Relying on fairly simple design principles, pressure seal valves have proven their capability to handle increasingly demanding fossil and combined-cycle steam isolation applications, as designers continue to push boiler, HRSG, and piping system pressure/temperature envelopes.

Pressure seal valves are typically available in size ranges from 2-24 inches and ASME B16.34 pressure classes from #600 to #4500, although some manufacturers can accommodate the need for larger diameters and higher ratings for special applications.

Keeping pace with advancements in material technology, today's pressure seal valves are available in a variety of materials dependent on the application: carbon (A105 forged and Gr. WCB cast); alloy (F22 forged and Gr. WC9 cast; F11 forged and Gr. WC6 cast); austenitic stainless (F316 forged and Gr. CF8M cast; for over 1000°F, F316H forged and suitable austenitic cast grades with carbon content > 0.04%); as well as a number of other alloy/stainless/special materials. Also available from most manufacturers is the F91 forged and/or C12A cast alloy (9 Cr-1 MoV) material used for high-temperature (e.g. main steam) piping systems in the last round of combined-cycle power plant construction and newer coal-fired super- and ultra-supercritical units.

The pressure seal design concept can be traced back to the mid-1900s, when, faced with ever-increasing pressures and temperatures (primarily in power applications), valve manufacturers began designing alternatives to the traditional bolted-bonnet approach to sealing the body/bonnet joint. Along with providing a higher level of pressure boundary sealing integrity, many of the pressure seal valve designs weighed significantly less than their bolted bonnet valve (BBV) counterparts.

## BOLTED BONNETS VS. PRESSURE SEALS

To better understand the pressure seal design concept, let's contrast the body- to-bonnet sealing mechanism between BBVs and pressure seals. Figure 1 depicts the typical BBV. The body flange and bonnet flange are joined by studs and nuts, with a gasket of suitable design/material inserted between the flange faces to facilitate sealing.

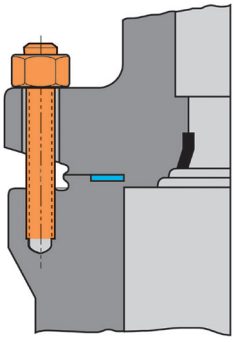


Figure 1

All images courtesy of Velan.

Studs/nuts/bolts are tightened to prescribed torques in a pattern defined by the manufacturer to affect optimal sealing. However, as system pressure increases, the potential for leakage through the body/bonnet joint also increases.

Now let's look at the pressure seal joint detailed in Figure 2. Note the differences in the respective body/bonnet joint configurations. Most pressure seal designs incorporate "bonnet take-up bolts" to pull the bonnet up and seal against the pressure seal gasket. This in turn creates a seal between the gasket and the inner diameter (I.D.) of the valve body. A segmented thrust ring maintains the load. The beauty of the pressure seal design is that as system pressure builds, so does the load on the bonnet and, correspondingly, the pressure seal gasket. Therefore, in pressure seal valves, as system pressure increases, the potential for leakage through the body/bonnet joint decreases.

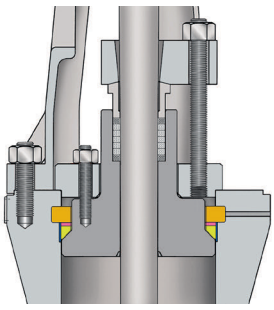


Figure 2

This design approach has distinct advantages over BBVs in main steam, feedwater, turbine bypass, and other power plant systems requiring valves that can handle the challenges inherent in high-pressure and temperature applications. However, due to its reliance on system pressure to aid in sealing, pressure seal valves are best applied in systems where the minimum, consistent operating pressure is in excess of 500 psi.

But over the years, as operating pressures/temperatures increased, and with the advent of peaking plants, this same transient system pressure that aided in sealing also played havoc with pressure seal joint integrity.

## PRESSURE SEAL GASKETS

One of the primary components involved in sealing the pressure seal valve is the gasket itself. Early pressure seal gaskets were manufactured from iron or soft steel. These gaskets were subsequently silver-plated to take advantage of the softer plating material's ability to provide a tighter seal. Due to the pressure applied during the valve's hydrotest, a "set" (or deformation of the gasket profile) between the bonnet and gasket was taken. Because of the inherent bonnet take-up bolt and pressure seal joint elasticity, the potential for the bonnet to move and

break that "set" when subjected to system pressure increases/decreases existed, with body/bonnet joint leakage the result. This problem could be effectively negated by utilizing the practice of "hot torquing" the bonnet take-up bolts after system pressure and temperature equalization, but it required owner/user maintenance personnel to do so after plant startup. If this practice was not adhered to, the potential for leakage through the body/bonnet joint existed, which could damage the pressure seal gasket, the bonnet and/or the I.D. of the valve body, as well as creating compounding problems and inefficiencies that the steam leakage could have on plant operations.

As a result, valve designers took

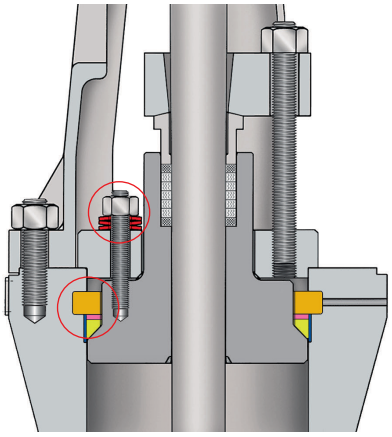


Figure 3

several steps to address this problem. Figure 3 shows a combination of live-loaded bonnet take-up bolts (thus maintaining a constant load on the gasket, minimizing the potential for leakage) and the replacement of the iron/soft steel, silver-plated pressure seal gasket with one made of die-formed graphite. The gasket design shown in Figure 3 can be installed in pressure seal valves previously supplied with the traditional type gasket. The advent of graphite gaskets has further solidified the dependability and performance of the pressure seal valve in most applications and for even daily start/stop operating cycles. Although many manufacturers still recommend "hot torquing," the potential for leakage when this is not done is greatly diminished.

The seating surfaces in pressure seal valves, as in many power plant valves, are subjected to, comparatively speaking, very high seating loads. Seat integrity is maintained as a function of tight machining tolerances on component parts, means of providing the requisite torque to open/close as a function of gears or actuation, and selection/application of proper materials for seating surfaces. Cobalt, nickel, and iron-based hardfacing alloys are utilized for optimal wear resistance of the wedge/disc and seat ring seating surfaces. Most commonly used are the CoCr-A (e.g., Stellite) materials. These materials are applied with a variety of processes, including shielded metal arc, gas metal arc, gas tungsten arc, and plasma (transferred) arc. Many pressure seal globe valves are designed having integral hardfaced seats, while the gate valve and check valves typically have hardfaced seat rings that are welded into the valve body.

## VALVING TERMINOLOGY

If you have dealt with valving for any length of time, you've probably noticed valve manufacturers are not overly creative with the terms and vernacular used in the business. Take for example, "bolted bonnet valves." The body is bolted to the bonnet to maintain system integrity. For "pressure seal valves," system pressure aids the sealing mechanism. For "stop/check valves," when the valve stem is in the closed position, flow is mechanically stopped, but when in the open position, the disc is free to act to check a reversal of flow. This same principle applies to other terminology used for design, as well as valve types and their component parts.

## PRESSURE SEAL GATE VALVES BASICALLY COME IN TWO TYPES:

**1. Flex-wedge type gate valves** (Figure 4) incorporating a flexible, wedge-shaped closure element that, relying on the torque generated by the handwheel or motor operator, is driven into the seats of the valve, thus effecting sealing. The flex-wedge gate valve is said to be "torque seated," because it relies on this applied torque to provide the sealing force, as well as some assistance from system pressure. This flexibility comes from the design of the wedge, where material is removed either by saw cutting or other processes inherent in forming/manufacturing,

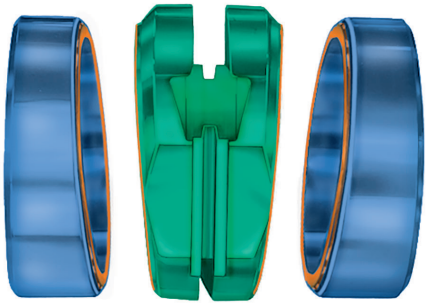


Figure 4

concentrically around a central hub. The increased flexibility allows for:

- less required torque to drive in and to extricate the wedge from the seat rings
- greater resiliency to deal with thermal expansion and in finding the optimal downstream seating surface as a function of upstream pressure
- less potential for coming off the seat as a function of piping loads and/or during piping system movement caused by seismic or a variety of potential plant operation events.

**2. Parallel slide gate valves** (Figure 5) feature two discs retained in a cage assembly, the seating surfaces of which are parallel to the valve seat rings.

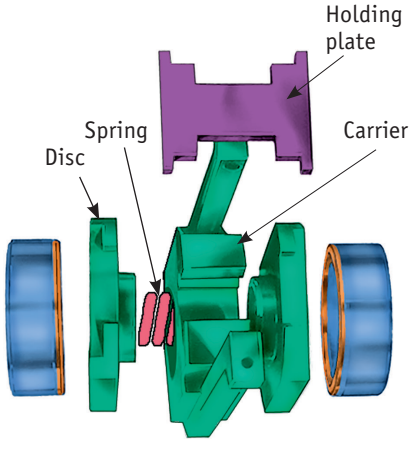



Figure 5

When the valve is cycled, these seats slide over one another. The two discs are held apart by spring(s). Parallel slide valves are said to be position seated, in that optimal sealing is achieved when the disc and seat ring mating surfaces are most closely positioned (i.e., no amount of additional turning of the hand-wheel will effect better sealing once the seating surfaces are mated).

Other designs are available including "two-piece" and "double-disc" wedge types that have proven to be effective.

## WHICH VALVE TO USE?

So why choose one over the other? Parallel slide valves rely almost entirely on upstream pressure to affect a seal on the downstream seat. Because of this, at low-pressure conditions, leakage through the seat may occur. In addition, the sliding action of the seating surfaces is more prone to wear, and if particulate is trapped between the seating surfaces, damage is more likely to occur. Due to the width and orientation of the seats, parallel slide valves are more difficult to maintain than their flex-wedge counterparts. But before you replace all your parallel slide valves with flex-wedge gates, read on.

Because the flex-wedge gate valve requires torque to energize the sealing surfaces (and then "un-wedge" itself), an actuator capable of providing comparatively higher torques (to parallel slide valves) is required, usually at a higher cost. Then there's the thermal binding issue.

At operating temperatures approximating 800°F and higher, wedge-type gate valves have the potential to bind in a variety of modes (e.g. when exposed to high operating temperatures, closed, then allowed to cool; or as is common in startup, beginning at ambient temperatures, exposed to a rapid thermal transient, then opened). This phenomenon is dependent on a wide variety of design and operating conditions, but can be mitigated by incorporating operating procedures that verify thermal equalization between the upstream and downstream bores (delta T of 200°F or less). Bypasses (Figure 6) connecting the valve upstream and downstream bores can facilitate this thermal equalization. Care must be taken to verify upstream vs. downstream thermal equalization at the valve itself, not away from the valve on connecting pipe. The new generation combined-cycle plants with their comparatively (with coal-fired plants) fast startup procedures are particularly susceptible to thermal binding. However, the most effective way to guard against thermal binding is to

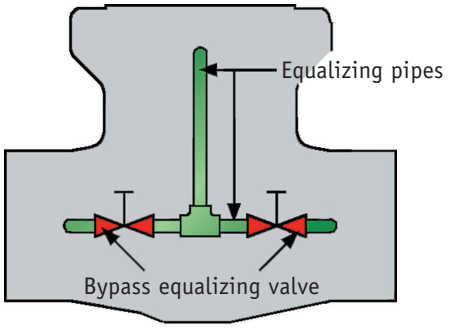



Figure 6

choose the parallel slide design.

If you recall, in the parallel slide design (Figure 5), the two discs are held apart in the cage by a spring(s). This spring(s) allows the discs more than enough travel to exceed the effects of thermal expansion.

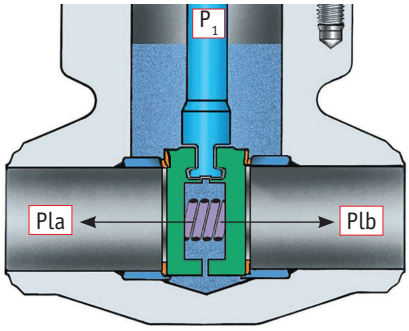
Thermal binding is not endemic to pressure seal valves. However, because pressure seals are routinely used in high-temperature service, take special care when addressing this issue.

## OTHER OPERATING CONCERNS

In addition, users of pressure seal valves must address two related operating concerns: center cavity over pressurization (CCOP) and pressure locking. Like thermal binding, these phenomena can result in an inability to stroke the valve. Note that thermal binding, CCOP, and pressure locking are three distinct concerns, the potential of which must be carefully evaluated and addressed in the design/procurement phase of the project. Paragraph 2.3.3 of ASME B16.34 places the responsibility on the owner to determine the potential for, and provide a means to protect against, CCOP and pressure locking.

The closure element of double-seated valves (wedge gates, parallel slide gates, ball valves, etc.) may become locked in place by either a buildup of pressure in the center cavity (CCOP) or an increase in the differential pressure upstream, downstream, or both of the seats in a closed valve as a function of decreased line pressure (pressure locking). In the case of CCOP (Figure 7), fluid trapped in the center cavity at ambient temperatures will expand when heat is introduced (e.g., during startup). This will cause the fluid to expand and, depending on the fluid type and temperature, could reach a pressure where insufficient torque is available (manually or actuated) to overcome the pressure and open the valve.

Pressure locking (Figure 8) occurs in double-seated valves where the line pressure drops (as a function of plant operation or accident) on either the upstream, downstream, or both sides of the valve seats, creating a sufficient differential pressure to preclude opening the valve.

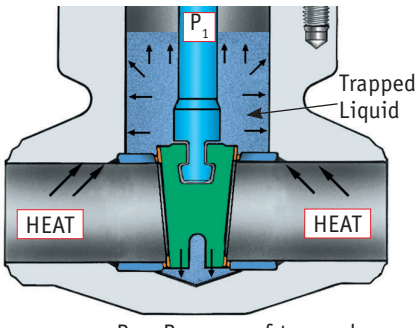



$P_1$ = Pressure of trapped liquid between seats
Pla & Plb = Line pressures

Figure 8

As in thermal binding, there are several methods to guard against CCOP and pressure locking. These include the following:

- A pressure relief hole drilled through the "pressure side" of the body or wedge/disc half into the valve's center cavity, thus relieving overpressure to that pressure side. This effectively makes the valve unidirectional in its sealing capability (Figure 9).




$P_1$ = Pressure of trapped liquid between seats

Figure 7

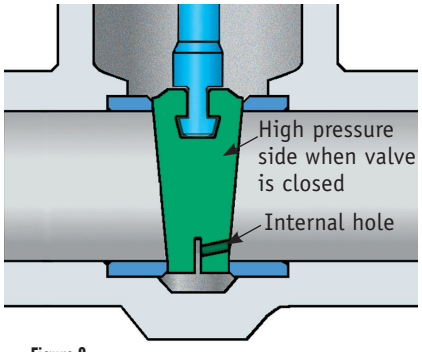



Figure 9

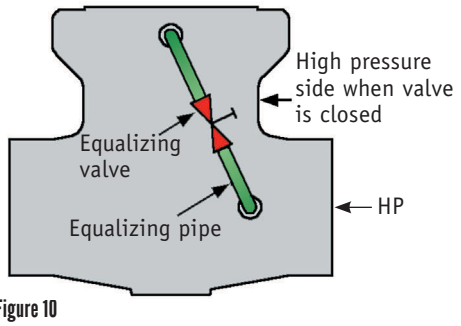



Figure 10

- A pressure equalizing pipe, drilled and tapped from the center cavity to the valve's "pressure side" bore (Figure 10). When a bypass valve is included, bi-directional sealing is maintained. Just remember that when the bypass valve is closed, center cavity pressure is not being relieved.
- A pressure relief valve that is connected to a pipe drilled and tapped into the valve's center cavity. This method maintains the valve's bi-directional sealing capability (Figure 11).

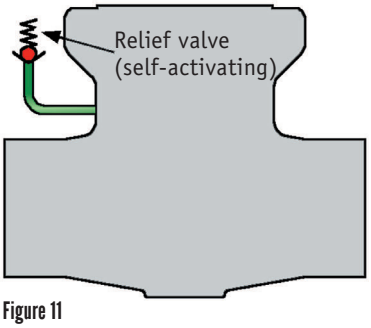



Figure 11

- A drain valve that is connected to a pipe drilled and tapped into the valve's center cavity (Figure 12). Remember that when the drain valve is closed, center cavity pressure is not being relieved.

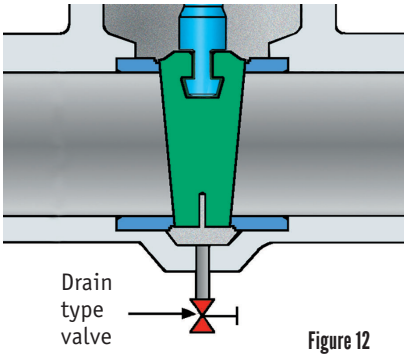



Figure 12

- Bypass with one or more bypass valves and an equalizing pipe joining the center cavity of the valve with the bypass pipe. Depending on the number and configuration of the bypass valves, bi-directional sealing may be maintained (Figure 6).
- Proprietary bypass valves that change sealing direction as does system pressure. Bi-directional sealing is maintained (Figure 13).

## PRESSURE SEAL GLOBE VALVES

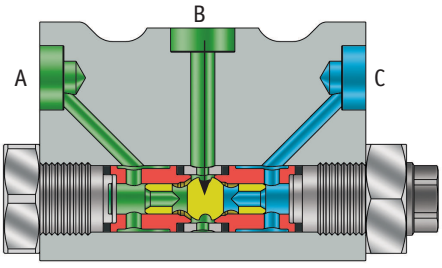



Figure 13

Pressure seal globe valves are utilized in applications where some degree of flow control (or throttling) may be required (e.g., in plant startup or shutdown modes). They are well suited for isolation applications in power plants (e.g., main steam isolation, feedwater heater isolation, boiler/economizer

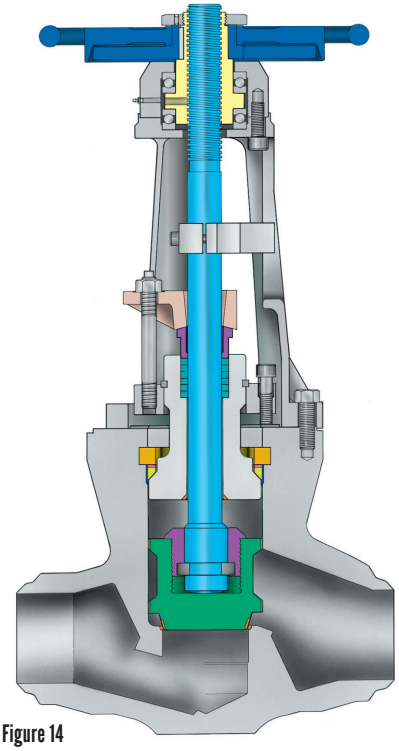


Figure 14

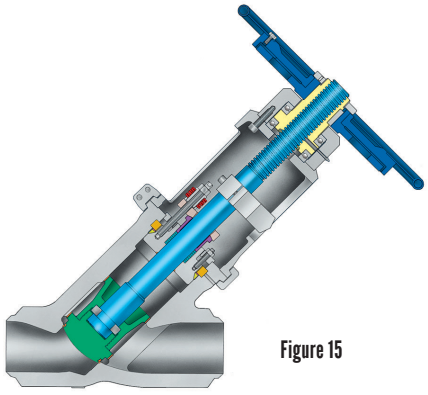


Figure 15

isolation, etc.). Pressure seal globes may be supplied in the same material types, actuation varieties (manual, gear operated, motor operated, pneumatic, electrohydraulic, etc.), trim combinations and materials, and ASME pressure classes as their gate valve counterparts. They can be supplied in a stem vertical (Figure 14) or inclined (Y-pattern) orientation (Figure 15), as a function of required flow (Cv). Pressure seal globes may be supplied with the disc mechanically affixed to the stem so that, when in the open position, flow is free to occur. However, they may also be supplied with the stem freely floating in the disc pocket

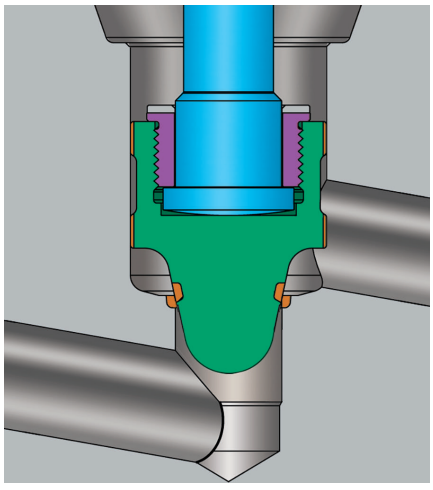


Figure 16

(see Figure 16). In this orientation (stop/check), when the valve is in the open position, the valve disc will close when a reversal of flow occurs, thus providing a check valve function in addition to the basic stop (or isolation) function.

The profile of the disc in globe valves may be modified to more finely control the amount of flow at operating conditions (Figure 16). This is particularly useful in throttling applications where the system is dependent on flow control to optimize performance. Scales may be affixed to the valve topworks to measure the valve stroke, which can be correlated to flow curves to accurately control the actual flow through the valve. Where tighter control such as modulating is required — and where consistent throttling at less than 20% open is expected — control valves, which incorporate valve operating systems designed for the application, are recommended. It is common to include an equalizing pipe to the non-pressure side to help balance the valve, increase lift, and control turbulence.

Pressure seal globe valves are not subject to CCOP, pressure locking, or thermal binding; however, the effects of high temperature (e.g., thermal expansion) must be evaluated on component parts (stem, seats, etc.), especially when the valve is to be actuated.

## PRESSURE SEAL CHECK VALVES

The primary responsibility of pressure seal check valves is to seal against a system flow reversal, thus protecting piping and components (pumps, instruments, etc.) not designed to handle that condition. They are supplied in the same materials, pressure classes, and orientations (vertical and inclined) as pressure seal globe valves. Selection of check valves is typically based on a number of variables, including system flow characteristics (e.g., Cv, velocity), media (e.g., type and size/concentration of particulate), and plant operating characteristics.

## PRESSURE SEAL CHECK VALVES MAY BE SUPPLIED IN CONFIGURATIONS, AS FOLLOWS:

**1. Swing Check** (Figure 17). Pressure seal swing check valves are commonly used in combination with gate-type isolation valves for reverse flow protection. Their relatively higher Cv (vs. piston checks), simple operation, and relative ease of maintenance make

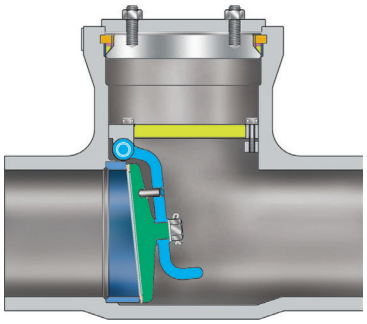


Figure 17

them popular among piping system designers.

**2. Tilting Disc Check** (Figure 18). Due to a shorter moment between the hinge pin and centerline of the disc (vs. swing checks), tilting disc check valves can react quicker to reversals in flow, thus providing a higher margin of safety to the upstream equipment and media "hammer" potential. Note the differences in cost and Cv between these two common types of check valves before purchasing.

**3. Piston Check** (Figure 19). Pressure seal piston check valves are

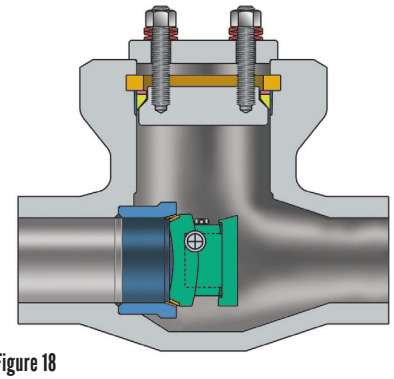


Figure 18

frequently used in conjunction with globe-type isolation valves for reverse flow protection. These valves are sometimes supplied with springs to aid in closing and/or equalizing pipes to aid overall performance.

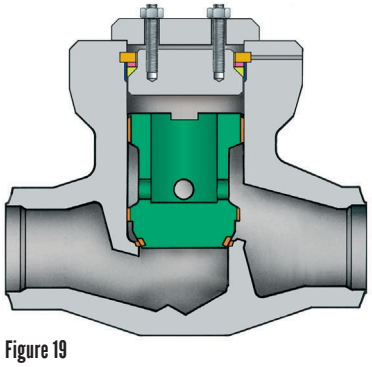


Figure 19

## SUMMARY

Although similar to their ancestors in concept, today's pressure seal valves have evolved to address a wider range of applications while delivering higher performance levels. Valve manufacturers continue their work in tweaking the various design elements contributing to pressure seal valve performance in order to provide greater value to the end user, thus assuring the key role that these valves will continue to play in power plant operation. VM

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# Nuclear Component Testing:

# The Impact of Stress Wave Testing on Safety Relief Valves

## Cold bar testing reveals a qualitative pass/fail status for valves, but more confirmation is needed for these critical components.

BY JEREMY STEVENS

To extend the useful life of today's nuclear reactors and prepare for license renewals that may extend as long as 80 years, maintenance technicians must pay careful attention to the risk of deteriorating valve performance, potential leaks and efficiency losses, especially within the steam cycle. Constant monitoring of pressure relieving devices including safety relief valves (SRVs), is an important maintenance item to ensure safe and efficient power production. Valve monitoring and maintenance technology can improve performance at all power plants, not just nuclear.

All plants perform cold bar testing to verify that a refurbished valve has been repaired properly and is operating correctly prior to installation. While the valve is under steam pressure, a cold bar is inserted downstream of the valve to see whether moisture droplets form on the surface of the cold bar to detect a seat leak. Unfortunately, traditional cold bar testing only reveals a qualitative "pass/fail" status for each valve at the time of testing. Sometimes, a valve will pass a cold bar test after refurbishment, and then develop a steam leak while in service. A leaky valve can lead to lost generation and increased fuel costs, and sometimes an expensive unscheduled maintenance outage is required to replace the leaking valve.

To gather quantitative data about the status of seat tightness and potential leakage on SRVs, some power plants use an ultrasonic leak detection system that measures stress waves — vibroacoustic, structure-borne signals that are correlated to the natural frequency of the associated material. Being able to detect and monitor this shear wave energy (SWE) is an effective way to identify valve seat leakage quantitatively and identify valve internal degradation in its early stages.

Photo courtesy of Getty Images

This article describes how a sensor-based, vibro-acoustic monitoring system — in conjunction with cycle isolation and smart software platforms — can help power plants to detect generation losses, reduce carbon emissions, reduce the risk of forced outages and cut costs.

### ABOUT THE SWE METHODOLOGY

The SWE methodology combines advanced pattern recogni-

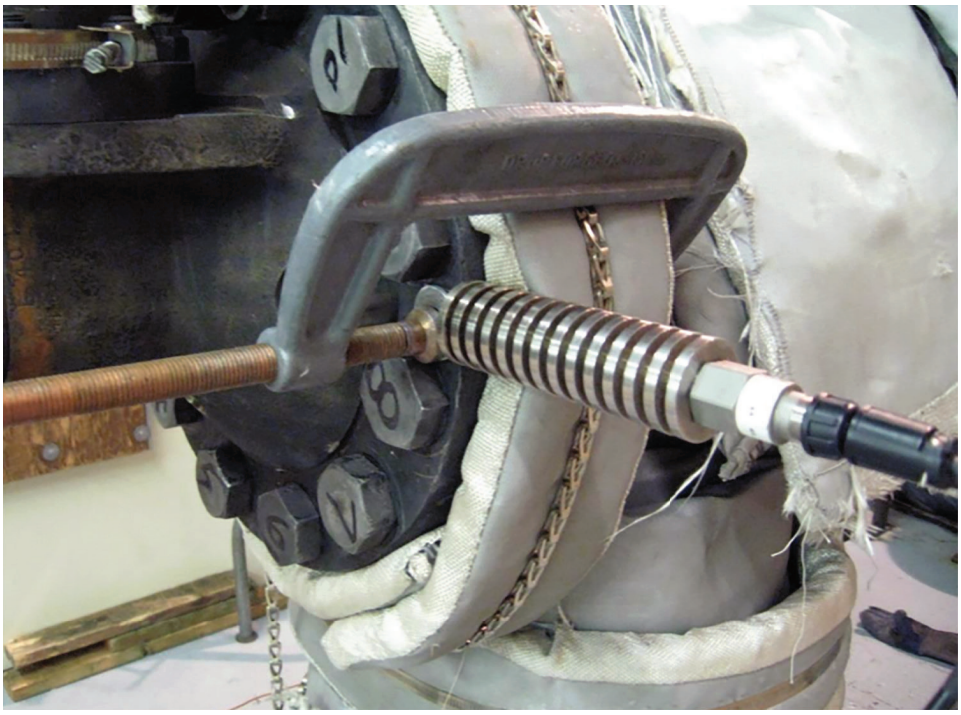

**Fig. 1: Example of SWE sensor location.**
Photo courtesy of Curtiss-Wright.

tion software, predictive technology, historical maintenance data and routine testing to provide a basis for extending valve maintenance and testing intervals, as well as a means of early detection of valve seat leakage. Optimum spring characteristics, seat geometry and seat surface finishes are critical to valve seating tightness and subsequent leakage parameters. SWE testing can quantify these maintenance practices into a number that can be trended and analyzed.

For example, tightly seated valves typically have SWE readings that are less than the defined upper control limit (UCL) criteria, and leaky valves have UCLs greater than the defined criteria. Since the UCL is a continuous measurement of valve performance, engineers can develop a comparison trend between this data and performance data. Proper attention to these SWE measurements enables power plants to quantify maintenance practices and valve sealing ability so that reliable valve performance can be achieved consistently.

This methodology has the unique ability to not only accurately gauge seat tightness of an SRV, but also help engineers and maintenance experts determine the safety margin to cold bar failure. Inputs include thermal imaging data, valve information, data on fuel costs and thermal efficiency calculations. Outputs include heat loss calculations plus estimated monetary losses based on cost per megawatt.

## THE UNIQUE ATTRIBUTES OF STRESS WAVE TESTING

Stress wave measurements study seat tightness conditions all the time, such as minute quantities of steam escaping through a faulty valve seat. Unlike other forms of condition monitoring, which measure vibration, stress waves reveal minute vibroacoustic energy changes created by the relative motion of two objects. These readings can detect internal mechanical damage that is valuable for operational mitigation and maintenance planning purposes. An increase in stress waves indicates an increase in component friction and impact events, which can be an early indicator of potential issues such as high energy process leakage across valve seating surfaces.

This type of stress wave monitoring can detect valve leakage that bypasses the generation process when combined with a complete cycle isolation program. In some cases, leaking steam cycle valves can result in many megawatts of lost generation. These losses are compounded by the undetected valve leakage continuously damaging the valve, increasing the leak, and leading to additional losses in generation and increased heat rate.

To detect stress waves, a specially designed sensor that is tuned to a specific ultrasonic frequency range is attached to the valve's surface (see Figure 1). The energy can be measured anywhere along the acoustic path that the energy traverses. When steam escapes around the seating surfaces of a valve, it creates stress wave energy, immediately detected by the SWE sensor. This data can be combined with other plant process data, such as pressure, temperature and flow, to detect leaks at an early stage and quantify cycle losses and thermal efficiencies.

To analyze the data, a complete Valve Maintenance Optimization Program (VMOP) includes a pattern recognition software application that acquires data from DCS and other monitoring systems, as shown in Figure 2. The program may also use Equipment Anomaly Detection (EAD) software to diagnose equipment behavior.

## CASE IN POINT: CONSTELLATION ENERGY

Constellation Energy is the nation's largest producer of carbon-free energy and the leading competitive retail supplier of power and energy products and services for homes and businesses across the United States. Constellation's nuclear fleet includes 21 reactors at 12 stations. Each reactor includes from eight to 20 SRVs in main steam service, for a total population of more than 300 SRVs.

Over the last 15 years, Constellation has used SWE testing and cycle-isolation technology to detect and eliminate leaks

throughout its nuclear fleet. The company has conducted over 1,500 valve as-left certification tests with piezoelectric sensors in conjunction with advanced pattern recognition software to compare historic data to current test results.

SWE technology was developed as a tool to help identify potential problems before they become significant leaks. In 2007, following a refueling outage at Constellation's Peach Bottom Atomic Power Station, a TR 3-Stage SRV began to leak excessively within a 24-hour period, about six months after it had been refurbished, passed a cold bar test, and been installed. The leaking valve was removed and replaced with a newly repaired and as-left certified one during the maintenance outage. Maintenance technicians at a vendor disassembled the leaking valve to determine what went wrong. When they put the valve on the test stand, a significant leak was discovered on the pilot valve, even though the previous cold bar test certified that the valve had been operating leak tight six months before.

Remember, cold bar tests merely indicate the pass/fail status of the entire valve at the time of testing; they don't determine the potential for future leak-free performance. SWE technology can provide individual sensor data on which of the three seats in the valve are acceptable based on historical test performance data. In this case, without supplemental stress wave data, the maintenance team would have had to repair and retest all three seats and all three disks in the valve, possibly expending unnecessary time and effort. Instead, to measure seat integrity in this valve, the Constellation team mounted piezoelectric sensors near each of the three seats. These sensors detect shock-induced stress waves at ultrasonic frequencies — a telltale sign that steam is escaping around the seating surfaces of the valve. The resulting data yielded quantitative insight into how each of the seats performed during each certification, allowing the team to focus on the SRV components that needed maintenance, as well as minimize maintenance costs for valve seats that were deemed acceptable.

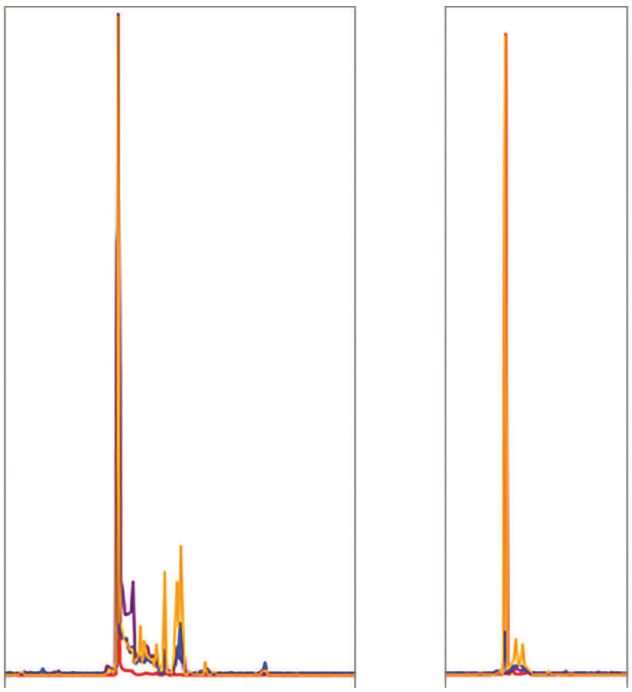

**Fig 2: Example of tightly sealed valve on the left and loosely seated, or simmering conditions, on the right.** Photo courtesy of Curtiss-Wright.

Over a 15-year period, from 2008 through 2023 YTD, Constellation has tested five different types of relief valves designed for main steam service, with set pressures ranging from 250 PSIG to 2,500 PSIG, and representing a wide range of seat diameters, pressure profiles and valve seat configurations. As more results are collected, the knowledge of how to predict future reliable valve performance has become more accurate. This has allowed Constellation's engineering team to determine the optimal data 'fingerprint' based on thousands of stress wave reports and to evaluate the health of various types of valves against proven as-left certification baselines.

## CONCLUSION: THE VALUE OF CONTINUOUS MONITORING

Having greater insight into the health of pressure relieving devices through SWE testing and advanced cycle isolation software can significantly improve power plants' operating performance by detecting and correcting potential leaks prior to installation. This proven testing method maximizes operating efficiency and can potentially eliminate generation losses due to leaking valves, from breaker to breaker. Early detection of potential issues makes stress wave testing an effective tool to determine spurious mechanical conditions before these conditions reach a critical damage point. A leaking valve can lead to significant power generation loss, increased fuel costs, and sometimes an expensive, unscheduled maintenance outage. At fossil plants, these efficiency gains have the additional benefit of reducing the carbon footprint.

SWE technology has a proven track record when used during the refurbishment process and will prove to be invaluable when utilized for continuous monitoring. Insights gained from SWE testing activities can be applied to procedures for online monitoring of valves, while they are in continuous operation. The long-term goal is to achieve continuous monitoring of all high-energy valves throughout the entire lifecycle of those valves. VM

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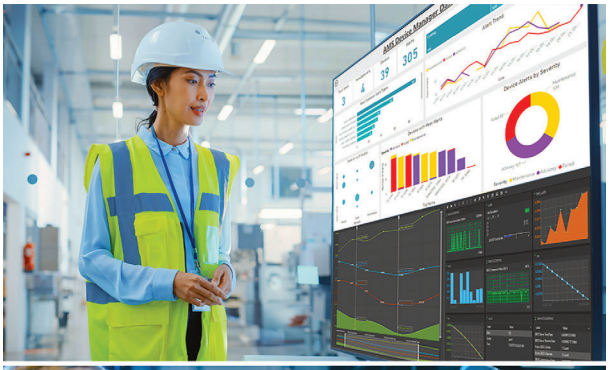


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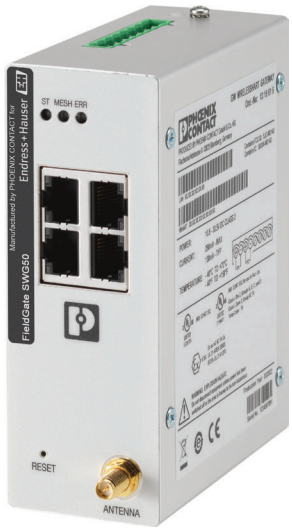
AMS Device Manager Data Server makes it easy to import critical instrument and valve data into common dashboarding tools and applications like Microsoft PowerBI, Emerson software tools such as the Plantweb Optics platform, Plantweb Insight, Aspen MTell and AspenTech Inmation, plant historians and others. **emerson.com**

## ENDRESS+HAUSER LAUNCHES NEW GATEWAY

Endress+Hauser announces the launch of FieldGate SWG50, a new WirelessHART gateway primed for secure communication from your field devices. FieldGate SWG50 is a compact and cost-effective ready for Netilion integration while providing an easy-to-use solution for multiple standard monitoring applications across various industries. Netilion is a cloud-based IIoT ecosystem designed for industrial processes, connecting the physical and digital worlds to send information from the field straight to a phone, tablet or other device.




The WirelessHART gateway FieldGate SWG50 enables users to monitor measurements and health statuses using WirelessHART connectivity. This offering is an economical alternative to complex and costly cable installations, reducing expenditure for process automation by up to 30%. It is a cost-effective concept that adapts to the process plant, both in greenfield and brownfield applications, giving customers simple access to digital communication.

With the launch of FieldGate SWG50, Endress+Hauser expands its WirelessHART portfolio focused on straightforward implementation, set-up and management of different monitoring applications.

Routinely used in monitoring applications, the WirelessHART network is a solution for standard level measurement, energy management or machinery performance monitoring.

As a gateway ready for digitalization, the integration of FieldGate

SWG50 into Netilion is simple and transparent using EdgeDevice SGC500, which is only available for purchase by Netilion users and for those with WirelessHART networks. This launch is the first of many new features Fieldgate SWG50 will receive.

FieldGate SWG50 can be paired with Endress+Hauser's FieldPort SWA70 and SWA50 adapters. It also works and seamlessly integrates with any WirelessHART device on the market. Holistically, FieldGate SWG50 allows for:

- Network migration: Change the network ID and join keys for the complete network after the network is running
- A device list with color code for a simple understanding of the device status.
- 4 x RJ-45 connectors for easy access to the connection of plant and cloud networks as well as its web interface for configuration
- Redundant power supply
- Modbus TCP and HART-IP outputs
- Indoor housing rated at IP20 with DIN rail mounting
- Connection to 100 nodes
- CommDTM to see and configure devices behind SWA50 and SWA70 in FieldCare

To learn more, visit the company's website. **endress.com**

## AUMA OFFERS CORALINK NETWORKED SOLUTIONS FOR ACTUATORS

Coralink provides closely networked support solutions for AUMA actuators. It helps plant operators to cope with growing challenges, supporting them across all phases of the plant's lifecycle, from commissioning and predictive maintenance to active lifecycle management of their AUMA actuators. Modules including the AUMA Assistant App, AUMA CDT and AUMA Cloud interact seamlessly to help plant operators cut costs and enhance plant availability.

"Coralink ensures efficient processes and sustained plant availability. Plant operators can tap the full digital potentials of their AUMA actuators," says Kevin Nietupski, product management service at AUMA.

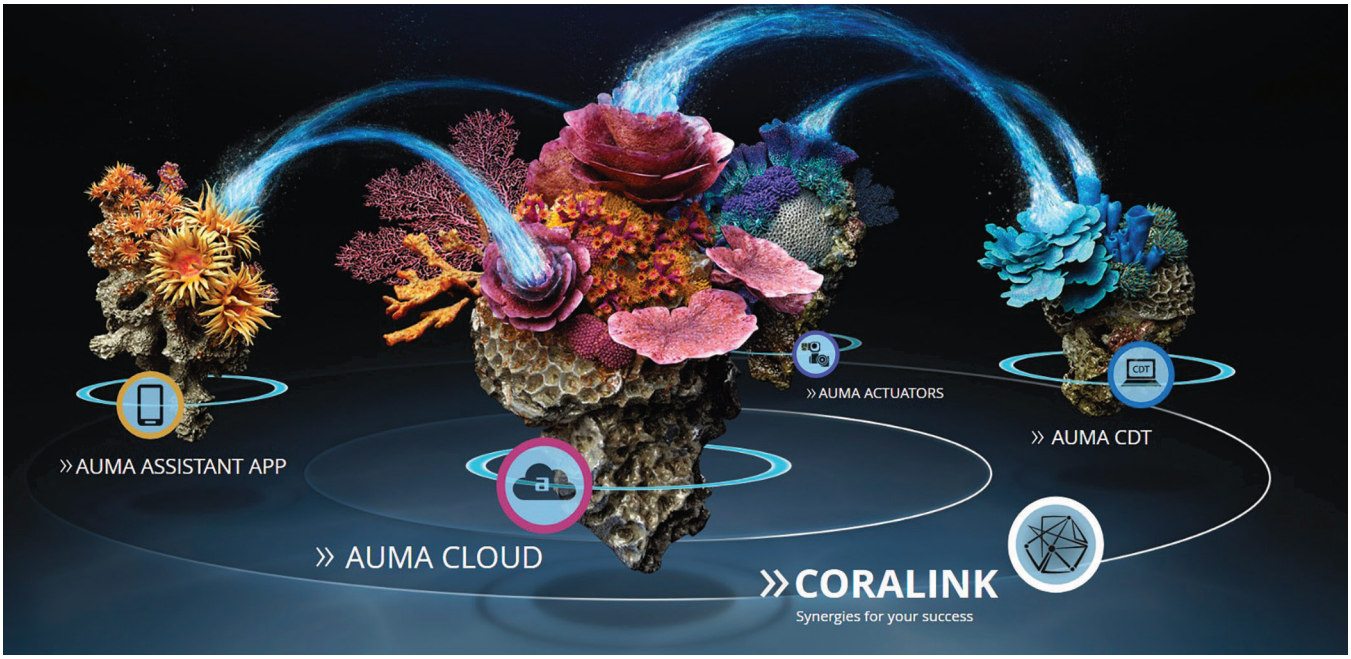
At the heart of Coralink is the ability to evaluate the extensive operating data that AUMA actuators record automatically in their role as intelligent field devices. The data can easily be read from each AUMA actuator, including via a smartphone, and then analyzed.

"A new feature is a detailed action plan with concrete recommendations for action, which is accessible through just a few clicks," Nietupski says. "By means of these automatically generated recommendations, plant operators benefit from the combined expertise of AUMA service experts and decades of field experience. Plant operators can identify maintenance requirements at an early stage and take corrective measures in good time."

Due to its scalability, Coralink saves time and money even when operators simply use it to check the condition of individual actuators. In advanced applications, Coralink can be used for comprehensive monitoring of all the actuators on a plant, as well as to implement IIoT solutions.

AUMA provides Coralink free of charge in a very comprehensive basic version. The modules run on standard PCs and smartphones, and need no extra investment in IT infrastructure.

More information is available at **coralink.auma.com**.



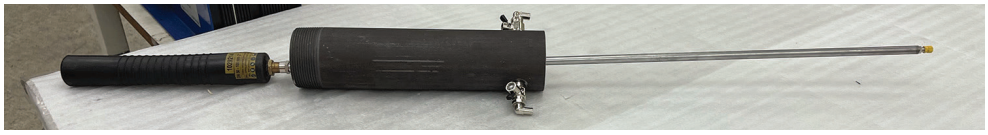
## TOOL DESIGNED FOR EASY VALVE CHANGEOUT ON TANKS

The Valve Xchanger, now available from Crawford Supply Company, was designed by an oilfield roustabout who was frustrated with potentially hazardous spills in the field or waiting on a vacuum truck crew to change out tank valves. The product was designed to change out an oil storage tank valve in under 10 minutes.

Weighing less than 15 pounds, the current model consists of inflatable nitrile bladder; insertion air stem and pump; fluid capture cylinder; drain and pressure equalization valves. It is rated for use with petroleum-based oils.

The current model can be used to change out ball, gate or butterfly valves up to 3 in. Adapters are available for 2- or 4-in. valves. Made of steel with a black oxide coating, the insertion tube is made of stainless steel. The total length of the tube with bladder attached is 49.5 in. Maximum inflatable pressure is 45 psi. Maximum back pressure at the tank flange is 34 psi, and maximum tank depth is 75 ft.

For more information, go to the product website at **valvexchanger.com**.



## VALVE TECHNOLOGY REDUCES COMPRESSOR SURGE RISK

With demanding performance requirements and targets for reducing emissions placing plant compressor equipment at risk of damage, proven anti-surge and compressor recycle valve technology can help the oil and gas industry avoid disruptive and costly unplanned compressor damage and consequently downtime.

To address these concerns, IMI Critical Engineering has developed an integrated anti-surge and compressor recycle valve that combines multiple, co-acting technologies to balance efficient production and equipment health. The valve is comprised of IMI CCI's patented DRAG Control Valve technology with SC/V actuators and smart, high-performance FasTrak or QuickTrak controllers and positioners. The solution's individual parts, developed in-house at IMI, continually interact to reduce the chance of cycle trips to optimize performance at start-up and during operation.

Designed for operations in the oil and gas sectors, the valve also uses a high number of stages for small openings at low flow conditions. As a result, greater velocity and flow control is provided, meaning that fewer cycles are required to achieve product compression targets, reducing the carbon footprint. This provides another way for the industry to reduce emissions by making processes more efficient.

"In demanding applications, the valve manages high dynamic forces, so failure risks must be minimized for the best possible performance," says Mike Semens-Flanagan, global engineering director at IMI Critical Engineering. "Similarly, valve issues including vibration, noise and erosion caused by the wide differential pressures that occur during these operations can impact nearby equipment if not addressed."

Semens-Flanagan continues: "Having greater control over compressor systems is crucial to ensuring optimal flow levels through the valve and improving plant sustainability in line with ever-tightening environmental legislation. Our unique, fully integrated anti-surge and compressor recycling valve is an excellent example of this approach in action.

For more information on IMI's anti-surge equipment portfolio, visit **imi-critical.com**

## ADVERTISER Index

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