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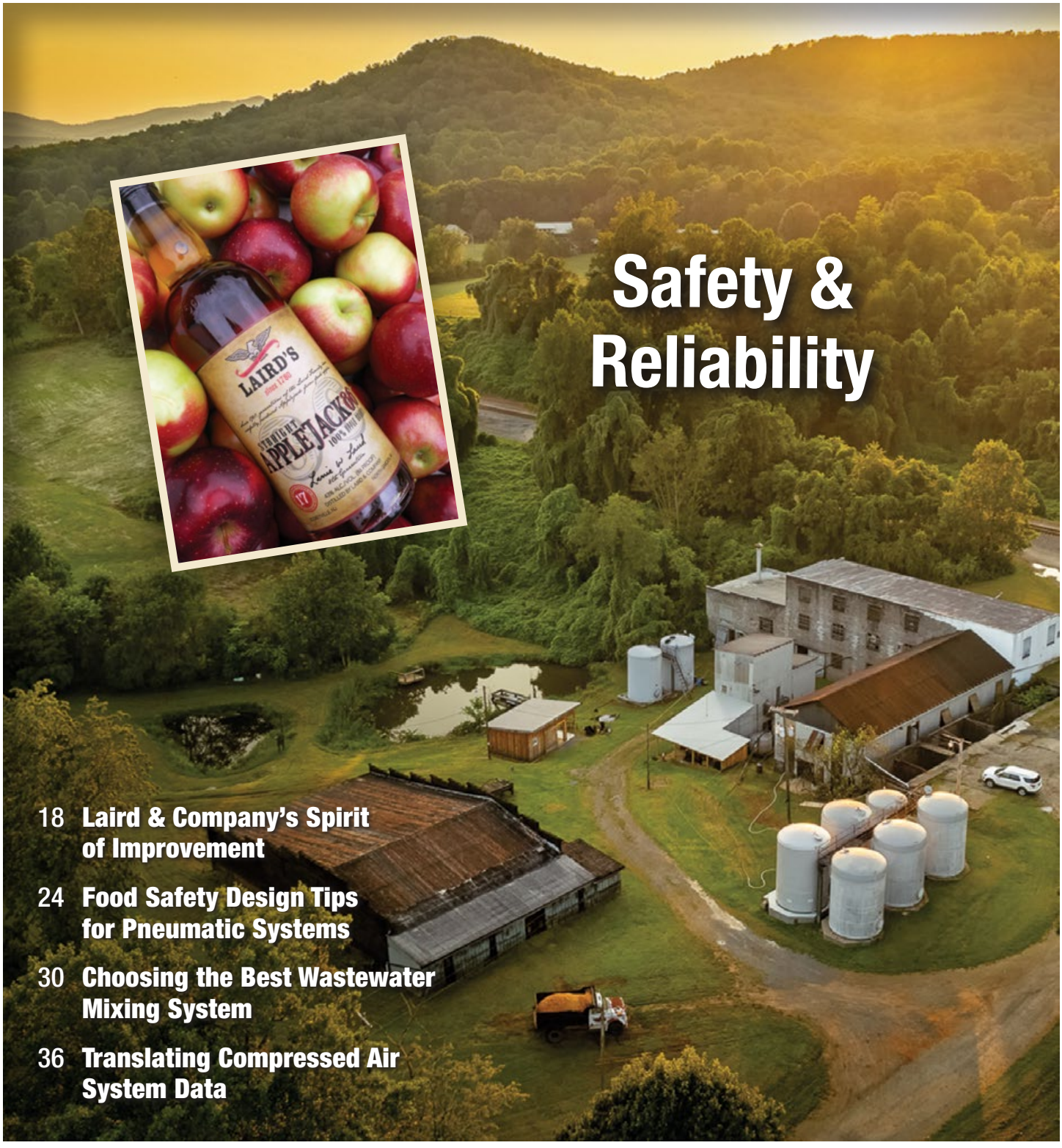

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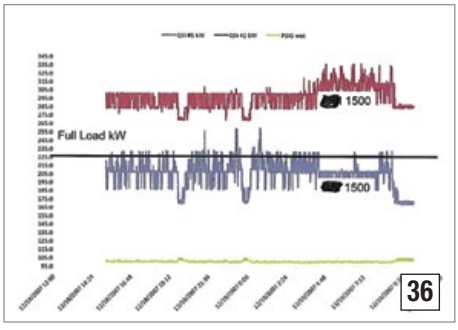

**Cover images provided courtesy of Laird & Company*

Compressed Air Best Practices® (USPS# 17130) is published monthly except January-February combined by Smith Onandia Communications LLC, 37 McMurray Rd., Suite 104, Pittsburgh, PA 15241. Periodicals postage paid at Pittsburgh, PA and additional mailing offices. POSTMASTER: Send address changes to: Compressed Air Best Practices®, 37 McMurray Rd, Suite 104, Pittsburgh, PA 15241.

FROM THE EDITOR

Safety & Reliability

Our cover story features the Laird & Company distillery, which has the distinction of their founders having served an apple brandy to General George Washington! I'd like to thank Brian Keelen, from Air & Gas Technology, and Brian Sorbello, from Rogers Machinery, for sending us this excellent case study. After several audits, they reached several conclusions – one being that a VSD air compressor, in this case, was not an appropriate solution for reliable compressed air supply.

Steve Bain is the Food & Beverage Industry Segment Manager for Festo US. He has sent us an excellent article titled, "Food Safety Design Tips for Pneumatic Systems." I recommend taking a very close look at the actions recommended in this piece.

We are very impressed by the writing and the depth of engineering provided to wastewater plants by EnviroMix Inc. Sarah Elger and John Koch have sent us an excellent article on how they deploy their BioMix compressed gas mixing system to overcome challenges faced by their clients.

Hank Van Ormer, from APenergy, has again supplied us with an educational article titled, "Translating Compressed Air System Data Into Meaningful Information." I know you'll learn a thing or two from this one.

Our team is excited to see all of you in Chicago, October 23-25, 2023, at the Best Practices 2023 EXPO & Conference! If you haven't already, please consider registering at https://cabpexpo.com/registration/.

Thank you for investing your time and efforts into ***Compressed Air Best Practices.***

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Compressed Air Industry News

Hitachi Global Air Power Acquires Henry Production and Pumps and Service

Hitachi Global Air Power US, LLC, an industry leader in innovative compressed air solutions since 1965, announced the purchase of Henry Production, Inc., parent company of Pumps and Service. Pumps and Service has been a distributor of Sullair air compressors since 1990 and provides sales and service of compressors, pumps, and related equipment. Henry Production, Inc. develops comprehensive gas compression solutions including fabrication. The companies are headquartered and co-located in Farmington, New Mexico, with sales and service locations in Albuquerque, New Mexico and Lubbock, Texas.

"Pumps and Service has strong market share in the Southwestern United States and this purchase allows us to cement our sales and service presence in the region," said John Randall, Hitachi Global Air Power President and CEO. "With the addition of Henry Production, this acquisition also allows us to deepen our customer focus – especially in the oil and gas industry. The added capabilities and expertise Henry Production brings to Hitachi Global Air Power helps further our strategy to provide total seamless solutions to our customers and better answers the evolving needs of our expanding customer base."

Henry Production, established in 1962, began with a focus on specific gas compression needs and continues to build high quality system packages and compressor skids. Pumps and Service, established in 1978 sells and services air compressors, pumps, engines, cooling towers and more. Together, the two companies provide turnkey compressed air solutions for customers, specializing in customized packages for the oil and gas industry. They also serve various other regional industries including mining, construction, and food and beverage.

Hitachi Global Air Power US purchased Henry Production, Inc., the parent company of Pumps and Service.

"What's always set us apart is the level of respect we have for customers and vendors," said Sam Henry, President of Henry Production and Pumps and Service. "Making a sale is a transaction. Treating a customer with respect creates a partnership. Hitachi Global Air Power operates with those same principles of mutual respect and trust."

All Pumps and Service and Henry Production employees will remain with their respective companies through the transition and both companies will operate under their original name pro tem to help ensure uninterrupted service to customers.

About Hitachi Global Air Power US

We build the machines that power industry. We are Hitachi Global Air Power, a leading global industrial compressed air manufacturer. Headquartered in Michigan City, Indiana, our compressed air solutions power manufacturing operations all around the globe; from food and beverage, to pharmaceuticals and computer chips. Our portable compressors provide the air power to build roads and bridges, lay pipelines and aid in oil and gas mining and production. As part of Hitachi Industrial Equipment Systems Co., Ltd., Hitachi Global Air Power operates ISO 9001 certified factories in Michigan City, Indiana and Suzhou, China, and sales offices strategically located in Europe, Australia, Southeast Asia, and South and Latin America. Through brands Hitachi, Sullair, and Champion (Australia), our machines have provided legendary reliability, durability, and performance for more than 57 years. Our global network of engineering and quality experts are building next generation, highly efficient and environment-forward compressed air solutions in direct response to customer need. For more information, visit https://america.sullair.com/en.

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Compressed Air Industry News

Fluid-Aire Dynamics Acquires The Titus Company in Pennsylvania

Fluid-Aire Dynamics, an industry leader in compressed air sales and services throughout the Midwest, is pleased to announce the acquisition of Philadelphia-area The Titus Company, a leading regional provider of compressed air and nitrogen generation systems. This strategic move allows Fluid-Aire Dynamics to extend its reach along the Eastern seaboard and further broadens the company's product portfolio and industry expertise.

The Titus Company brings new product offerings and expertise to Fluid-Aire Dynamics, including nitrogen generation, chillers, high- and medium-pressure reciprocating compressors, oil-free compressors, mist eliminators, and desiccant dryers. Founded by Stephen and Donna Titus in 1986, The Titus Company has earned a reputation for excellence, serving an array of businesses from Fortune 500 powerhouses such as DuPont and Air Products and Chemicals to local businesses like Amish Country Gazebos and RV Industries. They have also been the largest supplier of air dryers to the United States Navy, the Royal Australian Navy, and the Royal Navy of the United Arab Emirates.

"Fluid-Aire Dynamics' strategic expansion into the Philadelphia area marks a significant milestone in our journey," said Kevin Taylor, General Manager for Fluid-Aire Dynamics. "By integrating The Titus Company's portfolio into our existing services, we are not only expanding our geographic footprint but also enhancing our product offerings while adding new manufacturing capabilities. We are pleased to welcome a team of professionals who share our core values, including a customer-centric mindset."

With this acquisition, Fluid-Aire Dynamics now boasts a dedicated team of over 100 employees across six states, providing unparalleled service and products. The Titus Company will continue its operations as a regional service center for

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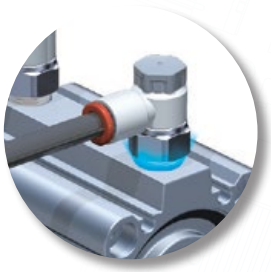
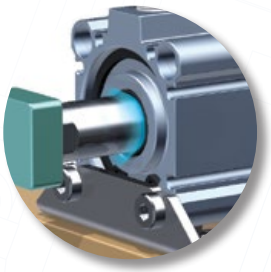
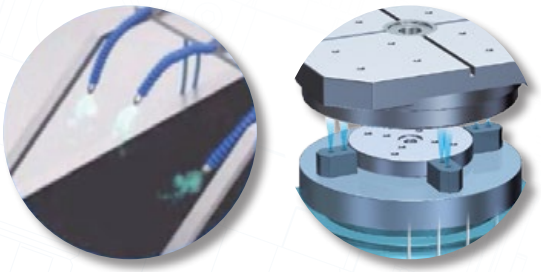


Leakage from piping connections due to poor piping installation



Leakage from cylinder due to worn seals



Blow and purge in equipment standby

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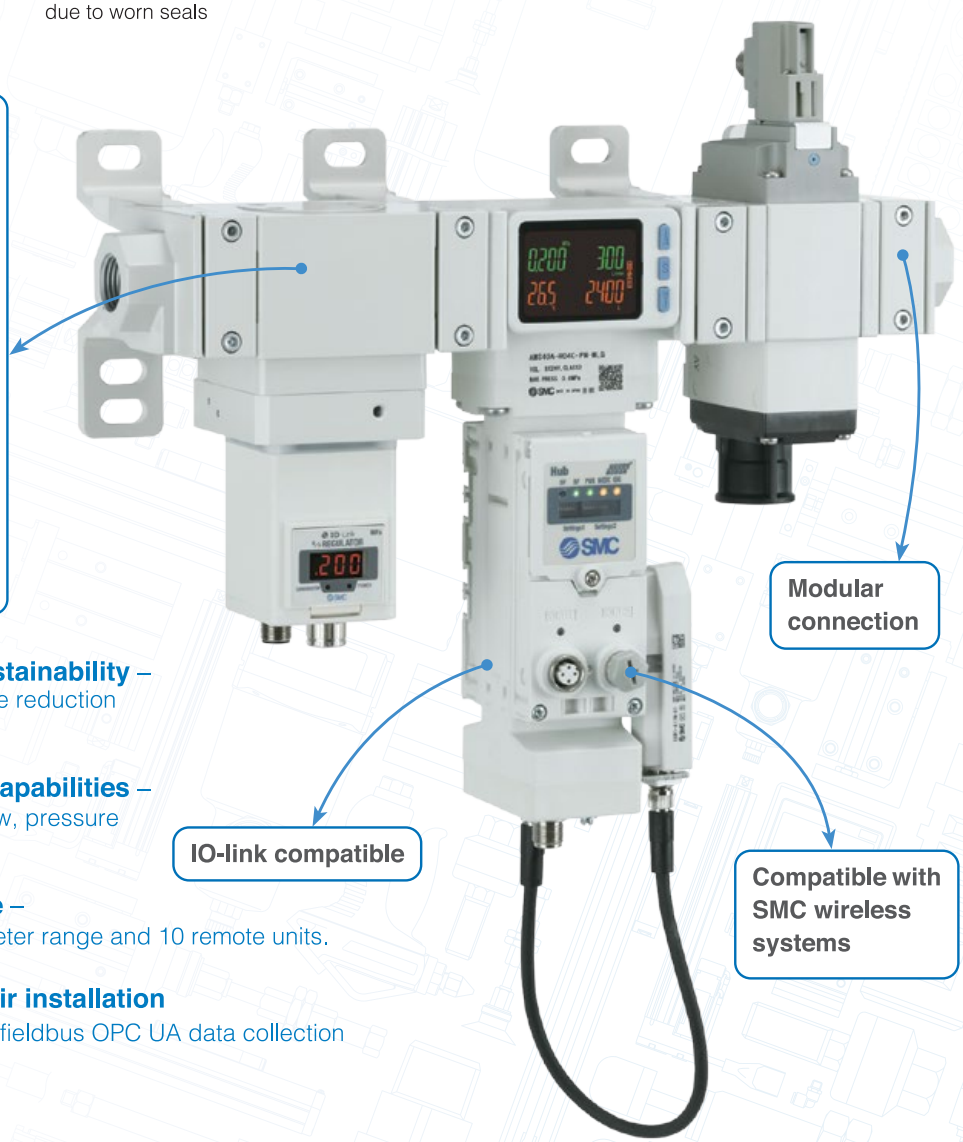

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Fluid-Aire Dynamics, serving Pennsylvania, New York, New Jersey, Delaware, and Maryland. The Philadelphia operation joins Fluid-Aire Dynamics' other regional service centers in Chicago, Milwaukee, Minneapolis, San Antonio and Detroit.

Jim Bowers, the location manager for the new Philadelphia service center, said, "We look forward to serving our existing clients under the expanded umbrella of Fluid-Aire Dynamics and welcoming new ones. Fluid-Aire Dynamics brings a wealth of organizational knowledge and proven systems that will support our growth and the sales and service excellence expected in our region. We are excited to be a part of the FAD team."

This acquisition showcases Fluid-Aire Dynamics' commitment to its vision of growth and leadership in the compressed air industry, promising an exciting future for both the company and its clients.

About Fluid-Aire Dynamics

Fluid-Aire Dynamics is a leading provider of industrial compressed air system sales and service in Chicago, Milwaukee, Minneapolis, Detroit, Philadelphia and San Antonio. Specializing in rotary screw air compressors, they offer compressed air system design and engineering, equipment sales, preventative maintenance, emergency repair and air compressor rentals. Based in Schaumburg, Illinois, Fluid-Aire Dynamics services all major makes and models of industrial air compressors and associated air accessories. They offer their proprietary brand of PneuTech compressed air system components and are the master importers of the Unipipe Aluminum Piping System. They pride themselves on excellence in service and response for their manufacturing and industrial customers….because response matters. For more information, visit www.fluidairedynamics.com.

ELGi Partners with Digi-Bridge to Promote STEAM Education

ELGi North America (ELGi), a subsidiary of ELGi Equipments Limited, one of the world's leading air compressor manufacturers, has partnered with Digi-Bridge. A non-profit organization, Digi-Bridge provides students with access to hands-on, technology-based (STEAM) science, technology, engineering, arts, and math experiences, ensuring they are well-equipped with the skills to succeed in a rapidly evolving world. As part of the partnership, ELGi supports the Southwest Charlotte STEM Academy with its after-school STEAM program. The partnership kicked off with ELGi's employees undertaking a group activity to disassemble and organize LEGO robotic kits for the students.

"We're excited to join forces with ELGi, an engineering-driven company that shares our values and vision for a future where all children have equal access to educational opportunities," said Piper Barnes, Development Director at Digi-Bridge. "Together, we look forward to expanding our efforts and impacting more children."

"At ELGi, we believe in fostering development and growth via special focus community outreach programs that engender a transformative effect on those that truly

need it. Our partnership with Digi-Bridge will provide children in the Charlotte area with fascinating and enjoyable experiences to stimulate their intellectual curiosity in STEAM subjects. STEAM education is proven to create critical thinkers who will form the next generation of innovators," said Anvar Varadaraj, Executive Director ELGi Equipments Ltd.

Going forward, ELGi plans to expand its collaboration with Digi-Bridge by offering mentorship opportunities to students and organizing hands-on workshops. These initiatives aim to bridge the gap between

The partnership kicked off with ELGi's employees undertaking a group activity to disassemble and organize LEGO robotic kits for the students.

Compressed Air Industry News

students' academic knowledge and real-world scenarios. Furthermore, ELGi plans to host field trips to its Charlotte, North America office, enabling students to experience a modern workplace and interact with industry professionals.

Launched in 2014, Digi-Bridge has provided technology-based, hands-on STEAM experiences to more than 17,000 students. The organization accomplishes this through STEAM and robotic programming with various schools and community partners.

About ELGi North America

ELGi North America, headquartered in Charlotte, NC, is a subsidiary of ELGi Equipments Limited, a leader in compressed air solutions for over 60 years. Established in 2012, ELGi North America, in conjunction with its subsidiaries, Pattons, Pattons Medical, and Michigan Air Solutions, offers a comprehensive range of compressed air products and services. Our product offering includes oil-lubricated and oil-free rotary screw and reciprocating compressors, dryers, filters, and ancillary accessories. ELGi and its subsidiaries serve multiple industry verticals spanning medical applications, pharmaceuticals, food & beverage, construction, manufacturing, and infrastructure. For further information, please visit www.elgi.com/us/.

BOGE Takes Over INMATEC

BOGE and INMATEC joined forces in August of 2023. This acquisition sees the compressed air specialist continue to grow and expand its product portfolio. In the future, customers will be able to choose from an even wider range of nitrogen and oxygen generators from BOGE. The objective: consolidating both companies' market profiles and combining their strengths.

INMATEC installs and manufactures systems for global use, they will remain an independent business unit located in Herrsching and will continue to trade under the name INMATEC.

With its takeover of INMATEC, compressed air specialist BOGE will be even more versatile in the future. The expanded product portfolio means it will be able to cater to more diverse and industry-specific requests in the future. This will make the family business in Bielefeld even more competitive.

"We have high quality standards, which INMATEC fulfills with its premium products," said Olaf Hoppe, Managing Director of BOGE. "By significantly expanding our product portfolio, we will become a one-stop shop, offering our customers high quality, complete solutions 'Made in Germany.'"

Together with the manufacturer of nitrogen and oxygen generators, BOGE will now be able to cater more individually to customer requests from both companies. For the compressed air specialist, this is a resolute continuation of its growth strategy. As well as a wider product range, customers will benefit from advanced catalytic processes for nitrogen generation, which can reduce energy costs by 50%.

About BOGE Compressors

BOGE America is the USA based America's subsidiary of BOGE KOMPRESSOREN Otto Boge GmbH & Co. KG based in Bielefeld, Germany. Whether for centrifugal compressors, screw compressors, high-pressure piston compressors, scroll compressors, controls, air treatment equipment, complete systems or individual devices, BOGE meets the most diverse requirements and highest standards – in a precise and customer oriented manner. BOGE solutions are used by all sectors of industry to supply compressed air for a wide range of manufacturing processes. The USA Operations of BOGE America stocks the various technologies of high-quality compressors and spares for immediate support to needs. Compressed air systems are designed, sold and serviced through a dedicated network of over 50 distributors in North, Central, and South America. For more information, visit www.boge.com.

BOGE and INMATEC joined forces in August of 2023.

Sauer Compressors USA Celebrates 25 Years of Success

Sauer Compressors USA, an affiliate of J.P. Sauer & Sohn GmbH, is proud to announce the celebration of its 25th anniversary. Since its inception in August 1998, Sauer Compressors USA has been committed to excellence, innovation, and customer satisfaction, and this milestone marks a momentous journey of growth and success. The Sauer USA headquarters, located in Stevensville, MD, is the largest and fastest-growing subsidiary and production location within the Sauer Group.

Over the last 25 years, Sauer USA has grown into an international network throughout the United States, Canada, and Mexico maintaining a fully staffed sales, engineering, production, controls, service, and rental teams ready and

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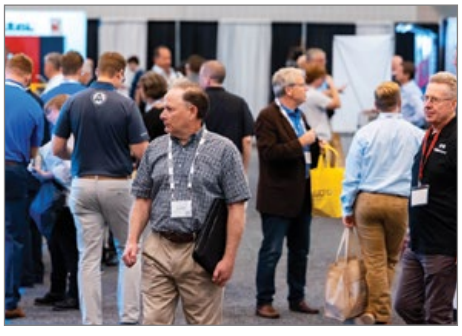

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Compressed Air Industry News

Sauer Compressors USA Celebrates 25 Years of Success *(continued)*

able to provide the best possible compressor package solutions.

After the most recent expansion in 2023, Sauer USA has added 42,000 square feet to their facility, including doubling capacity on the production floor, a new training center, a pressure testing lab, expansion of the controls division, dedicated rentals space, and a 40% increase in warehouse storage.

"It fills us with great joy and gratitude to mark a quarter of a century of excellence and growth," said Don Eaton, President and CEO. "This anniversary signifies not only the years of hard work and determination but also the immense potential that lies ahead as we continue to revolutionize the compressed air and gas markets."

Since its beginning, Sauer USA has been committed to fostering a culture of innovation and adaptability. By embracing emerging technologies and staying abreast of industry trends, the company has consistently delivered compressor solutions that provide the highest standards of quality and dependability.

Looking ahead, Sauer USA aims to enhance its offerings further, explore new market opportunities, and continue delivering exceptional value to its customers.

In celebration of this significant milestone, Sauer Compressors USA has planned an intimate gathering of employees and families to acknowledge their invaluable contributions to the company's growth.

The Sauer USA headquarters, located in Stevensville, MD, is the largest and fastest-growing subsidiary and production location within the Sauer Group.

About Sauer Compressors

Sauer Compressors is a group of companies of German origin with fourteen international subsidiaries. The company was founded over 130 years ago and has more than 80 years of experience in compressed air technology. Sauer USA, located in Stevensville, MD, is an affiliate of J.P. Sauer & Sohn, headquartered in Kiel, Germany. Sauer Compressors USA specializes in the manufacturing of medium and high-pressure air and gas compressors for naval, commercial maritime, offshore, research & development, and demanding industrial applications. In addition to air, Sauer Compressors are saturated in the CNG, N_2, He, Hydrogen, and inert gas markets. For more information, visit www.sauerusa.com.

Compressed Air Industry News

Atlas Machine & Supply Opens New Facility

Atlas Machine & Supply, a trusted name in the industrial space for over a century, proudly unveils its latest milestone in the realm of compressed air solutions. In response to unparalleled growth over the past few years, Atlas Machine & Supply is thrilled to announce the opening of a new facility that will house their Industrial Products Group (IPG).

The expansion of the Industrial Products Group is a testament to Atlas Machine & Supply's commitment to providing cutting-edge compressed air solutions and first-rate customer support. The move will enable the IPG team to cater to their customers' increasing demands while delivering unmatched expertise in the field.

Renowned as an official Sullair distributor, Atlas Machine & Supply's IPG offers an extensive range of compressed air solutions. The company's trained technicians in Kentucky, Indiana, Ohio, and Tennessee ensure that customers receive top-notch service, setting them apart as the region's only factory-recognized service provider of Sullair equipment.

"Our continued success and record growth in recent years have necessitated this strategic move to accommodate the rising demand for our Industrial Products Group," said Dave Sullivan, IPG Vice President at Atlas Machine & Supply. "With the new facility, we aim to enhance our capacity to offer unparalleled support to our customers and elevate their experience with our top-quality compressed air solutions."

The IPG's strong partnership with Sullair ensures ample access to premium products, and they offer a comprehensive range of services, including compressed air products, parts, rentals, oil-free solutions, and the servicing of other compressed air systems regardless of the manufacturer. Customers in the region benefit from the assurance of working with a company with a remarkable legacy of success, backed by over a century of expertise, solidifying Atlas Machine & Supply's IPG division as a trusted leader in the industry.

The IPG has quickly risen to the top of the compressed air market, rivaling competitors with their unparalleled service and swift response. The expansion of the Industrial Products Group signals a new era of excellence for the company, poised to meet the evolving needs of its valued customers.

As a business, Atlas Machine & Supply's mission is to apply the skills of its highly skilled workforce to tackle the most complex industrial problems. With a passion for excellence and a legacy of success, the company's Industrial Products Group continues to lead the way in compressed air solutions.

About Atlas Machine & Supply

Established in 1907, Atlas Machine & Supply, Inc. is a fourth-generation family business that has garnered a reputation for excellence in the industry. With a strong commitment to caring for both customers and employees, the company's core values revolve around delivering top-notch service and providing responsive solutions to industry challenges. Atlas Machine & Supply is an official distributor of Sullair and an expert in all compressed air services, products, rentals, repairs, and more, for the region. For more information, visit www.atlasmachine.com.

The new location, located at 11001 Plantside Drive Louisville Ky 40299, is their seventh compressed air branch across the Midwest region.

In the Spirit of Improvement

Nation's Oldest Distiller Takes Practical Approach To Compressed Air System Upgrade

By Brian Keelen, Vice President, Air & Gas Technologies and
Brian Sorbello, Northeast Region Manager, Rogers Machinery

Laird & Company is the nation's oldest distillery. Pictured is Straight Applejack 86, Blended Applejack, and Straight Apple Brandy and of the entrance to the Bonded Distillery in Scobeyville, New Jersey.

➤ From Scotland to Serving Applejack Brandy to General George Washington

Laird & Company has been pioneering and perfecting Applejack brandy for 325 years. In 1698, William Laird immigrated from County Fyfe, Scotland to Monmouth County, New Jersey, bringing nothing but the distillation skills of his homeland with him. Keen to experiment with the ingredients of the New World, William began to dabble in the distillation of the most abundant crop in the area – apples. He began sharing the spirit fondly known as "Jersey Lightning". This "cyder spirit" grew in popularity and the torch passed from William to his son Alexander Laird, and then to his son Robert Laird.

Along with being a craft distiller, Robert Laird also served in General George Washington's Revolutionary Army. After having tried the family's experimental spirit, General Washington wrote a letter to the Lairds asking for their spirit recipe. The recipe was shared with the first general and he served applejack to his fellow troops, providing a quality libation that served as liquid courage in the battle against the British.

After garnering nearly a century's worth of experience refining their apple spirit, and just four short years after the birth of our great nation, Laird & Company was officially established in 1780. They hold the unique distinction today as America's oldest distillers, and were granted the first ever bonded warehouse in the country by the federal government, along with DSP NJ-1 (Distilled Spirits Plant New Jersey-1).

Starting with humble roots as a family distillery making Applejack for friends and neighbors in a building located behind the Colts Neck Inn, and serving as a pit stop for stagecoach travelers in the early 1700's, today, Laird & Company produces eight expressions of their iconic apple distillate, as well as a ready-to-drink cocktail. In particular, their internationally known "Applejack" has earned the reputation as a quality product produced by a quality company using quality equipment to do so.

Laird & Co. employees filling barrels with apple brandy to be aged, circa 1935.

Upgrading to an Oil-Free, Two-Stage, Rotary Screw Air Compressor

One such piece of quality equipment was their 40+ year-old oil-free air compressor, which was recently retired and replaced with a brand-new Rogers KNW Series water-cooled, two-stage, oil-free rotary screw air compressor. Having worked closely together with their air compressor service provider, Air & Gas Technologies located in Keyport, NJ, for the past 26 years, the need for the upgrade had been on the minds of Laird's management for quite some time.

However even with difficult obstacles like parts obsolescence, the collective team had managed to keep the old unit running for many years beyond typical life expectancy. Laird personnel even had the foresight long ago to purchase an old spare identical compressor to utilize its parts whenever they would be needed in a pinch, but even this compressor was now looking rather bare. They knew relying on the aging, existing compressor for much longer may put their facility at risk of unplanned downtime.

According to the VP of Production, the plant operates 9.5 hours per day, as a single shift operation, and has multiple production and filling lines running as well as a rectifying department that blends and filters the liquid. Oil-free, clean, dry, and filtered compressed air is used directly to mix and move products through hoses during the filtering and bottling process. The quality and reliability of the compressed air system is critical to the operation.

In the interest of supporting facility uptime and Laird & Company's personnel productivity, it was time for an upgrade.

8th to 10th Generation Laird Family members continue the distilling tradition. Larrie Laird and Lisa Laird Dunn (top row left to right), Gerard Dunn and Laird Emilie Dunn (bottom row).

In the Spirit of Improvement

The new Rogers KNW Series Oil-Free Rotary Screw Air Compressor supporting Laird & Co's Scobeyville, NJ distillery operations.

Compressed Air Audits Performed by Air & Gas Technologies and Rogers Machinery

Like many of the system upgrades that occur today, energy efficiency was a factor considered for the type of equipment. However, Laird & Company knew based on their long history that too heavily weighing efficiency by making sacrifices in other important factors like installation cost, reliability, and serviceability had the potential to cost them more in the long run.

With the support of Air & Gas Technologies and Rogers Machinery, they took a practical approach and considered all pertinent aspects in their choice of the new equipment. To determine the right size compressor air audits were performed at two separate times with different products being produced.

Concluding in 2022, a third look at the system flow demands helped provide data during dissimilar times in production. While the distilling and bottling process air consumption ebbs and flows based on product demand and buyers' tastes, the data revealed the system's overall air consumption remained relatively consistent in all three evaluations.

This proved that the existing 100 hp, fixed speed, load/unload compressor with across-the-line starting had excess capacity. With energy savings to be had, this would further help justify the upgrade. Calculations showed the overall performance of 2.1 ACFM/kW for the existing compressor could be improved to 5.0 ACFM/kW or more by using the right size compressor.

VSD Air Compressors Aren't Always the Right Solution

A variable speed drive (VSD) air compressor was considered to maximize part load energy efficiency. However, the facility's electrical infrastructure posed a big challenge to this: the building's main power is 208v/3ph. So, a VFD for the right size compressor would have to be approximately 2.5x the size of a comparable size 460v VFD. The copper wiring for a dedicated 208v package would also add significant cost to the electrical installation. While this could be solved by using a transformer and keeping the new compressor's voltage 460v, this led to discussions about how much energy a VSD would even save in comparison to the already high efficiency of the smaller load/unload compressor being considered. A dedicated 208v variable speed compressor was ruled out due to the significantly higher installation and purchase costs.

After looking at the payback in comparison to the average VSD life expectancy for the much more industry standard 460v package, it still didn't make financial sense since the smaller load/unload compressor was already highly efficient and designed to far outlast a VSD. Also, not having a VSD simplifies the compressor package and removes a major electronic device as a potential point of failure from the system entirely, bolstering system reliability.

Lastly, by downsizing to a 75 hp compressor with a solid-state (soft) starter, this would greatly reduce the facility's demand charges compared to the existing 100 hp air compressor with an across-the-line starter. Those working closely on the project

All of the apple expressions. Laird's Straight Apple Brandy Bottled in Bond, Blended Applejack, Straight Applejack 86, Jersey Lightning (Top row, from left to right), Laird's 12 Year Old Rare Apple Brandy, 10th Generation Straight Apple Brandy, Ready to Drink Old Fashioned, Old Apple Brandy 7 1/2 Year, Single Cask Select (Bottom row, from left to right).

In the Spirit of Improvement

had realized what many compressed air professionals work to educate their clients about wherever it applies: variable speed compressors are a viable solution for many compressed air systems, but not all of them.

The cost of both the wiring and electrical installation for a 460v package, with the initial cost of the transformer factored in, was on par with a dedicated 208v package for the load/unload configuration. However, with 460v motors and other electrical components being less expensive and more readily available, choosing 460v for the package voltage would set the system up for long-term uptime success.

A Closed Loop Cooling System

As for the last remaining aspect of the air compressor package, it was the easiest of them all: cooling. The existing system had utilized a HydroThrift closed loop cooling system since 1988. It provided over thirty (30) years of reliable service, and the new compressor package features reliable shell-and-tube style heat exchangers. Since personnel at Laird were familiar with water-cooled heat exchangers and their forgiving nature in comparison to air-cooled, a new HydroThrift closed loop system was installed to complement the new compressor package. The existing refrigerated air dryer with filtration remains in use in the system.

This example of how Laird & Company carefully considered multiple aspects for their new compressor provides an important reminder for both suppliers and users of compressed air systems. Energy efficiency is an important consideration when choosing the right equipment, and with the prevalence of variable frequency drives in modern industrial equipment, it is only natural to gravitate toward the common fallback of a variable speed compressor.

However, it is prudent to remember: 'at what cost.' For the long-term success of a compressed air system and the facility it

Star Cocktail, a variation of the Manhattan and a true classic cocktail that first appeared in print in George J. Kappeler's 1895 bartending guide, "Modern American Drinks". The recipe for Star Cocktail can be found here: https://lairdandcompany.com/recipes/star-cocktail-2

supports, other key factors like reliability should not be overlooked. Ultimately the 75 hp load/unload compressor configured as 460v/3ph, water-cooled, was chosen as it was the best balance of initial investment, energy efficiency, installation cost, and long-term reliability and serviceability. The demand charge reductions have provided an immediate payback of over $1,000/month consistently off the facility's electric bills.

The parts obsolescence issues with the old compressor are no longer a concern, and they are saving on service costs with preventative maintenance being performed without multiple breakdown occurrences. As the future of Laird & Company continues to flourish through the 8th, 9th and 10th generation family, Laird & Company has made the investment in the future of its business with high quality, reliable, domestically manufactured equipment supported by local, reliably competent service providers. BP

About Air & Gas Technologies

Air & Gas Technologies was established in New Jersey in 1995. At the heart of its three business segments are compressors. Compressors for high pressure breathing air and process gas, compressors for all industrial manufacturing requirements and compressors for alternative fuels, specifically CNG & RNG. AGT is a prominent independent distributor. As such, the company is not obligated to promote only a single manufacturer. This allows for selecting the most prudent and cost-effective equipment for any specific application. Contact us and see for yourself: www.airgastech.com

About Laird & Company

Laird & Company is synonymous with apple spirits and three centuries of family distilling tradition. The company produces the vast majority of all Applejack and American Apple Brandy on the market, which have been enjoyed since colonial times and are equally prized by today's mixology community. https://lairdandcompany.com

About Rogers Machinery

Rogers Machinery manufactures air compressor and vacuum systems, as well as blowers and industrial pumps. Rogers proudly offers the KNW Series oil-free rotary screw compressors, and Rogers K Series lubricated rotary screw compressors and vacuum pumps. Rogers has been serving the U.S. and International markets since 1949. https://rogers-machinery.com

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Food Safety Design Tips for Pneumatic Systems

By Steve Bain, Industry Segment Manager
Food & Beverage, Festo US

➤ Current Good Manufacturing Practices (cGMPs) under FSMA CFR Title 21 117.40 is the cornerstone of this food safety effort. Title 21 details the cleanability and cross contamination standards that plants must meet so that food is deemed safe. The following are tips for updating existing pneumatic systems in food and packaging and what to look for when purchasing new systems.

Ensure Compressed Air Does Not Contaminate Food

Ambient air contains a host of impurities, and in food plants adulterating and allergenic particles are added to the mix. Compressed air systems used in direct food contact and in motion control increase the density of these contaminants. It is vital that compressed air intended for direct contact with food and used at the end of the packaging line is made as clean as possible through filtration. For this reason, air filtration efficiency is the first line of defense for maintaining food safety.

However, cGMPs under CFR Title 21 117.40 do not define a required compressed air quality for direct contact with food and primary packing, which means the required filtration level must be determined by the end user. While many end users have determined their own air quality requirements, others may be unsure of recommended purity.

Organizations such as British Compressed Air Society (BCAS), 3A Sanitary Standards, VDMA Mechanical Engineering Industry, and Safe Quality Food (SQF) have published recommendations for specific air quality requirements. SQF recommends, for example, a final filtration stage of 0.01 micron with a filtration efficiency of 99.999% to be located at the point of use for direct food contact. If a plant has not created its own risk assessment, operations personnel may consider meeting the SQF standard. The compressed air preparation unit, shown in Figure 1, has a filtration cascade meeting SQF. Assuming 7:4:4 (Solid particles: Water: Oil) air quality from the compressor, the resulting air quality of 1:4:2 also meets the ISO

Figure 1. Festo MS Series air filter offers compressed air quality with 99.9999% efficiency.

8573-1:2010 standard that specifies purity classes of compressed air with respect to particles, water, and oil.

Evaluate Additional Potential Contamination Points with Compressed Air

While compressed air intended for food contact is often addressed with proper filtration, there are several additional ways that compressed air can come into contact with food. For example, leaking fittings and tubing allow compressed air to exhaust in unexpected areas, which can often include areas directly over the food production. This means not only checking air nozzles and cylinders, but also finding and stopping leaks.

Preventive maintenance in terms of ongoing leak detection makes both food safety and operational sense; leak detection lowers the risk of indirect contamination and reduces energy costs. New technology can provide an automated means for detecting leaks. Once a baseline of air usage is established, these new intelligent devices alert plant personnel when too much air is consumed. The system automatically lowers pressure when a machine is idle to further save energy. By monitoring compressed air usage, leaks can often be discovered soon after they occur, and potential contamination issues prevented.

Another unintentional contamination source is the exhaust from valves controlling pneumatic components. Valves are often mounted near or above the food zone, and the air exhausting from the valve therefore poses a contamination hazard. Distance exhaust as much as possible from food and packaging and eliminate leaks that may blow contaminants into the atmosphere. If the valve cannot be moved, then the exhaust should be ducted to a safe area.

A quick exhaust located on a pneumatic actuator will also vent compressed air. As quick exhausts are usually mounted to the actuator that controls part of the process, this means quick exhausts generally expel air near the food zone. Quick exhausts should be avoided if possible by installing the controlling valve closer to the application. By utilizing IP69K

Food Safety Design Tips for Pneumatic Systems

rated valve manifolds, tubing lengths can be significantly reduced, which improves machine speed and often eliminates the need for a quick exhaust. If quick exhausts are still required, the exhaust should be ducted to a safe area.

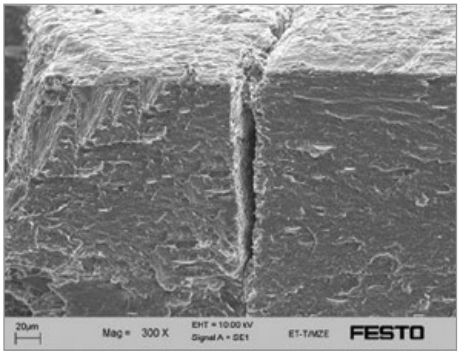

Figure 2. Scanning Electron Microscope micrograph shows cracking in incorrectly applied polymer tubing.

Use Tubing That is FDA-Approved and Resistant to Cleaning Processes

Plastics and elastomers that come into direct contact with food must comply with the directives of the FDA. The material must not give off or absorb any hazardous substances. Plastics and elastomers must also resist stress and be cleanable. Pneumatic tubing is at risk from various environmental influences as shown by the microscopic crack in the micrograph in Figure 2 – a crack that can house contaminants.

Approximately 90% of the defects on pneumatic tubing are traced to chemical, microbiological, or physical influences. Proper tubing selection and upgrade can minimize or eliminate failures due to these influences. Hydrolysis-resistant polyurethane (PUN-H) and Polytetrafluoroethylene (PTFEN) tubing are ideally suited for use in the food industry. Both resist cleaning agents, microbes, and hydrolysis and are FDA compliant. PUN-H is more flexible and economical, while PTFEN is ideal for the harshest environments.

Begin Standardizing on Metric Actuators with G-Thread Fittings

Exposed pneumatic fitting threads provide the perfect breeding ground for contaminants as the small spaces between the threads are difficult to clean. Any fitting threads that

cannot be avoided should therefore be closed off with suitable blanking caps and sealed.

There are several thread types used in pneumatic connections. BSPP, also known as G-thread used in metric-based pneumatic systems, left in Figure 3, is a parallel thread that features a clean design that eliminates exposed threads by sealing flush to a gasket. Utilizing G-threads wherever possible is an easy choice for improved FSMA compliance.

Tapered threads such as R-thread and NPT, center and right, seal by wedging threads together and through the use of sealing tape. These tapered threads risk contamination, not only through exposed threads, but also from metal fragments or flaking tape. For this reason, tapered fitting threads should be avoided for equipment in the food industry.

Make Sure Actuators Use Food Safe Lubricant

The U.S. has the strictest regulations on the use of lubricants and additives used in the food industry. Lubricating greases and oils must comply with CFR 21 178.3570. For equipment and components that will unavoidably come into occasional contact with foods and primary packaging, approved lubricants such as NSF-H1 must be used.

One potential food contaminate often overlooked is the lubricant in pneumatic cylinders. Close examination sometimes shows that grease is actually leaking from the nose of cylinders onto the food or primary packaging. It is imperative to audit cylinders for the NSH-H1 grease and replace those that do not have it.

In the washdown area, intensive cleaning can wash lubricating grease out of the cylinder. Not only does this pose a contamination problem, but also serves to impair cylinder operation. In the washdown area, utilize cylinders that feature FDA-approved dry-running seals. This

Figure 3. Parallel threads such as G-threads, left, secure to a sealing gasket and eliminate exposed threads. R-threads, center, and NPT, right, pose a contamination risk.

Food Safety Design Tips for Pneumatic Systems

will ensure clean, optimum operation even when the grease has been washed from the cylinder. Eliminating the use of components that fail because lubrication can be washed away is an example of how cleanability and cGMPs can improve uptime.

Figure 4. This image shows the incorrect choice of materials for a pneumatic cylinder based on the amount of corrosion.

Replace Problem Components with Those Designed for Sanitary Applications

Many potential sources of contamination in food production such as bacteria, chemical influences, and corrosion particles can be eliminated by utilizing a few basic design considerations. To ensure that cleaning is safe, the materials used must not react with the cleaning agents or disinfectants. Machine parts must be resistant to corrosion and be mechanically and chemically stable.

Contrast the components in Figure 4 with the actuator made of stainless steel in Figure 5.

Its design rigorously conforms to cGMP criteria. For example, there are no threads on the bearing cap and thus a reduced possibility of trapping contaminants. Its self-adjusting end position cushioning system is designed without contaminant susceptible adjusting screws. The actuator also utilizes NSF-H1 grease and FDA approved seals.

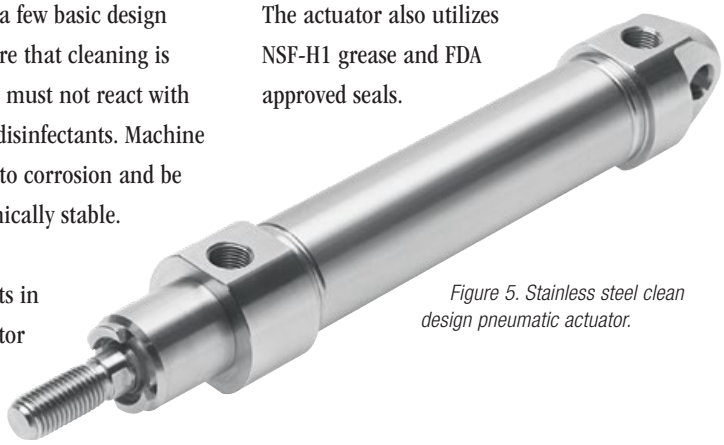

Figure 5. Stainless steel clean design pneumatic actuator.

Conduct Audits

Pneumatic systems are not static. Components wear out and vibrations can loosen fittings. New components are not only easier to clean, but also more rugged, performing better in harsh environments. It is not cost effective to replace every older machine, but it is worthwhile in terms of clean operation and overall equipment effectiveness (OEE) to maintain and upgrade pneumatics and automation components based on the findings of regularly scheduled audits.

Food safety tips for pneumatic systems

1. Ensure compressed air intended for food contact does not contaminate food.
2. Evaluate additional potential contamination points with compressed air.
3. Ensure that pneumatic tubing is approved by the Food and Drug Administration (FDA) and is resistant to cleaning processes.
4. Eliminate fittings that are difficult to clean.
5. Ensure that actuators utilize food-safe grease.
6. Eliminate components that easily corrode and are not designed for the food environment.
7. Conduct audits at scheduled intervals. BP

* Photos courtesy of Festo

About the Author

Steve Bain is the Industry Segment Manager for Food and Beverage for Festo US. A Chemical Engineer by degree, Steve worked for Kimberly-Clark and Ecolab in engineering roles before joining Festo in 2011. Steve works on a national level as a primary interface between Festo employees and customers to discuss food applications and compliance with food regulations.

About Festo US

Festo is a leading manufacturer of pneumatic and electromechanical systems, components, and controls for process and industrial automation. For more information, visit www.festo.com.

Steve Bain, Industry Segment Manager Food & Beverage, Festo US

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Choosing the Best Wastewater Mixing System

How Compressed Gas Mixing Overcomes Daunting Challenges

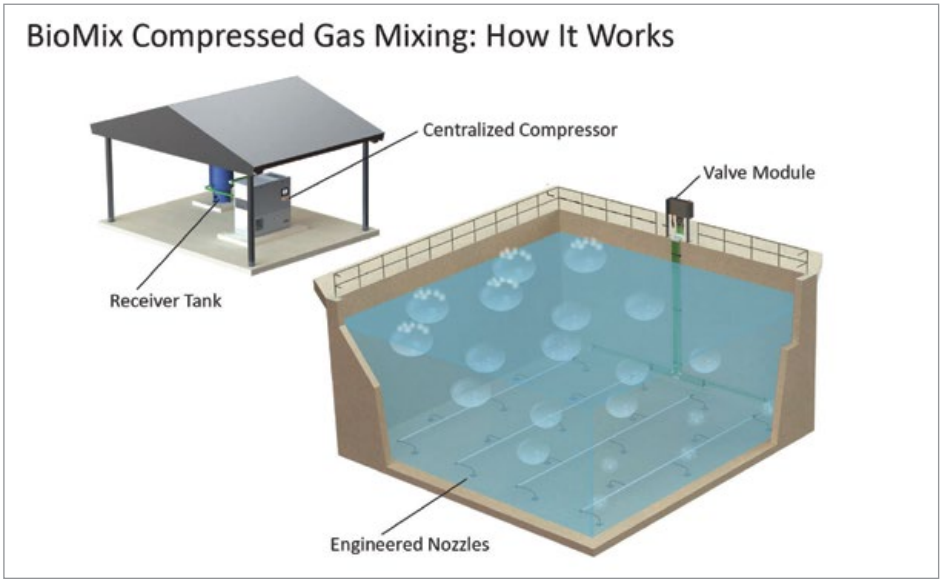
By Sarah Elger, P.E., Director of Strategy and Marketing and
John Koch, P.E., Vice President of Technology, EnviroMix Inc.

Influent flow equalization tanks at NRWRF in Manatee County, Florida.

When selecting a mixing technology, wastewater treatment plants (WWTPs) and their consultant engineers must consider numerous factors, balancing specific treatment demands with plant priorities and ultimately choosing the technology that best suits their needs and specifications. Compressed gas mixing (CGM) is often the best solution, allowing designers to circumvent many challenges that alternative technologies either create or cannot overcome. Widely accepted, CGM has gained popularity over the past decade as its consistent advantages have been realized more broadly throughout the market.

Developed by EnviroMix, BioMix™ Compressed Gas Mixing provides uniform mixing of tank contents by firing programmed, short-duration, high-intensity bursts of compressed air through patented, engineered nozzles located near the tank floor. Mixing parameters – including pressure, sequence, duration, and frequency – may be adjusted, either through operator input or automatic process feedback, to optimize power utilization and deliver ideally mixed conditions.

BioMix starts with a centralized compressor system that can be used for multiple applications, regardless of treatment process, liquid depth, or solids concentration. The compressor, which uses ambient air, modulates output to maintain system pressure while conserving energy when demand is low. Charged by the compressor, the receiver tank supplies compressed air to the valve module. The valve module controls the mixing intensity and releases the bottled-up air in high-pressure, high-velocity timed bursts through groups of nozzles across the floor of the tank. Large



volumes of gas generate an upwelling motion and create circulatory currents, suspending solids and maintaining a completely mixed environment.

BioMix empowers design engineers and WWTPs to eliminate the following formidable challenges, delivering a wide range of benefits along the way.

Challenge 1: Wasted Energy

BioMix systems provide significant power savings compared to mechanical mixers by uniformly distributing mixing energy across the basin floor rather than directing it outward from a localized point in the tank.

BioMix Energy Savings by Application

Application	Conventional Technology	Energy Usage (HP/1000 ft³)	BioMix Energy Savings
Septage Receiving	Diffused Aeration	0.5	60%
Influent Equalization	Jet Mixing	0.4	70%
Distribution Channels	Diffused Aeration	1.25	60%
BNR Selectors	Mechanical Mixers	0.25	60%
Swing Zone	Mechanical Mixers	0.25	60%
Aerobic Digestion	Diffused Aeration	1.5	50%
Sludge Holding	Jet Mixing	1	70%

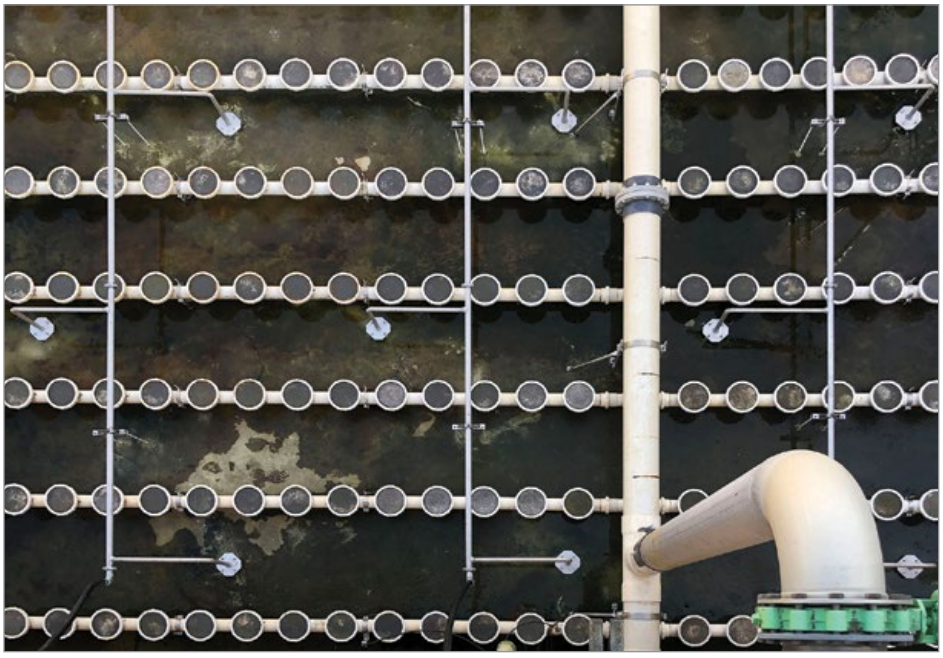
Multiple studies have documented a 60% or greater reduction in power usage versus mechanical mixers and even more versus diffused air mixing.

Choosing the Best Wastewater Mixing System

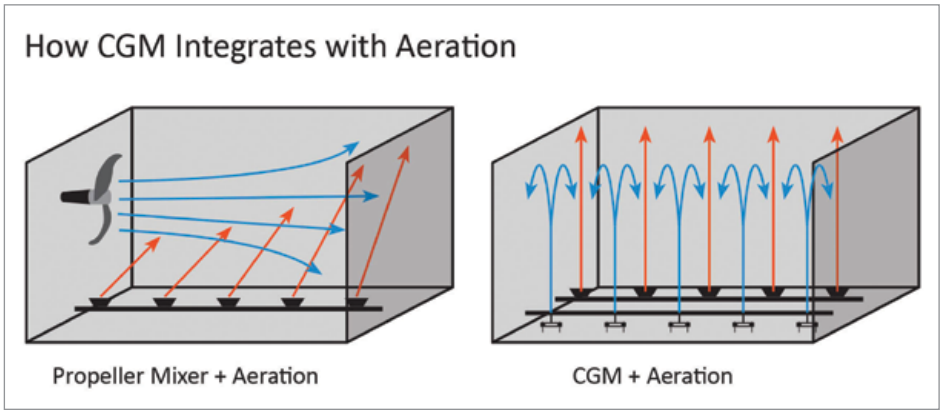
Case Study: Manatee County, Florida

In 2017, Manatee County upgraded the North Regional Water Reclamation Facility (NRWRF). Treatment was improved through the construction of three 1-million-gallon influent flow equalization tanks utilizing a BioMix system. Use of BioMix in lieu of conventional diffused aeration resulted in energy cost savings of over $150,000 annually.

The NRWRF system utilizes one duty and one standby 30 HP compressor to provide the mixing energy for all three equalization tanks. A traditional diffused aeration mixing system would require ten times the horsepower to provide equivalent mixing. Optimal mixed conditions for each tank are automatically adjusted to accommodate variable depth operation, ranging from a few feet of liquid depth to a maximum of 23 feet. The BioMix system reduced the facility's O&M costs by 90% versus conventional diffused air mixing, saving Manatee County millions of dollars over the life the system.



BioMix nozzles interlaced with diffused aeration.



Challenge 2: High Maintenance Demands

All in-tank components of a BioMix system are maintenance free, non-clogging, and self-cleaning. While conventional solutions require high maintenance impellers, motive pumps, diffusers, blowers, and more, the centralized compressor system creates a single maintenance touchpoint in a controlled environment. Electrical requirements are limited to the power needed to operate the air compressor and the valve modules.

Based on his nearly 30 years of industry experience, Superintendent Blaine Shipley of Price River Water Improvement District in Wellington, Utah, stated about BioMix, "I like the fact that there are no mechanical or electrical parts underwater. That's part of the reason I wanted to go this [CGM] route versus some other kind of mechanical mixing. And I like the fact that it's pretty much all stainless steel. So, there's not much opportunity for corrosion." Shipley added, "The system is surprisingly even more simple and easy to take care of than I expected."

"The maintenance is super minimal. There is nothing we have to do to this tank. It works perfectly," said Greg Hill, Operations Manager at Mount Pleasant (SC) Waterworks, of his BioMix system.

Challenge 3: Integration with Aeration

Unlike mechanical mixers, bottom-up CGM easily integrates with aeration equipment for swing zone, low oxygen demand, and mixing limited applications. The technology can operate concurrently with or independently from aeration for optimized process conditions. Decoupling oxygen demand from mixing requirements provides the operational flexibility

BioMix nozzles alleviate dead zones in the aerobic digester in Emporia, Kansas.

to reduce the diffused aeration system airflow rate to meet the air required for plant loading.

BioMix nozzles can be interlaced with diffused aeration grids, allowing simultaneous operation at a wide range of airflow rates. This results in:

- Promotion of anoxic and anaerobic conditions to enable biological nutrient removal (BNR)
- Simultaneous nitrification and denitrification
- Conditions that promote a healthy biomass with good settling characteristics
- Stable dissolved oxygen (DO) profile throughout the aeration tank
- Significant energy savings

BioMix uniformly mixes tank contents at 85% less energy than diffused air mixing. Though it may look like coarse bubble aeration to the untrained observer, BioMix produces a much larger, intermittent bubble with 95% less air volume so it doesn't transfer oxygen.

Challenge 4: Dead Zones and Minimum Operating Depths

BioMix's patented nozzles and headers are compatible with any tank geometry or configuration. Headers are designed to conform to the slope of the tank floor, eliminating "dead spots." The system can also mix through a range of operating depths with no low-level limitations.

Case Study: Emporia, Kansas

The City of Emporia upgraded its wastewater treatment plant in 2019 with a primary goal of upgrading and expanding the plant's conventional activated sludge process to an integrated fixed film activated sludge

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Presenter Tim Dugan, P.E., President and Principal Engineer, Compression Engineering Corporation – *Sponsored by VPInstruments and FS-Curtis/FS-Elliott*
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Low Pressure (15-60 psi) Air Applications: Blower or Air Compressor?
Presenter Ron Marshall, Chief Auditor, Marshall Compressed Air Consulting – *Sponsored by Kaishan*
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APR 13
Oil-Free vs Lubricated Rotary Screw Air Compressors: Pros and Cons
Presenter Paul Edwards, Principal, Compressed Air Consultants – *Sponsored by Kaeser Compressors*
Thursday, April 13, 2023 – 2:00PM EST

APR 27
Compressed Air as a Quality/Safety Manufacturing Process Variable
Presenter Tom Taranto, Owner, Data Power Services – *Sponsored by Kaishan*
Thursday, April 27, 2023 – 2:00PM EST

MAY 11
Vacuum System Fundamentals: Depth of Vacuum vs. Absolute Pressure
Presenter Andy Smiltneek, President, Growth Solutions Consultants – *Sponsored by Rogers Machinery*
Thursday, May 11, 2023 – 2:00PM EST

MAY 18
CTI STD-201RS Thermal Certification for Cooling System Heat Rejection Equipment Part 1: Performance Ratings
Presenter Mike Womack, Thermal Certification Administrator, Cooling Technology Institute – *Sponsored by EVAPCO*
Thursday, May 18, 2023 – 2:00PM EST

JUN 08
Vacuum Pump Maintenance
Presenter Tie Duan, Solutions Engineer, E.W. Klein & Co. – *Sponsored by Kaishan*
Thursday, June 8, 2023 – 2:00PM EST

JUN 22
Greener Compressed Air Systems- Reducing the Environmental Impact
Presenter Paul Edwards, Principal, Compressed Air Consultants – *Sponsored by VPInstruments and Kaeser Compressors*
Thursday, June 22, 2023 – 2:00PM EST

JUL 13
Design Considerations When Transitioning to Oil-Free Compressed Air Systems
Presenter Tim Dugan, P.E., President and Principal Engineer, Compression Engineering Corporation – *Sponsored by Rogers Machinery and FS-Curtis/FS-Elliott*
Thursday, July 13, 2023 – 2:00PM EST

JUL 23
Engineering Rooms for Aeration Blowers
Presenter Tom Jenkins, P.E., President, JenTech Inc. – *Sponsored by APG-Neuros*
Thursday, July 23, 2023 – 2:00PM EST

JUL 27
From Fresh to Soggy – Quality Monitoring: How Compressed Air Condensate Affects Food Quality
Presenter Francisco Lara, Manager, Airtec Global LLC – *Sponsored by SUTO iTEC*
Thursday, July 27, 2023 – 2:00PM EST

AUG 10
Air Compressor Size: The Struggle of Getting it Right
Presenter, Ron Marshall, Chief Auditor, Marshall Compressed Air Consulting – *Sponsored by Kaishan.*
Thursday, August 10, 2023 – 2:00PM EST

AUG 17
Compressed Air as a Food Ingredient
Presenter Roderick Smith, Publisher, Compressed Air Best Practices Magazine – *Sponsored by Trace Analytics and BEKO Technologies*
Thursday, August 17, 2023 – 2:00PM EST

AUG 24
ASME PTC 13: Efficient Blower, Sustainable Systems
Presenter Tom Jenkins, P.E., President, JenTech Inc. and John Conover, Business Development Manager, Air Clean USA – *Sponsored by Lontra*
Thursday, August 24, 2023 – 2:00PM EST

SEP 21
Information Required to Specify an Air Compressor
Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – *Sponsored by Vaisala*
Thursday, September 21, 2023 – 2:00PM EST

OCT 05
Compressed Air Systems for Cheese Manufacturing
Presenter Frank Melch, Vice President, Zorn Compressor & Equipment – *Sponsored by Quincy Compressor*
Thursday, October 5, 2023 – 2:00PM EST

NOV 09
Chiller Selections for Central Plants: Lowest Overall Costs for Process Cooling
Presenter Clayton Penhallegon, Jr., P.E., Integrated Services Group – *Sponsored by Carrier*
Thursday, November 9, 2023 – 2:00PM EST

NOV 30
Vacuum System Efficiency
Presenter Andy Smiltneek, President, Growth Solutions Consultants – *Sponsored by Rogers Machinery*
Thursday, November 30, 2023 – 2:00PM EST

DEC 07
Compressed Air Dryer Maintenance and Monitoring
Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – *Sponsored by BEKO Technologies and CALMS*
Thursday, December 7, 2023 – 2:00PM EST

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Choosing the Best Wastewater Mixing System

(IFAS) process with aerobic sludge digestion. The design team selected EnviroMix technologies for the BNR selectors and the aerobic sludge digestors.

The upgraded aerobic digestion system utilizes a pre-existing 27' deep anaerobic digester that was converted to an aerobic digester and a new 18.5' deep aerobic digester that is about 50% greater in capacity. Both digesters have deep conical hopper bottoms, making it virtually impossible to completely mix the tanks with just a diffused aeration system. The BioMix system was installed below the aeration grid following the slope of the floor to ensure mixing all the way to the bottom of the cone, thereby eliminating the large dead volume that would result in sludge deposition and digester upsets due to septic conditions.

When selecting the mixing technology that best suits their specific needs, WWTPs and consultant engineers must consider all the options that are available to them. CGM offers a powerful energy-efficient, low-maintenance solution that supports process optimization and highly scalable and flexible operations. BP

About the Authors

Sarah Elger, P.E. is the director of strategy and marketing at EnviroMix Inc. She has been in the water and wastewater industry for more than 15 years and specializes in biological wastewater treatment and process controls. Sarah received her B.S. in engineering mechanics from University of Wisconsin; received her M.S. in environmental engineering from Milwaukee School of Engineering; and is a registered professional engineer in the State of Wisconsin.

John Koch, P.E. is currently the vice president of technology at EnviroMix, Inc. He received his B.S. in civil engineering from Marquette University. John has more than 30 years of experience in the wastewater treatment industry, specializing in biological wastewater treatment systems including sequencing batch reactors, membrane bioreactors, membrane aerated biofilm reactors, oxidation ditches, and conventional activated sludge systems. John is an active member of Water Environment Federation and a registered professional engineer in the State of Illinois.

About EnviroMix

With offices in Charleston, SC, and Grafton, WI, EnviroMix designs and manufactures treatment technologies which protect the environment and reduce energy consumption in the water and wastewater industry. Utilizing patented and proprietary technology, we provide mixing and process control solutions to enhance plant performance for a wide variety of applications in the treatment process. Visit www.enviro-mix.com for more information.

To read similar articles on ***Industrial and Municipal Wastewater*** please visit https://www.blowervacuumbestpractices.com/industries/wastewater

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Translating Compressed Air System Data Into Meaningful Information

By Hank Van Ormer, Technical Director, APenergy

Compressed air system performance data and proper interpretation is required in order to:

- Compare accurately to equipment OEM data sheet performance
- Establish an accurate performance baseline
- Measure the impact of system changes to compare with past compressed air system performance and efficiency

This article is a follow-up to a similar topic, covered in the October 2022 Issue of Compressed Air Best Practice Magazine, titled "What is CFM in Compressed Air? How Much Do I Have? How Much Do I Need?" This article dealt with all the various conditions that can and do affect the performance capacity of various types of air compressors in actual flow capacity (SCFM at site conditions).

For those of you that don't remember exactly what was in the article, there were several significant take-aways.

- Any change in actual inlet pressure to the air compressor will affect the delivered volume and ability to perform work.
- The higher the inlet pressure in PSIA, the higher the rated flow. The appropriate mathematical equations are included.
- ACFM is actual delivered air at ambient conditions.
- SCFM is mathematically converted from ACFM to allow for differences in flow with actual measured conditions – compared to the OEM data and its rated conditions. It is a misconception that all SCFM ratings are equal! This is true only if the test rated conditions of the inlet pressures, inlet temperature and relative humidity are equal at the operating site. The article goes on to show various accurate methods to reconcile the differences.

This article's emphasis is to establish a similar protocol for energy data measurement, particularly the HP and KW used to produce compressed air. When properly combined, with an accurate ACFM to SCFM reconciliation, this will deliver a good portrait of air compressor energy efficiency in KW/SCFM and with KWH

the energy that creates the energy cost in SCFM.

A few definitions are in order:

BHP

You often see BHP in OEM reference sheets. This is the power required at the air compressor drive shaft (often tested at the facility). It does not include any drive motor and power train losses such as Motor Efficiency (ME), Power Factor (PF), VSD Drive loss and belt or gear loss. All of this data must be considered to identify an answer that is not just data but information one can act on.

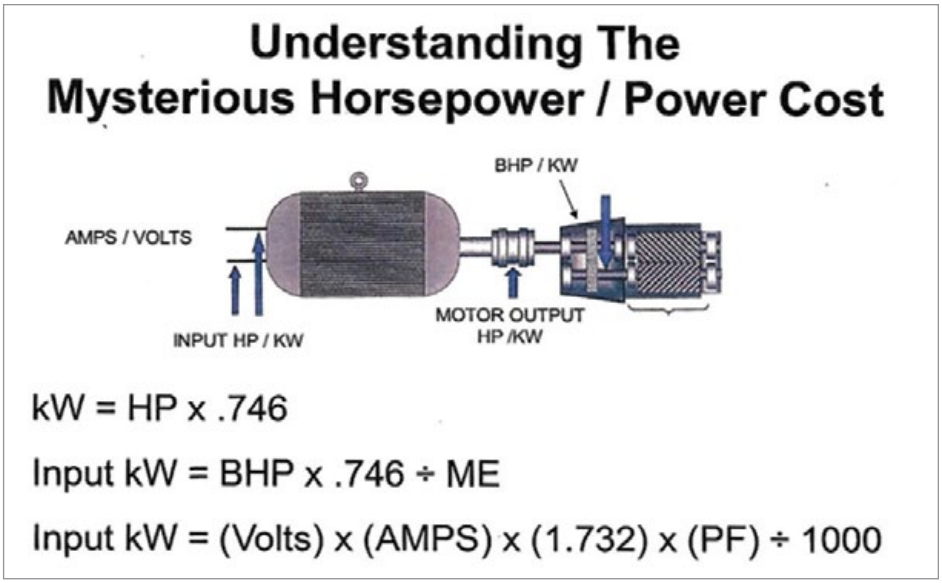

Figure 1.

Translating Compressed Air System Data Into Meaningful Information

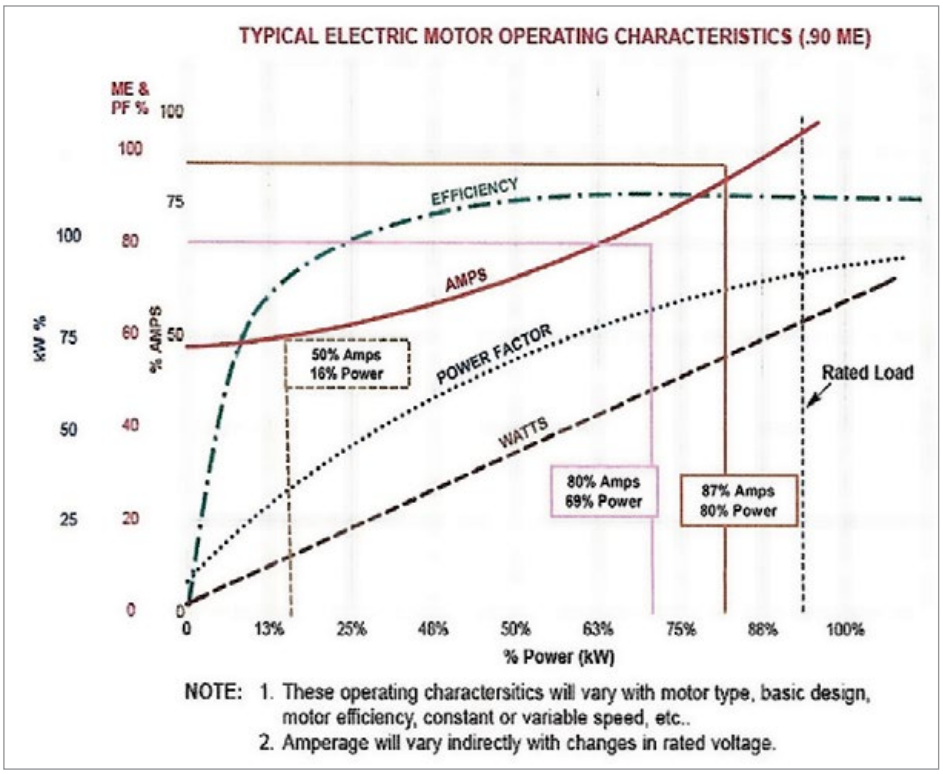

Figure 2.

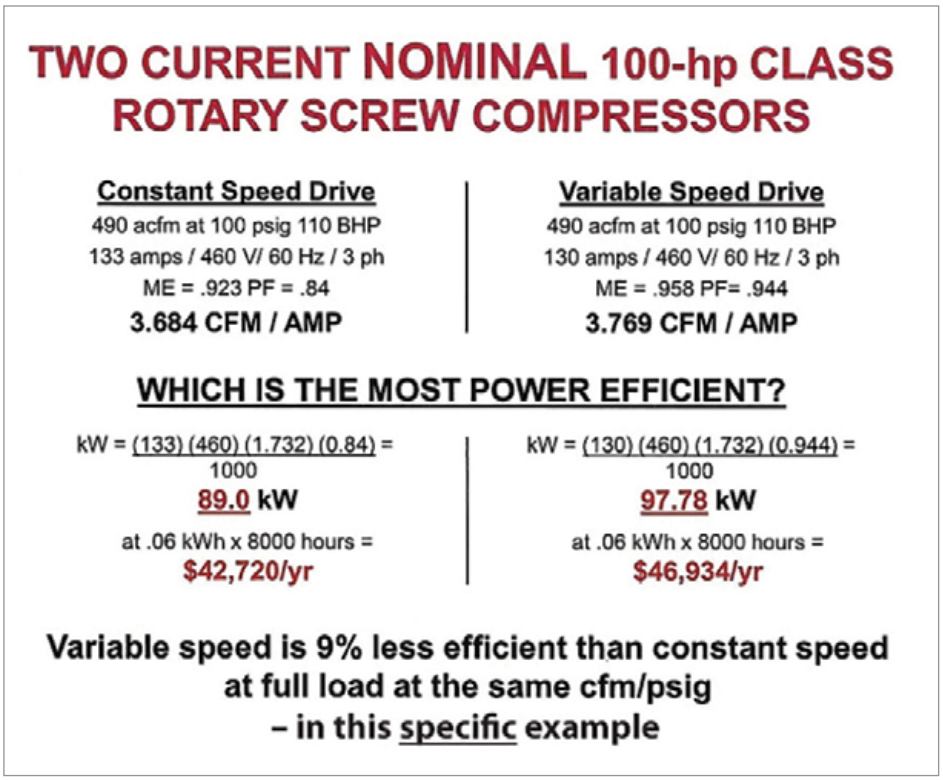

Figure 3..

Primary Points of BHP at the air compressor (power required at the compressor shaft).

- Motor output HP may be same as BHP, or not
  - Probable losses: VSD, gears, PF, ME
- Input HP/KW is what counts to create your energy bill
- Power factor and motor efficiency fall as the load falls from full to part to idle
- Motor efficiency and power factor may both be affected by electrical motor speed changes

Amp Measurement

Do not use percent of full load amps to identify the probable inlet power (KW) at part load. You will see that both the Motor Efficiency Curve and Power Factor Curve fall as the load falls (See Figure 2).To be meaningful, amps must be measured simultaneously with voltage. As the voltage varies the amps vary indirectly. As the voltage falls, the amps go up – with no load change.

When these operating curves in Figure 2 for the specific motor drive are available, they will allow a relatively accurate estimate of the amps to KW relationship. This is the design input KW at rated load when this specific motor and electric system are correct at rated speed. Speed variation will probably modify these curves.

How do we measure this data so it becomes useful information? The most accurate way to

measure input KW is with meters on the motor and each leg that record amps, volts & PF simultaneously. The formula for this is (only applies to three phase power):

Input KW =

(volts) x (amps) x (1.732) x PF ÷ 1000

(1.732 = $\sqrt[2]{3ph}$)

The Data Point Spacing should be aligned with any collected flow & pressure data points to reflect an accurate profile.

It is important to remember Amps alone do not accurately reflect input power. It is input KW that generates the energy cost (KWH). In addition, KW properly measured is "a great tattle-tale" for maintenance.

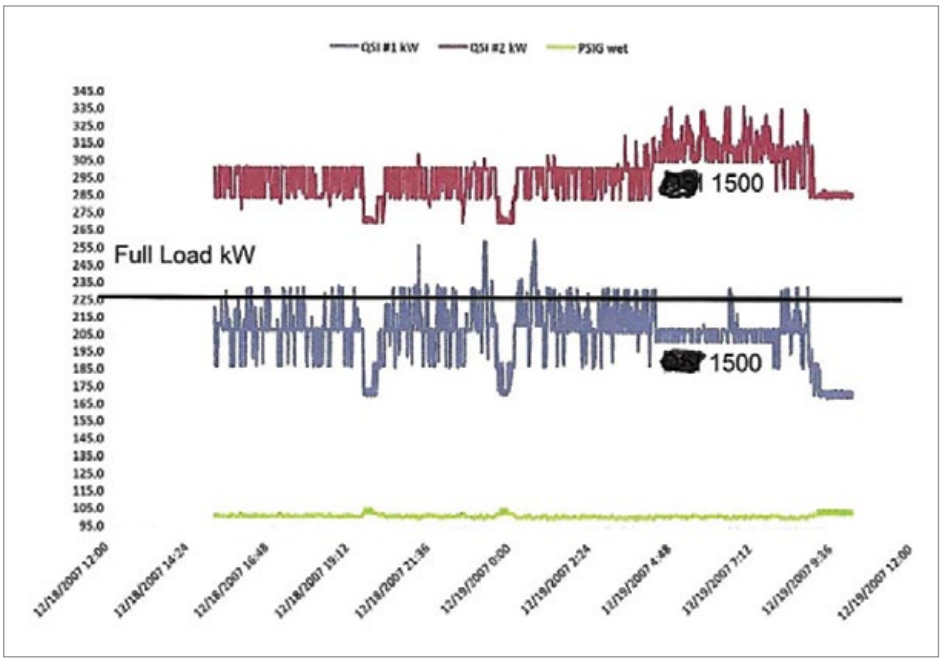

Figure 4.

An Example: Comparing Two Air Compressors

Here is an example. Two current nominal 100 HP single-stage, lubricant-cooled, rotary screw air compressors with the same full load pressure and flow ratings.

- 1 fixed speed air compressor – 133 amps
- 1 VSD Drive air compressor – 130 amps

Note that Amps are not proportional to power and that Amps, when measured without simultaneously voltage measurement, are meaningless. Which air compressor is the most efficient (in Figure 3)? Note the effect of power factor.

Measuring Input KW for Trouble-Shooting

Figure 4 shows how properly measured and monitored input KW is a very effective trouble-shooting tactic. The KW curves shown in Figure 4 are for two identical 300 HP class single-stage, lubricant cooled, rotary screw air compressors installed next to each other. Their full load rated input KW at 100 psig was 225 KW. In actuality, the second unit used 285 to 325 KW, about 100KW extra, and ran like this for seven (7) years. This added up to $48,000 per year ($336,000 over 7 years) in additional electrical energy costs.

There are many things that could have been the root cause of this situation: motor rewinds, starter/disconnect issue (this turned out to be the cause), connected wiring, mechanical or hydraulic issues. If input KW had been measured and monitored, the issue would have been identified much sooner.

We strongly recommend that all larger compressed air system consider installing a proper KW measurement / monitoring system, along with any other key performance indicators. BP

For more information on APenergy visit www.apenergy.com or call 740.862.4112

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Compressed Air Challenge

Level 1: Fundamentals of Compressed Air Systems*

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COMPRESSED AIR CHALLENGE

Tuesday, 10/24 – (Part 1) 10:15AM–12:15PM (Part 2) 2:00PM–4:00PM
Wednesday, 10/25 – (Part 3) 8:00AM–12:00PM

This is a two-day introductory course designed to teach facility engineers, operators and maintenance staff how to achieve 15-25% cost savings through more effective production and use of compressed air.

*Compressed Air Challenge workshop only open to distributors, engineering firms/consultants and manufacturing personnel who are paid registrants of the full conference package. Not available to single-day registrants.

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Ron Marshall
Chief Auditor, Marshall Compressed Air Consulting

Frank Moskowitz
Consultant, Draw Professional Services

Compressed Air & Gas Institute (CAGI)

Certified Compressed Air System Specialist (CCASS) Exam

Monday, 10/23 & Tuesday, 10/24 – 2:00PM **Wednesday, 10/25 –** 8:30AM & 2:00PM

CAGI's personnel certification program for compressed air system specialists provides a means of verifying the capabilities of professionals in the compressed air systems industry. The program will allow customers, utilities, employers, and others to have confidence in the skills and abilities of the professionals in the industry who design, service, sell, and install compressed air systems and compressed air systems equipment. The program has been designed to comply with the ISO 17024 standard, Conformity Assessment – General Requirements for Bodies Operating Certification of Persons.

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Compressed Air Technology News

Doosan Bobcat Introduces New 150-hp Industrial Air Compressor

Doosan Bobcat has expanded its lineup of industrial air compressors with the introduction of its new 150-hp, fixed-speed, oil-flooded, rotary screw compressor: the D150. The D150 is in stock and available to order.

Doosan Bobcat industrial air compressors are designed with larger, more durable components and simpler designs, resulting in reliable, consistent flow output to meet the demands of even the most challenging jobs. Doosan Bobcat's rotary screw compressors are ideal for operations with consistent and heavy air demands as they offer maximum air intake and production. The D150 offers top-tier flow rates, as well as durable components for a long lifespan.

The D150 features a reliable IE3 premium efficiency TEFC (totally enclosed, fan-cooled) motor. The TEFC motor offers protection from outside contaminants, such as dust or moisture, making this an ideal product for industrial manufacturing operations.

Doosan Bobcat has expanded its lineup of industrial air compressors with its new 150-hp, fixed-speed, oil-flooded, rotary screw compressor.

The D150 comes standard with a 7" LCD intelligent touchscreen with high-definition color display. The touchscreen makes it easy to test individual control outputs without having to access the electrical control panel or run the compressor.

It has a 100,000 hour-rated airend featuring three bearings for improved reliability, maximized uptime and minimized downtime.

The D150, along with all other Doosan Bobcat industrial air products, comes with an industry-leading, five-year, full coverage warranty. The Doosan Bobcat team also offers unrivaled customer service for a superior experience including technical support and readily available machine parts in stock.

About Doosan Bobcat Industrial Air Products

As a leading global provider of rotary air compressor lines, Doosan Bobcat puts the power of air to work with the reliable, consistent flow the job demands. Doosan Bobcat offers industrial air compressors ranging from 30 to 200-hp, with both fixed and variable speed offerings. In 2024, the company will expand its range further with options from 10 to 400-hp. With its dependable performance and quality products, Doosan Bobcat supports unrivaled customer service for industrial manufacturing operations. Earlier this year, Doosan Bobcat announced its global branding strategy to create business and growth opportunities for the Doosan Bobcat product portfolio. As part of this work, the Doosan Industrial Air lineup will rebrand under the Bobcat trade dress in North America in 2024. As part of the transition, Doosan Industrial Air products will be renamed and rebranded. The D150 will be renamed as the IA150 in 2024. For more information on the industrial air lineup or to contact Doosan Bobcat regarding its industrial air products, visit www.doosanportablepower.com.

Prevost Introduces PPS SQ Line

Prevost Corporation, an international manufacturer of pneumatic equipment, is pleased to announce its Prevost Piping System (PPS) 100% aluminum line now includes a modular, fully customizable solution to outfit individual workstations in manufacturing settings. The PPS SQ line is constructed of extruded aluminum and transforms the structure of a workbench into an active compressed air system.

The 25 mm (1") diameter center of PPS SQ acts as a pipe to move air, while the external grooved profile can be used to mount accessories and tools. Choose from an extensive selection of adaptive fittings to connect the 1- or 2-meter (3 3/8 ft. or 6 ½ ft.) sections to create a customed workbench on production or assembly lines. By running air power to each station, workers can move unhindered from station to station increasing productivity.

The system is intuitive and easy to assemble resulting in reduced installation time. PPS SQ accessories directly integrate into existing workstations and are compatible with existing extruded aluminum workstation profiles available on the market today. PPS SQ's revolutionary design is the first in its class and will set a new standard for pneumatic powered aluminum work benches in the manufacturing industry.

Compressed Air Technology News

Design and build ergonomic, efficient workstations tailored exactly to specific application. Some accessories include:

- FRL Connector PPS SQFRL – Mount a Prevost FRL unit (ATU B OR ATU M) with a prevoS1 coupling port
- Valve Quick Branch PPS SQBFV – Turn off air when not in use to reduce consumption
- Outlet Body PPS SQBFT – Install prevoS1 quick connect safety coupling outlets
- Double Body Outlet PPS SQO9C2512 – Connect a tool balancer and install an outlet to hang pneumatic tools with a coil hose
- Cross Body Fitting PPS1 CR27 – Link consecutive PPS SQ workstations together to eliminate exposed pipe throughout the facility and reduce the overall amount pipe required
- Join Body PPS JN – Move air flow around a 90° angle
- Prevost offers a full range of installation tools for quick assembly

Technical specifications

Material: 100% aluminum
Colors: blue or gray
Lengths: 1 m (3 3/8ft.) or 2 m (6 ½ ft.)
Diameter: 25 mm (1")
Maximum service pressure: 232 psi
Service temperature: -4°F to 176°F

Internal accreditation

Through our rigorous Research & Development processes, stringent manufacturing operations and thorough quality inspections the Prevost Piping System is the ideal choice for clean air and sterile environments. Our products meet the following international requirements: ISO 9001 for quality management, ISO 8573-1 Class 0.0.0 for air quality, ASME B31.1 & ASME B31.3 for pressurized equipment, Fire Classification UL 723 - ASTM E84 and ATEX approved for gas, areas 1 & 2 then dust, areas 21 & 22.

Customize your workbenches with a full range of accessories.

About Prevost

Since 1978, Prevost has been developing, manufacturing, and marketing a complete range of products suitable for air, fluid, and vacuum systems. Innovation has always been our core value and why we strive to develop professional grade, safe and sustainable products. We specialize in safety couplings, blowguns, piping networks, air filtration and pneumatic equipment. For more information, visit www.prevostusa.com.

Next Air & Gas Introduces New Compressed Air Dryer Lines

Next Air & Gas unveiled its next generation of desiccant and refrigeration dryer lines.

The Pura-Aire product lines focus on global compliance standards and economical design. Pura-Aire aims to be the cost-effective solution for distribution partners globally.

The new generation of dryers offers streamlined, innovative desiccant and refrigerated product offerings. Consecutive parallel product lines focus on the application of specific uses. Examples include thermal mass and multiplex refrigerated dryers, point of use modular desiccant dryers, industrial twin tower modular configurations (for applications that require the efficiency of twin tower regenerative dryers but need a smaller overall footprint), rental application desiccant dryers, and refrigerated dryers designed for any working condition and environment. High pressure dryers up to 10,000+ PSIG, a pneumatic heatless desiccant dryer line completely operated by pneumatic controls, and breathing air application dryer lines for the medical and food processing industry are also in the pipeline.

Supporting the Pura-Aire generation of dryer lines, Next Air & Gas will also release Flow-Stream, a full line of low and high pressure compressed filters, along with Aqua-Pure, a spectrum of condensate management products. These products were designed in a collaborative technology initiative by both Next Air & Gas engineers and its supporting global partner.

"With the introduction of these dryer lines, we hope to start a new platform of innovation in the air treatment industry. This new generation of dryer products are designed to be simple in their purest form yet highly engineered, if required, with a conscious mindset of global compliance standards and price points. The Pura-Aire dryer line is our 8th generation of dryer platform and will become our benchmark for future iterations and advancements," said Kevin F. Zarif, Vice President, Next Air & Gas.

About Next Air & Gas

Next Air & Gas, headquartered in Lenoir City, TN, is the next chapter in the Zarif's air treatment legacy spanning over 30 years in the industry. The company is led by Founders CEO Mike Zarif and Vice President Kevin F. Zarif. NEXT Air & Gas is a research and development firm and mass manufacturer of compressed air & gas dryers, with a specialty in desiccant and refrigeration drying technologies, process cooling, compressed air filtration, and gas generation in nitrogen and oxygen. The vision of the company is to build upon its manufacturing experience and capabilities with a concentration on the development of innovative air & gas treatment products. For more information, visit www.nextairgas.com.

Pura-Aire compressed air dryer lines from Next Air & Gas.

Compressed Air Technology News

FS-Elliott Launches P400HPR Centrifugal Air Compressor

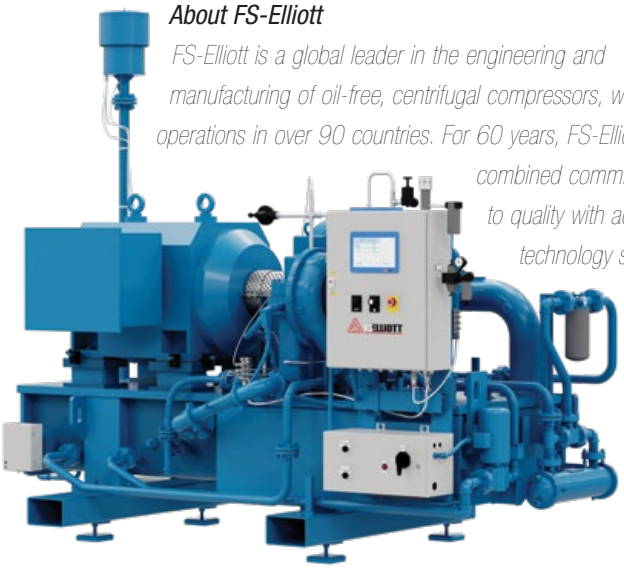
FS-Elliott is proud to unveil the new P400HPR Centrifugal Air Compressor. Built upon the success of the P400 model, the P400HPR has advanced features and superior performance to meet any high-pressure application while ensuring energy efficiency and reliability. The P400HPR is engineered with more aero stages to support higher discharge pressures up to 250 PSIG. With three pages of compression, this compressor is extremely versatile and ideal for lots of industrial applications. The excellent aero design of the P400HPR ensures minimal energy without compromising performance, leading to reduced operation costs and a greener footprint. This makes the compressor an economical and eco-conscious solution.

Users can trust the P400HPR to perform consistently, minimize downtime, and increase productivity. Much like its predecessor, the P400/A1, the P400HPR will carry on its legacy of reliability and robust performance. A P400HPR centrifugal air compressor is perfect for Heat of Compression (HOC) applications. Industries that function in high-temperature air can rely on the P400HPR for exceptional results.

"The launch of the P400HPR shows our continued commitment to innovation, efficiency, and reliability," said Michael Wik, Director of Product Management at FS-Elliott. "This compressor has the capacity for high discharge pressures and its aero design will set a new standard in the industry."

About FS-Elliott

FS-Elliott is a global leader in the engineering and manufacturing of oil-free, centrifugal compressors, with operations in over 90 countries. For 60 years, FS-Elliott has combined commitment to quality with advanced technology so our customers can increase their productivity and lower system operating costs. For more information about the P400HPR centrifugal air compressor and to explore the full range of our products, please visit www.fs-elliott.com.



The P400HPR has advanced features and superior performance to meet any high-pressure application while ensuring energy efficiency and reliability.

Generon Ships 6800 Series Nitrogen Generator Cabinet

Generon IGS announced the successful completion and shipment of a 6800 Series Nitrogen Generator Cabinet, as contracted by Industrial Supply & Service based in Shreveport, Louisiana. The Model CP-6800-G4-115 Nitrogen Cabinet was specifically designed and fabricated using Generon Hollow Fiber Membranes. These advanced membranes selectively remove oxygen and water vapor from the compressed air stream, resulting in an enriched Nitrogen product. This Nitrogen will serve as an inert blanket gas within the production processes. The installation of this system will take place at a production plant located in Lone Star, Texas.

Model CP-6800-G4-115 Nitrogen Cabinet from Generon.

The Generon Nitrogen generation system plays a crucial role in the operations of the production facility. The 6800 Series N_2 Generator Cabinet produces Nitrogen that enables the safe and efficient production of coal tar and petroleum pitch products. These products are widely utilized in the manufacturing processes for graphite electrodes, carbon anodes, activated carbon, specialty graphite, and refractory products across the United States and other global regions.

Generon IGS meticulously designed the 6800 Series N_2 Generator Cabinet to meet the precise process specifications and requirements of the application. The hollow fiber membrane modules were manufactured at our facility in Pittsburg, California, while the final engineering and manufacturing of the complete cabinet system took place at Generon's facility in Houston, Texas.

For more information about Generon, visit www.generon.com.

Revindus Launches Fully Automated Test Bench for Air Compressors

Revindus is one of the few developers in the world that specializes in testing equipment for air compressors. Their latest innovation, the Fully Automated Test Bench, or FAT-Boy, is a groundbreaking advancement in the compressed air market. It solves the challenges and complexities of testing air ends or compressor packages and eliminates the risk of human-machine interaction. This makes testing sessions much simpler, and helps manufacturers get the most accurate and consistent results with ease.

Testing a Compressor and Air-End requires a lot of technical expertise and knowledge. Therefore, the process depends heavily on human interaction, which can lead to potential errors. Moreover, adjusting the flow rate and pressure is not only difficult but also time-consuming, sometimes taking up to an hour. Given that a VFD Compressor needs 5 flow rate points for testing, the whole testing procedure might take a whole shift.

This technology provides a solution that frees manufacturers from the burden of finding the "right" staff for testing. The FAT-Boy automates much of the process, saving time, energy, and money. Manufacturers can now focus on other critical aspects and streamline their testing operations with unmatched efficiency.

Experience the revolution in compressor testing with Revindus' groundbreaking FAT-BOY technology.

Compressed Air Technology News

One can enjoy the best in automation with the advanced bench design, which offers a smooth and user-friendly testing experience with minimal human-machine interaction. One just needs to connect the compressor to the bench, and easily get testing data using the integrated barcode reader. The system then accesses the database, retrieving vital information like pressure, cooling type, flow rate, drive type, and more. In seconds, the system automatically adjusts the flow rate and pressure, simplifying the entire process.

Adhering to ISO1217 & CAGI procedures, the system automatically selects the sonic nozzle for testing and records relevant data for each flow rate and pressure result. Enjoy unparalleled efficiency as the system operates effortlessly, allowing staff to focus on more important tasks with minimal effort.

About Revindus

In 2018, Revindus was established with a visionary goal of delivering cutting-edge technology products to the industry. The company comprises dedicated divisions for precise refrigeration and compressed air engineering. Our diverse product range includes high-quality gas flow meters, flow computers, lab automation, sonic nozzles, data loggers, compressed air engineering solutions, and precisely temperature-controlled refrigeration units. We offer ultra-low temperature chillers (-100°F), freezers, freeze dryers, and climate cabinets, all meticulously crafted in-house with expert software development, automation, manufacturing, and final testing. Revindus serves a wide array of industries, including gas flow meter manufacturers, medical laboratories, manufacturing, food and beverage, pharmaceuticals, and infrastructure sectors. For more information, please visit www.revindus.com.

VPInstruments Releases VPVision Mobile

VPInstruments released VPVision Mobile, a complete energy monitoring system now in a sturdy explorer case. It enables auditors to offer their customers a complete audit of plant utilities. You can use VPVision Mobile for on-site data logging, with remote access, thanks to built-in cellular connectivity. This gives you the option to check the system remotely, saving you time and money.

The complete energy monitoring system VPVision is now in a sturdy explorer case.

By monitoring plant utilities like compressed air, industrial gases, steam, water, and electricity, you can provide your customers with factual system and performance data. You can pinpoint areas to save energy and money and reveal opportunities to the production capacity. VPVision Mobile enables you to offer your customers a complete audit of their plant system. Meanwhile you can also show them the benefits of permanent monitoring, like continuous energy savings and optimizations.

VPVision Mobile comes in a sturdy explorer case. Making it withstand the most challenging industrial conditions. Companion 1m/3.2ft. and 10m/32.8ft. cables and Modbus T-splitters provide an easy plug-and-play setup.

VPVision is the complete real time energy monitoring solution for all utilities within your company. It provides real-time data on usage and shows the patterns on your supply and demand side. This gives you all the insights to save energy, allocate costs, and improve efficiency. VPVision also helps to prevent unexpected downtime. And it will prevent unnecessary production losses.

About VPInstruments

VPInstruments offers industrial customers worldwide easy insight into energy flows. We believe that industrial energy monitoring should be easy and effortless, to enable insight, savings, and optimization. VPInstruments products are recommended by leading energy professionals and offer the most complete measurement solution for compressed air flow, gas flow and electric energy consumption. Our monitoring software VPVision can be used for all utilities, and enables you to see where, when, and how much you can save. Our products can be found all over the world. We serve all industrial markets, for example, automotive, glass manufacturing, metal processing, food and beverage and consumer goods. We can also help your industry. Let us open your eyes and start saving energy. For more information, visit www.vpinstruments.com.

Aignep Introduces T022 Precision Pressure Regulator

Aignep has expanded its range of fluid and compressed air components by introducing the T022 precision pressure regulator, which allows more accurate regulation of the air outlet pressure. It is part of the FRL Standard series, which includes components for compressed air processing.

The purpose of pressure regulators is to maintain the air pressure within pneumatic systems below certain limits in order to ensure the proper functioning of the instruments being supplied, as well as the safety of the systems as a whole.

The new T022 model is suitable for applications where even a slight pressure variation can have a significant impact on the downstream system, such as in medical equipment, air meters, calibration instruments or semiconductor machinery.

The T022 pressure regulator automatically sets and maintains a specific desired pressure in the compressed air, thus ensuring safe and efficient operation of instruments and machinery.

For more information, visit www.aignepusa.com.

The T022 precision pressure regulator from Aignep.

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A Publication of Smith Onandia Communications LLC
37 McMurray Rd., Suite 104, Pittsburgh, PA 15241

BEST PRACTICES

2023 EXPO OCTOBER 23-25 CHICAGO

COMPRESSED AIR / VACUUM / COOLING

Sustainable, Safe & Reliable

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Powering Automation

In the Market For a Compressed Air System?

Meet the Technical Leaders of the Manufacturers

Discover Innovations at the New Technology EXPO Classroom!

Located on the EXPO Floor, the New Technology EXPO Classroom presents new technologies from around the world directly to EXPO floor visitors.

While the Best Practices Conference program upholds brand neutrality guidelines, this separate classroom on the EXPO Floor is reserved for exhibitors to present their latest technologies for compressed air, pneumatics, vacuum, chiller and cooling tower systems.

New technology presentations will feature oil-free and lubricated, fixed drive and VSD rotary screw, centrifugal, high-pressure and low-pressure rental air compressors, air compressor heat recovery modules, desiccant and refrigerated air dryers, compressed air filters, nitrogen gas generators, aluminum piping systems, ultrasonic leak detectors, compressed air measurement instruments and pneumatics.

MONDAY, OCTOBER 23 1:00PM – 4:00PM

1:00-1:25	**Aluminum Compressed Air Pipe Sizing & Installation** Chad Hills, Director, AIRpipe USA
1:30-1:55	**We are Bobcat... Now in Industrial Air** Patrick Jakeway, General Manager, Doosan Bobcat North America
2:00-2:25	**Air Management System** Jon Jensen, Energy Efficiency Manager, SMC Corporation of America
2:30-2:55	**From Compressed Air to Power Generation: Kaishan's Vision for Building a Better, More Efficient Future** Dave George, President, Kaishan USA
3:00-3:25	**Deoxo Nitrogen/Hydrogen Purifier and MDX Gas Dryer** Mike Kinnucane, Nitrogen Business Development Manager, Mikropor
3:30-3:55	**Kaeser Measurement Technology (KMT), a New Suite of Compressed Air Sensors** Neil Mehltretter, Technical Director, Kaeser Compressors

TUESDAY, OCTOBER 24 1:00PM – 4:00PM

1:00-1:25	**Oil Carryover: Prevention is Better Than the Cure** Cody Leatherman, Product Manager – Consumable Products, Hitachi Global Air Power US/Sullair
1:30-1:55	**The Future of Compressed Air Instrumentation** Martin Zeller, General Manager, CS Instruments USA
2:00-2:25	**Application of Rental Blowers in Industrial Wastewater and Pneumatic Conveying** Meghan Babineaux, Regional Sales Manager, Aerzen Rental
2:30-2:55	**Clean Energy. Clean Air. Clean Food.** Tilo Fruth, President, BEKO Technologies
3:00-3:25	**Applications Vary by Pressure; Selecting the Right Technology** Mert Alpagut, Country Manager, Hertz Kompressoren
3:30-3:55	**Seeing the Unseen: Illuminating Energy Conservation & Electrical Safety with Ultrasonic Imaging** Dean Wolever, Regional Manager, UE Systems

WEDNESDAY, OCTOBER 25 1:00PM – 4:00PM

1:00-1:25	**Upcoming Department of Energy 2025 Regulation of Rotary Air Compressor Isentropic Efficiency** Bruce McFee, President, Sullivan-Palatek
1:30-1:55	**Remote Monitoring on Rental Compressors** Jim Riley, Business Development Rental Manager Sauer Compressors USA
2:00-2:25	**Energy Recovery Solutions to Lower Your Carbon Footprint** Luc Linart, Global Product Manager Energy Recovery & Measurements, Atlas Copco Compressors
2:30-2:55	**Why Compressor Direct Output Flow Rate is Important, and How to Measure** Ray Fang, International Sales Director, Comate Intelligent Sensor
3:00-3:25	**Centrifugal Air Compressor Sizing & Fundamentals** JD Schroeder, Applications Engineering Manager, FS-Elliot
3:30-3:55	**Oil Free Air** Wolfgang Strobelt, Sales Manager Plant Engineering – CEP, Boge America Inc.

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