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FEATURES

QUALITY, SAFETY & RELIABILITY FEATURES

PRODUCTIVITY, SUSTAINABILITY & ENERGY CONSERVATION FEATURES

COLUMNS

FROM THE EDITOR

Quality, Safety and Reliability

The Compressed Air & Gas Institute has sent us an excellent article titled, "Is your Controller a Blast from the Past?" I recommend sharing this with your maintenance teams along with Derrick Taylor's article (Part 2 of 2) titled, "Air Receiver Tank Care Guide: Sizing, Safety and Storage."

A system assessment was done at a global glass container manufacturer in the Netherlands. Our thanks go to VPInstruments for introducing our own Mike Grennier to the project story. Flow meters provided critical data guiding the design of this compressed air system upgrade able to increase product quality, plant uptime and reduce energy consumption.

We have received an article exploring the world of GMP (Good Manufacturing Practice) systems and how they are applied to compressed air in pharmaceutical plants. Our thanks go to SUTO iTEC and gmp-experts GmbH for sending it to us.

Productivity, Sustainability & Energy Conservation

The Unilever Sustainable Living Plan, since 2008, has helped drive $186 million in energy cost reductions resulting from efficiency improvements in production. Randy DeForge, from Festo, shares how an ice cream plant in Heppenheim, Germany reduced compressed air consumption in their production lines. They used an "energy efficiency module" able to reduce pressure losses and identify leaks automatically – this is what I would call an "advanced best practice" in compressed air. Lastly the Magnum ice cream bars produced at this plant are coincidentally my favorite, so we couldn't help but put them on the cover of this issue!

Is a single-stage or a two-stage rotary screw air compressor the right solution for your compressed air system? Plants are often presented both options. We are grateful to Scott Folsom, from air compressor manufacturer FS-Curtis, who has provided a solid "Pros and Cons" neutral review to help plants know how to evaluate both technologies.

Best Practices EXPO & Conference Announcements

We have announced the postponement of the Best Practices 2020 Expo & Conference to November 2-4, 2021. It will be held at the same venue – the Schaumburg Convention Center located in Chicago's convenient outskirts near O'Hare International Airport.

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

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COMPRESSED AIR SYSTEM INDUSTRY NEWS

Sulzer to Make Significant Investment in Tamturbo Plc

Sulzer has made an investment to acquire 25% of Tamturbo Plc. Founded in 2010, Tamturbo is a technology company that develops and manufactures oil-free industrial air compressor systems. Tamturbo's disruptive solutions enable cleaner, more energy-efficient and close-to maintenance-free compressed air production with next generation Touch-Free™ compressor technology.

The successful co-operation with Sulzer started in 2018 with a sales and supply agreement as Tamturbo's oil-free industrial air compressors fit well with Sulzer's lower pressure compressor offerings in industries such as pulp and paper, food, metals, mining and chemical processing. Tamturbo will complement Sulzer's portfolio well, leading to scale effects from Sulzer's strong industrial brand reputation, its experience in manufacturing similar compressor products, its capillary worldwide sales and service network, and its access to key suppliers.

Tamturbo sold their first air compressors in 2017. The company's sales grew strongly in 2019. In 2019, the company served several of the world's largest companies within the food, beverage, paper, and electronics industries, and is already making in-roads into providing compressed-air products to large household names.

Frédéric Lalanne, President of Sulzer's Pumps Equipment Division, said, "Tamturbo complements our existing offering in industrial air compressors with its disruptive technology that minimizes cost of ownership. By joining forces, we'll be well placed to serve a strongly growing industrial automation market with increasing demand for compressed air. Tamturbo has done an outstanding job since inception and we are very happy for Sulzer to have a tight collaboration and support their growth".

Sulzer has made an investment to acquire 25% of Tamturbo Plc.

"We are excited to welcome a company with the size and reputation of Sulzer as a significant partner in our venture. Sulzer have had a leading position in the low-pressure market with high-speed turbo compressor products in the past 20 years. We can now join our efforts together using Tamturbo's higher-pressure products to address a market which is significantly larger." – says Timo Pulkki, CEO of Tamturbo.

About Sulzer

Sulzer is a global leader in fluid engineering. We specialize in pumping, agitation, mixing, separation, and application technologies for fluids of all types. Our customers benefit from our commitment to innovation, performance, and quality and from our responsive network of 180 world-class manufacturing facilities and service centers across the globe. Sulzer has been headquartered in Winterthur, Switzerland, since 1834. In 2019, our 16'500 employees delivered revenues of CHF3.7 billion. Our shares are traded on the SIX Swiss Exchange. For more information, visit www.sulzer.com.

About Tamturbo

Tamturbo is a Finnish industrial growth company in the cleantech sector that enables cleaner and more energy-efficient industrial compressed air production with a new generation of Touch-Free™ compressor technology and service models that add value to customers. Tamturbo develops and manufactures air compressors, which offer a more environmentally friendly solution that is completely oil-free, energy-efficient and a long-lasting option which is significantly cheaper for the customer than traditional technology in terms of total cost of ownership. It is possible to implement the solution as an Air-as-a-Service business model, in which case the customer only pays for the compressed air they use. Tamturbo operates in a fast-growing market and its growth is supported by global megatrends. The Company aims to continue its strong growth in the medium and long term. For more information, visit www.tamturbo.com.

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COMPRESSED AIR SYSTEM INDUSTRY NEWS

FS-Compression Launches Pittsburgh Location

FS-Compression Co., LLC, is excited to announce the opening of a new branch location in Export, Pennsylvania. FS-Compression is an authorized customer center for FS-Elliott and FS-Curtis compressed air systems. Since 2010, FS-Compression has delivered unmatched reliable, energy-efficient air compressors paired with top-of-the-line service.

"I appreciate the opportunity to come on board in my new role as the general manager for FS-Compression Pittsburgh. It will be our mission to be the best total solutions provider for the compressed air industry in the greater Pittsburgh and surrounding areas. Our primary focus will be on exceptional customer service and rapid response to the critical demands of our compressed air customers," said Kris Wertman, General Manager of FS-Compression Pittsburgh.

"We at FS-Curtis and FS-Elliott are committed to partnering to grow market share with our ever-strengthening Channel Partner network. The announcement of FS-Compression Pittsburgh will further this strategy and help us grow share in our "home" centrifugal territory," said Matt Smith, Director Channel Partner Sales, FS-Elliott & FS-Curtis.

The staff is focused on the sales and service of FS-Curtis and FS-Elliott compressed air systems. The experienced and dedicated team looks forward to providing the highest level of sales and service support to customers in the Greater Pittsburgh Area.

About FS-Compression Co. LLC

Headquartered in Houston, Texas, FS-Compression is the authorized customer center for FS-Elliott and FS-Curtis compressors. Opened in 2010, FS-Compression has set the standard for trusted and dependable service and products in the greater Houston, Texas area. The professional staff has the experience and technical expertise to provide all industries with comprehensive and timely service for reciprocating, rotary, centrifugal, vacuum, air treatment and scroll technologies. Additionally, the state-of-the-art facility hosts custom centrifugal air-end rebuilds, newly stocked inventory of both new machines and aftermarket parts, and regular training sessions on all things compressed air. FS-Compression customers have access to comprehensive compressed air audits and consultations from highly trained professionals. To learn more about FS-Compression Co. LLC visit www.fs-compression.com

Ohio Transmission Corporation Names New CEO

After 38 years of service, OTC'S CEO, Phil Derrow, will be transitioning to a new role as Chairman. David Scheer has been named the new CEO. Air Technologies® is a division of OTC.

OTC was co-founded in 1963 by Phil Derrow's father, David Derrow, and L. Philip Carstens. Since its founding, OTC has grown from just six employees in a single location in Columbus to more than 1,200 employees in 47 locations across the United States. Phil Derrow became CEO in 1998 and led a period of growth that saw the company's revenue increase by more than 10 times and the firm's employees increase by five times. In 2013, Derrow led the company

through a transition to private equity ownership, culminating in a sale to Genstar Capital in April 2019. Derrow's move to the Chairman role was planned as part of the Genstar acquisition.

"It is impossible to adequately express my profound gratitude to all of our associates, customers and suppliers for their trust, support and friendship during my career. It has truly been the gift of a lifetime of service for which I am profoundly grateful," said Derrow. "I am excited to hand over the reins to an executive as accomplished as David."

Scheer said, "I am honored and excited to join OTC as CEO. Phil has built an extraordinary business that has offered an unparalleled level of service to America's leading industrial companies for many years. I look forward to working with all of OTC's team members to continue to grow and build one of the country's largest industrial solutions providers."

Scheer has more than 30 years of experience leading global industrial manufacturing businesses and specialty industrial distributors. Currently, he serves on the board of Clarience Technologies, LLC. Prior to joining OTP, Scheer was the Chief Executive Officer of Power Products, LLC and its related entity, ECM Industries. Power Products is a diversified electrical products platform with locations in North America, Europe, and Asia. Previously, Scheer was Executive Vice President/Electrical Segment of Actuant Corporation and led the 2013 spin-off of the segment, which was renamed Power Products. He also has served as Chief Operating Officer for Pearlman Group, the nation's leading distributor of tools, supplies, and machinery for the hard surfaces industry. Earlier in his career, Scheer was Chief Operating Officer of Sigma Electric Manufacturing Corp., Division President/Southeast for Rexel USA, and he had several commercial and operating roles with Thomas & Betts Corporation.

About Ohio Transmission Corporation

Established in 1963, Ohio Transmission Corporation is one of the largest industrial distributors and service providers in the United States. Its divisions include OTP Industrial Solutions, a provider of expert solutions for industrial motion control, factory automation, fluid power, pumping systems, spray finishing, and power transmission, and Air Technologies®, a compressed air system equipment and service provider and the largest distributor of Atlas Copco compressed air equipment in North America. Ohio Transmission Corporation maintains locations throughout the South, Southwest, Midwest, and Northeast regions. Ohio Transmission Corporation's more than 1,200 associates share its founding vision of delivering excellent value through work with integrity. For more information, please visit www.otpnet.com and www.aircompressors.com.

COMPRESSED AIR SYSTEM INDUSTRY NEWS

Atlas Copco Acquires French Distributor

Atlas Copco has acquired Ovity Air Comprimé. The company is specialized in distribution of industrial air compressors and solutions for compressed air. Ovity Air Comprimé is located in Le Mans in the Loire Valley in France and has 8 employees.

"The acquisition will open up opportunities to further develop our presence in the area and grow our service offering in the north west of France", said Vagner Rego, Business Area President Compressor Technique.

The purchase price is not material relative to Atlas Copco's market capitalization and is not disclosed. The company will become part of the service division within the Compressor Technique Business Area.

Atlas Copco Group & Atlas Copco Compressor Technique

Great ideas accelerate innovation. At Atlas Copco, we have been turning industrial ideas into business-critical benefits since 1873. Our passionate people, expertise and service bring sustainable value to industries everywhere. Atlas Copco is based in Stockholm, Sweden, with customers in more than 180 countries and about 37,000 employees. In 2019, revenues were BSEK 104, approximately 10.8 BUSD

Atlas Copco Compressor Technique partners with customers to turn industrial ideas into smart, connected air and gas solutions and leading-edge compressed air technology. By listening to our customers and knowing their needs, we deliver value and innovate with the future in mind. For more information, visit www.atlascopco.com.

Kobe Steel Turns Wuxi Compressor into Subsidiary

Kobe Steel, Ltd announced that it has turned its Chinese affiliate, Wuxi Compressor Co., Ltd., into a subsidiary after acquiring additional shares in the company in April 2020. Based in Wuxi, Jiangsu Province, Wuxi Compressor manufactures designs and sells non-standard (process gas) compressors, a core component used in petroleum refining, chemical and natural gas plants.

In response to the growing demand for non-standard compressors in China, Kobe Steel acquired a 44.3% equity share of Wuxi Compressor from Wuxi Victor Group Co., Ltd. in 2011. With Kobe Steel's equity participation, Wuxi Compressor began to improve its manufacturing, design, and sales capabilities. Kobe Steel reached agreement with Wuxi Victor to acquire an additional 25.7% in Wuxi Compressor, turning it into a 70% owned subsidiary of Kobe Steel.

Non-standard screw compressor made by Wuxi Compressor.

By turning Wuxi Compressors into a subsidiary, Kobe Steel will be able to provide more flexible business operations and further strengthen its marketing capabilities while offering more attentive service in China. It aims to meet the growing demand for non-standard compressors in China, as well as contribute to improving customer satisfaction.

The Kobe Steel Group has manufacturing locations for non-standard compressors in Japan, the United States and China, along with sales and service locations in Germany, the United Arab Emirates (UAE), Brazil, the Philippines and Singapore. By strengthening its Group operations with these bases, Kobe Steel aims to build an optimum manufacturing and sales structure to further expand its business.

About Kobe Steel

Kobe Steel is one of the few manufacturers in the world that supply three types of major compressors: screw compressors, reciprocating compressors, and centrifugal compressors. Kobe Steel has the world's largest market share for non-standard screw compressors. Under its medium-term management plan, Kobe Steel is expanding its compressor business as a growth strategy of its Machinery Business. For more information, visit www.kobelco.com.

CSA Group Offers Free Training on Compressed Air Data Collection/Use

The CSA C837-16 – Monitoring and energy performance measurements of compressed air systems was originally developed as part of a growing family of benchmarking standards, to provide a methodology for uniform, validated, repeatable and consistent methods of energy measurement. Further, it was intended to align with the requirements of ISO 50006:2014, Energy management systems – Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) – General principles and guidance.

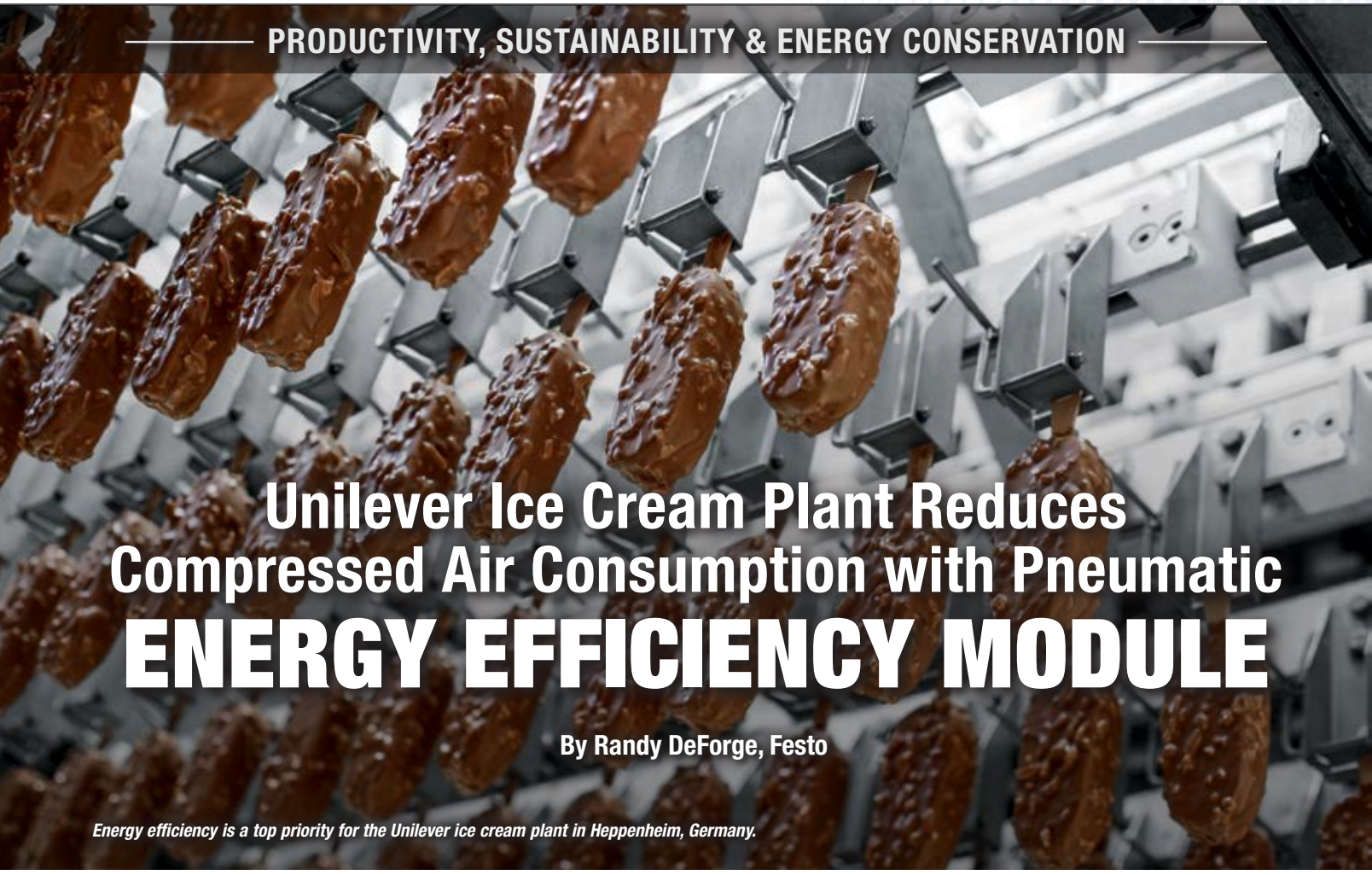
These new courses, developed by the CSA Learning Centre, complement and provide an understanding of the fundamentals of the CSA C837-16 Standard. They are intended to train the users of compressed air system data to Identify where energy performance improvements can and should be made, and measure, track, and report energy performance measurements.

C837 Training for Data Users and C837 training for Data Collection are available on the CSA Learning Services website at no cost to the trainee. You may access the modules like other training on the CSA Store by adding the training to your cart and check for a $0 charge. (Note that a CSA account will need to be created).

About CSA Group

CSA Group is a global organization dedicated to safety, social good and sustainability. We are a leader in Standards Development and in Testing, Inspection and Certification around the world including Canada, the U.S., Europe, and Asia. Our mandate is to hold the future to a higher standard. For more information, visit www.csagroup.org.

PRODUCTIVITY, SUSTAINABILITY & ENERGY CONSERVATION



Unilever Ice Cream Plant Reduces Compressed Air Consumption with Pneumatic ENERGY EFFICIENCY MODULE

By Randy DeForge, Festo

Energy efficiency is a top priority for the Unilever ice cream plant in Heppenheim, Germany.

Ice cream is refreshing and with its proteins and carbohydrates are considered a source of energy. However, it also takes a lot of energy to mix ingredients like milk, dairy chocolate, sugar, and vanilla beans into the finished product.

Electricity and compressed air play an important role in the thermal and kinetic processes for everything from mixing and extruding the ingredients, deep-freezing to -13°F (-25°C), dipping into various chocolate coatings through to final packaging. Energy efficiency is therefore right at the top of Unilever's list of priorities. As part of the Unilever Sustainable Living Plan, this global corporation has succeeded in saving more than $186 million in energy costs from efficiency improvements in production alone since 2008.

In the area of pneumatics, the use of innovative developments offers the potential to save energy and thereby lower costs. Toward that end, Unilever installed a pneumatic energy efficiency module at its ice cream plant in Heppenheim, Germany, and in the process, reduced the amount of compressed air used to power pneumatics on its ice cream production lines.

Producing 20,000 Ice Cream Bars Per Hour

The Heppenheim factory is one of the main Unilever production locations for ice cream. Products produced at the plant include the well-known Wall's line including Magnum,

"We've been able to reduce compressed air consumption on the Magnum production system step by step with the energy efficiency module."

— Alexander Hemmerich, Automation Engineer, Unilever

Feast, Viennetta and Carte d'Or. High production quantities form the basis for supplying other parts of the European market.

Just one of the five Magnum production lines in Heppenheim produces more than 20,000 ice cream bars per hour. This requires a lot of energy. In order to reduce the compressed air consumption for pneumatic components, the ability to visualize and measure the compressed air consumption was of huge importance to Unilever. Previously, compressed air consumption on the individual production lines had not been determined.

"Until now we were just unaware," said Alexander Hemmerich, Automation Engineer at the Unilever Plant, Heppenheim. "Air is not visible, so it is not immediately obvious if the consumption is too high."

As part of the Unilever Sustainable Living Plan there had already been successes in other areas of the plant. Energy-intensive geared motors were replaced with more efficient ones, achieving energy savings of up to 60%.

One production line at the Heppenheim plant produces more than 20,000 ice creams bars per hour.

Numerous 18 kW ventilators in the cooling tunnels, which previously ran for 24 hours in continuous operation, were also converted to frequency converters with variable torque loads. This lowered the energy consumption of the ventilators by around 40%.

Energy Consumption Made Visible

Hemmerich and his team took steps toward lowering compressed air consumption with the installation of the energy efficiency module MSE6-E2M from Festo.

"The energy efficiency module gave us the opportunity to see the amount of compressed air we were using during operation of a line," said Hemmerich. "In addition, we were able to determine how the compressed air requirement developed when we switched off individual consumers. We were thus able to locate leaks and eliminate unnecessary consumption."

The module automatically monitors and regulates compressed air supply, also actively monitoring the condition of the pneumatic system in real time. Doing so provides access to up-to-the-minute process-related data as well as comparative data over time. Data can help personnel determine historical trends on consumption, the amount of air consumed per product batch, and pressure and flow at the time of a malfunction or bad batch of product.

Based on user defined parameters, the module detects when a machine is idle and

UNILEVER ICE CREAM PLANT REDUCES COMPRESSED AIR CONSUMPTION WITH PNEUMATIC ENERGY EFFICIENCY MODULE

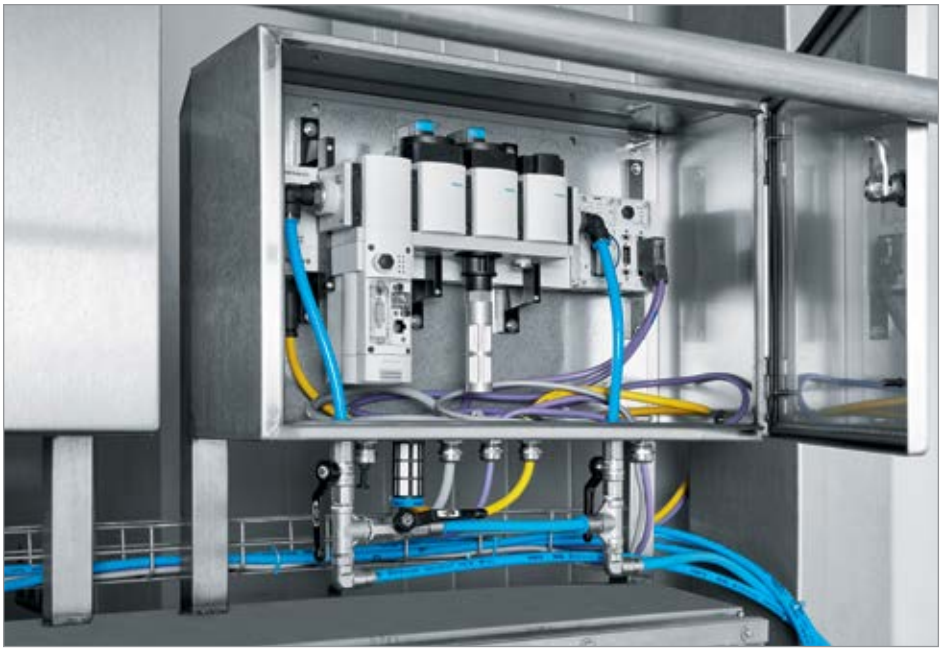
automatically shuts off the air supply. When the unit receives a startup signal from an operator, it re-supplies compressed air. In the case of a particularly complex production process, automatic standby detection can be deactivated in favor of manual operation. Compressed air consumption is thus reduced to zero during system down times and breaks.

In addition, one of the core functions of the module is the automatic shut-off of the compressed air in stand-by mode. While closed, the unit monitors the drop in pressure. This measurement provides the baseline of how quickly the system exhausts. Thereafter, the module immediately reports to the system controller an unusually quick drop in pressure, which typically indicates there is a compressed air leak. At the same time, the automatic pressure shut-off function prevents further compressed air consumption while the system is not in operation thus saving energy.

The energy efficiency module also collects all information such as pressure, flow, consumption, and pressure change. The data can be merged centrally with other data points for a detailed understanding of the pneumatic system. These modules are designed to send information directly to PLCs via such communication protocols as Ethernet/IP, EtherCAT, ModbusTCP, PROFINET IO, and PROFIBUS DP.

Reducing Compressed Air Consumption Step by Step

At the plant, Hemmerich now has access to continuous process-relevant data related to pneumatics on the Magnum machines since the energy efficiency modules regularly exchanges important measurement parameters, such as flow, pressure, and consumption with the machines' controller.



Housed in a cabinet, the Festo energy efficiency module automatically monitors and regulates compressed air powering pneumatics used at the Unilever plant to produce the Magnum brand of ice cream bars.

With an energy efficiency module, the Unilever ice cream plant gains visibility into compressed air powering pneumatics on its ice cream production lines, in turn, helping to reduce compressed air consumption.

"We've been able to reduce compressed air consumption on the Magnum production system step by step with the energy efficiency module," Hemmerich said. "We did not have to add any additional communication or power cables when converting our existing systems." On the Magnum line, the costs for compressed air consumption were reduced by more than $650 per year. BP

About the Author

Randy DeForge is a Product Manager at Festo, focusing on air supply products for the North American Cluster. Randy has 38-plus years of experience in the fluid power industry with the last 14 years in the product management role. He is an active certified member with the International Fluid Power Society (IFPS) and holds a civil engineering tech degree from Michigan Technological University. Contact Randy at tel: 513-486-1107; email: randy.deforge@festo.com.

About Festo

Festo is a leading manufacturer of pneumatic and electromechanical systems, components, and controls for process and industrial automation. For more than 40 years, Festo Corporation has continuously elevated the state of manufacturing with innovations and optimized motion control solutions that deliver higher performing, more profitable automated manufacturing and processing equipment. For more information, visit www.festo.com/us.

All photos courtesy of Festo.

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PRODUCTIVITY, SUSTAINABILITY & ENERGY CONSERVATION

The Pros and Cons of Single-stage and Two-stage ROTARY SCREW AIR COMPRESSORS

By Scott Folsom, FS-Curtis

➤ In today's modern manufacturing facilities, key plant personnel are faced with a number of challenges. How do I maximize production? How do I reduce costs? What type of improvements will give me the greatest return? The questions plant managers must continually ask themselves are as common as they are important: "Is my plant operating at peak efficiency and is my 'cost per widget' as low as it can possibly be?"

Among the many "systems" plant personnel are concerned with, the compressed air system often provides the biggest opportunity for improvement and overall savings. There are many manufacturers and several air compressor technologies to choose from. Reciprocating or rotary? Fixed speed or variable speed? Oil flooded or oil free? Single-stage or two-stage technology? It's enough to make anyone want to run and hide!

This article discusses single-stage versus two-stage rotary screw air compressors and the pros and cons of each technology. Both have a place and there are some distinct differences between the two.

Rotary Screw Compression Fundamentals

The principle of rotary screw air compression is really no different than reciprocating (piston) compression. Both are positive displacement machines that take in a fixed volume of air at atmospheric pressure with each revolution and reduce that volume to increase pressure to some value above atmospheric.

Unlike reciprocating air compressors that use a cylinder and piston arrangement in a linear compression process, rotary screw air compressors use a pair of intermeshing screws (rotors) contained in a stator housing (airend), with an inlet port on one end and a discharge port on the other end. The male rotor has "lobes" cut in a helical (spiral) pattern down the length of the rotor, and the

Rotary screw air compressors often provide plants with the biggest opportunity for improvement and savings.

female rotor has matching "flutes" (grooves) cut in a helical pattern down its length. The male and female rotors are cut to very tight tolerances and intermesh together as they turn. As the tips of the male and female rotors come together on the inlet port side of the airend, there is a vacant space (volume) where atmospheric air is sucked into the compression chamber.

Once the male and female rotor have "met" at the inlet port, the volume of air taken in becomes trapped between the lobes/flutes and the stator housing. Because of the helical pattern of the lobes/flutes on the rotors, the space between the rotors and the stator housing is gradually reduced until the intermeshing rotors are exposed to the discharge port. At the discharge, the volume of atmospheric air that was taken in has been reduced, resulting in a higher pressure per Boyle's Law: volume and pressure are inversely related.

Basic Units of Measure

Pressurized air contained in a sealed system is stored energy that can be used for "work" by allowing the air to expand back to atmospheric pressure. It's the expansion of the compressed air back to atmospheric conditions that conveys air down the pipe, powers linear and rotary actuators, powers automated production equipment, and a plethora of other useful "work."

There are three basic units of measure to consider when talking about a compressed air system…flow, pressure, and power.

- **Flow** is a measure of volume rate and is expressed in cfm, which stands for Cubic Feet per Minute. Keep in mind "cfm" is a generic description and without further definition of ambient conditions and the point at which the measurement is taken, it is really a meaningless number. One should educate themselves about the differences between acfm, scfm, and icfm. For purposes of this discussion, we will use the generic description, cfm.

- **Pressure** is a measure of force and is expressed in psi, which stands for Pounds per Square Inch. It is a generic description as well, and without further clarification as to what kind of pressure you're talking about, psi is really a meaningless number. One should educate themselves about the differences between psia, PSIatm, and psig. For purposes of this discussion, we will use the generic description, psi.

- **Power** is a measure of the energy required to produce x rate of flow, at y pressure and is expressed in kW, which stands for kilowatts.

Technically, end users do not pay for compressed air, they pay for the energy (kW) required to produce the desired flow and pressure. The challenge for the end user is to determine the most efficient way to produce the required volume of compressed air at the required pressure.

Single-stage Versus Two-stage Compression

There are two basic types of rotary screw compression: single stage and two stage.

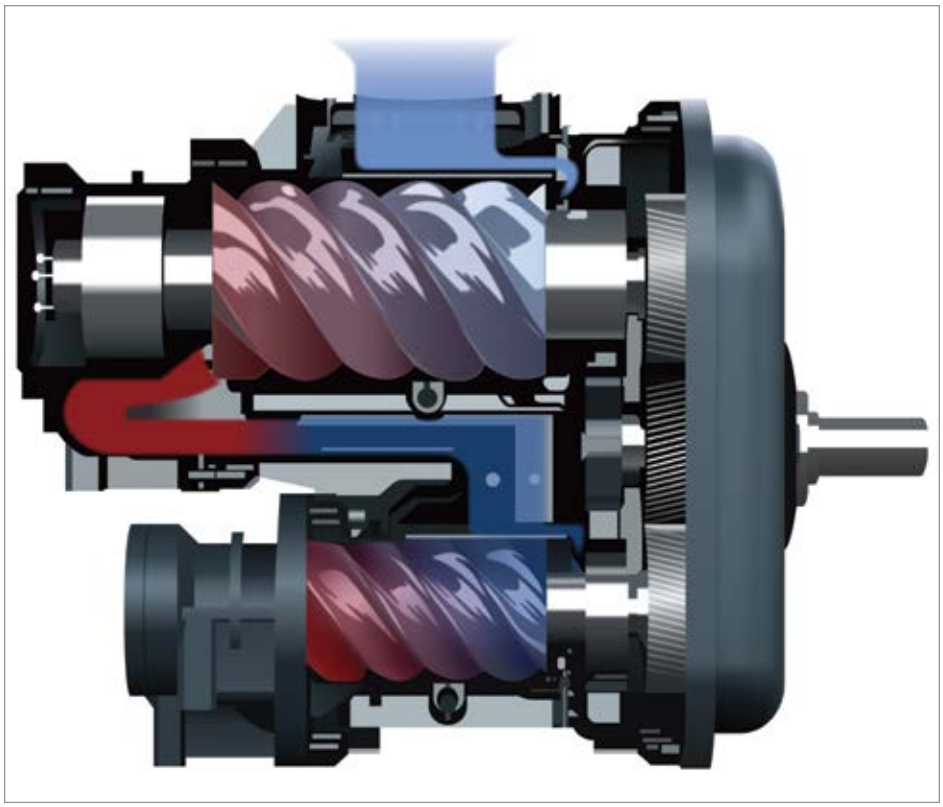
THE PROS AND CONS OF SINGLE-STAGE AND TWO-STAGE ROTARY SCREW AIR COMPRESSORS

A single-stage rotary screw air compressor contains a single set of rotors in a single stator housing and is typically driven directly by the motor shaft, through a set of gears, or by a belt and pulley arrangement. A two-stage rotary screw air compressor contains two sets of synchronized rotors and can be housed in a common stator housing (over/under design) or two separate stator housings bolted together in tandem (end-to-end design).

The over/under design utilizes "interstage" cooling via an injected "curtain" of lubricant/coolant, which improves overall efficiency. Two-stage rotary screw air compressors are typically direct or gear drive. A single-stage rotary screw air compressor takes in atmospheric air and does "the work" (x rate of flow, at y pressure) in one compression process. A two-stage rotary screw compressor takes in atmospheric air but "shares the work" over two separate compression processes and cools it in between.

The difference between the two is not the end result, rather the energy required to produce the end result. A simple analogy: If you were asked you to push your car from point A to point B on a level parking lot, it would require a certain amount of energy on your part to do so. If you had a friend help push the car the same distance, the end result would be the same, but it would require less energy overall because the work is being done by two people instead of one!

It's important to note every application is unique, and all rotary screw air compressors of a given size and technology have similar but different performance characteristics (flow, pressure, power consumption). The intent of this discussion is to demonstrate the differences between single-stage and two-stage compression and is not based on actual applications. There are pros and cons to everything, and air compressors are no different. Both single-stage and two-stage rotary screw air compressors have their place in industry and plant managers are charged with making the right choice based on their unique needs and requirements. End users should make sure they're working with a compressed air professional who has the credentials to design the correct system.



A two-stage over/under airend design features first-stage compression on the top, interstage cooling between the compression chambers, and second-stage compression at the bottom.

Single-Stage Air Compressor Pros and Cons

Single-stage rotary screw air compressors are lower in initial cost than two-stage air compressors, so if you're working with a limited budget, there are plenty of reliable and efficient solutions, readily available from a wide variety of manufacturers.

Single-stage rotary screw air compressors are manufactured in a wide range of horsepower sizes, generally from three to 600 horsepower (hp), which makes them a versatile solution for multiple air compressor applications with different "demand profiles" between shifts or even during the same shift. Single-stage air compressors offer multiple options such as tank mount, integral dryer, open or enclosed, and a choice of micro-processors (controller). As with two-stage, multiple control methods are available on single-stage air compressors.

All single-stage air compressors use pressure at the discharge of the air compressor to control the operation of the machine. Load/unload controls allow the air compressor to operate at its two most efficient points on the "power curve," meaning full load (compressing air) and unload (running but not compressing air). It's important to note that the "most efficient" air compressor is the one that is turned off! With proper receiver storage capacity, load/unload controls can approach efficiency levels close to that of variable speed. Without proper air receiver storage, load/unload can put undue

stress on the airend bearings and shorten its life expectancy.

Modulation control "throttles" the inlet valve via an air pressure signal from the discharge and allows the air compressor to stay in a loaded condition when plant demand is variable and load/unload controls may cause the air compressor to "rapid cycle" (loading and unloading in short rapid cycles). While modulation may extend the life of the airend by reducing or eliminating the on/off thrust loads associated with load/unload, it is very inefficient. Variable Speed Drive (VSD) technology senses the discharge pressure and varies the speed of the main motor, delivering the best part-load efficiencies of all the control methods. Single-stage rotary screw air compressors offer several different drive arrangements to choose from including belt drive, direct drive and gear drive, giving you the flexibility to select the right drive arrangement for your particular application and maintenance capabilities.

Although the life expectancy of any rotary screw airend is dependent on the installation conditions, the level of maintenance performed, and the application itself, single-stage airend life expectancy is generally less than that of a two-stage rotary screw airend...more on that later. Whatever brand you buy, make sure the manufacturer is a member of the Compressed Air & Gas Institute (CAGI) Third Party Performance Verification program. CAGI uses third-party verification to substantiate the claims manufacturers make about performance (flow rate at pressure, and energy consumption). Energy efficiency in single-stage rotary air compressors has improved over the years and with CAGI's Third Party Verification Program, you can be confident the performance characteristics claimed by participating manufacturers are accurate. It's important to note that not all manufacturers participate in the CAGI Third Party Performance Verification Program.

Two-Stage Air Compressor Pros and Cons

By now, it should be clear the biggest advantage of two-stage compression over single-stage compression, is energy efficiency.

Two-stage technology is more limited in terms of horsepower range (typically 125 hp plus) as is the number of manufacturers that produce this technology. As you might have guessed, the initial purchase price of two-stage technology is higher.

Two-stage air compressors are available with the same control schemes as single-stage machines, but there are fewer options at your disposal as one might imagine…you can't physically mount a 125 hp plus air compressor on a tank! Depending on which type of two-stage air compressor you consider (over/under versus tandem design), the footprint might be larger than a single-stage machine offering… there's just more stuff inside the box!

The energy efficiency advantages of two-stage compression over single-stage compression are maximized in high, relatively steady-flow applications, when the two-stage can be applied as a "base load" air compressor. In other words, "let the big dog eat." Two-stage energy efficiency benefits are best realized when the air compressor runs at 100% full load, all the time. The initial cost of a two-stage rotary screw air compressor can be as much as 30% higher when compared to the

THE PROS AND CONS OF SINGLE-STAGE AND TWO-STAGE ROTARY SCREW AIR COMPRESSORS

equivalent size single-stage air compressor, a distinct disadvantage if you're working with a limited budget.

On the surface this looks drastic but because the two-stage air compressor is more efficient, you'll likely be able to supply the required flow with less hp and this will help close the gap to about 15 to 20 percent. But still, why would anyone pay more for a smaller air compressor? The answer is simple…because the initial purchase price of the air compressor is but a fraction of the total cost of ownership. You pay for the air compressor once, but you pay for the power to run that air compressor for its entire lifespan.

Factor Power Costs into Purchasing Decision

Power costs represent up to 75% of the total cost of ownership of a rotary screw air compressor, and the energy savings over the life of a two-stage air compressor can be significant.

For example, let's assume your plant operates twenty four hours a day, seven days a week (8,736 hours per year), requires 1,000 cfm at 125 psi to meet production requirements, and you pay $.10/kWh to your local power company.

Option A offers the following:

- 250 hp single-stage rotary screw air compressor.
- Rated for 1,029 cfm at full load and 125 psi.
- Consumes 212.6 kW at full load (1,029 cfm).
- Motor efficiency of 96%.
- $65,000 sell price.

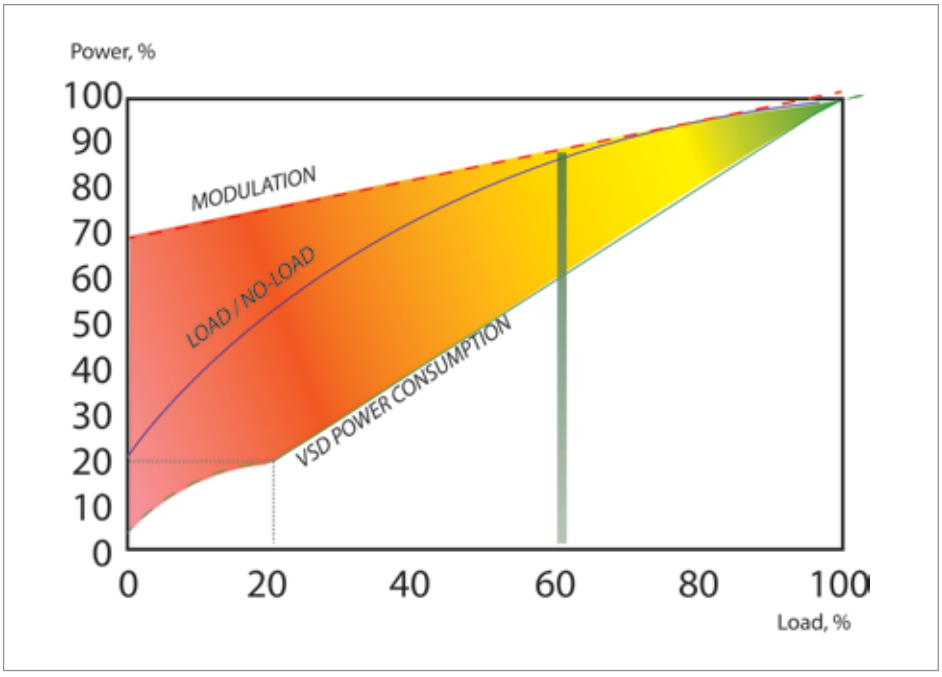
Option B offers the following:

- 200 hp two-stage rotary screw air compressor.
- Rated for 1,074 cfm at full load and 125 psi.
- Consumes 188 kW at full load (1,074 cfm).
- Motor efficiency of 96%.
- $78,000 sell price.

Option A's single-stage offering may be a very efficient and cost-effective solution when compared to other single-stage offerings, but the mechanical advantages of two-stage compression ("sharing the work") makes it worthy of serious consideration. This simple formula [(kW X hours)* rate]/motor efficiency gives a good estimate of what the annual power cost of each would be:

- Power cost of Option A – 250 hp single stage: 212.6 X 8,736 X .10/.96 = $193,466 per year.
- Power cost of Option B – 200 hp two-stage: 188 X 8,736 X.10/.96 = $171,080 per year.

Both air compressors supply the required cfm at the required pressure, but the two-stage unit does it more efficiently, saving $22,386 per year in power costs. Option B is 20% ($13,000) more than the single-stage air compressor, but the power savings alone will recover the two-stage premium price in seven months ($13,000/$22,386). In fact, with the energy savings the two-stage air compressor will pay for itself in its entirety in about 3.5 years when compared to what would have been spent with the single-stage offering ($78,000/$22,386). From that point on, the $22,386 savings happens every year and goes right to your bottom line! An added benefit of two-stage technology over single-stage is longer air end life.



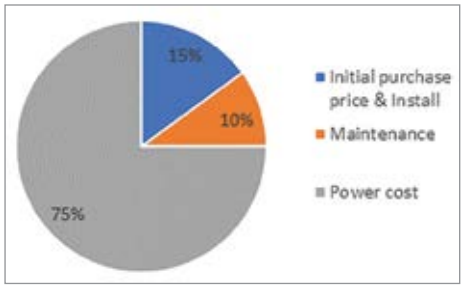
Shown are efficiency differences of single-stage and two-stage air compressors using load/unload, modulation, and Variable Speed Drive methods of control at any particular point on the power curve.

Why Longer Life Expectancy with Two-Stage Compression?

Couple the power savings benefits of two-stage technology in the example with longer airend life expectancy than single-stage technology, and the savings become quite significant over time! As with single-stage rotary screw air compressors, the buyer should ensure that all manufacturers being considered are members of the CAGI Third Party Performance Verification Program to ensure the performance data being quoted is accurate.

So why is the life expectancy of a two-stage machine greater than a single-stage air compressor? It has to do with compression ratio and thrust (axial) Load. Compression ratio is the ratio between the absolute discharge pressure and the absolute inlet pressure (absolute pressure considers atmospheric pressure and gauge pressure) and is expressed by the formula: gauge pressure + atmospheric pressure/ atmospheric pressure. As compression occurs down the length of the airend and pushes against the surface area of the rotors, a thrust load directly proportional to the compression ratio created.

For example: to reach 100 psig at sea level (atmospheric pressure = 14.7 psia) with a single-stage rotary screw air compressor, the compression ratio is (100 plus 14.7)/14.7 = 7.8. In other words, you would have to compress one cubic foot of atmospheric air at sea level, by 7.8 times to raise the pressure to 100 psig. The higher the required final pressure, the higher the compression ratio. The higher the compression ratio, the more thrust load is put on the airend bearings.



Rotary screw air compressor "lifecycle" ownership costs.

All rotary screw air compressors have thrust bearings to handle this axial load, but because the single-stage air compressor is compressing

THE PROS AND CONS OF SINGLE-STAGE AND TWO-STAGE ROTARY SCREW AIR COMPRESSORS

air from atmospheric pressure to final discharge pressure over a single compression process, the thrust loads are greater than the two-stage unit that shares the work and utilizes interstage cooling to remove heat of compression from the first stage. Compression ratios in two-stage rotary air compressors can be as low as 3.1 in the first stage, and 2.5 in the second stage. A lower compression ratio equates to lower thrust load on the bearings, yielding a more robust, reliable, and longer lasting air compressor. Back to our car analogy… While you're struggling to push your car from point A to point B, you're putting a load on your "bearings"…your back, your legs, your arms, your shoulders, etc. If a friend helps, you put less load on your "bearings" and you last much longer than the person pushing by themselves!

One Size Does Not Fit All

At the end of the day, single-stage and two-stage rotary screw air compressor technologies are both robust and reliable solutions for a very large sector of industry. There are distinct differences between the two, and one size does not fit all.

Both technologies are firmly rooted in industry and each has its place. There are a host of variables the purchaser of a rotary screw air compressor should consider. In this article we've covered the technology (single-stage versus two-stage technologies), initial purchase price, power costs, and airend life expectancy. There are many other variables to consider such as incoming power requirements, noise level, ease of maintenance, air compressor room layout and environment, and ancillary equipment. This is not an exhaustive list and the buyer should do their due diligence to ensure that the compressed air professional they're working with understands how all of these variables play into the most economical, efficient, and reliable compressed air solution. BP

About the Author

Scott Folsom is the Director of Channel Development for FS-Curtis and has been with the company for nine years. He is responsible for training, educating, and supporting internal and external channel partners, as well as system assessments. He joined the compressed air industry in 1993 and his past experience includes time spent working in the compressed air manufacturing and distribution areas of the industry. Contact Scott at tel: 314-383-1300 x 210, email: sfolsom@curtistoledo.com.

About FS-Curtis

FS-Curtis has been committed to manufacturing quality equipment and providing unparalleled service since 1854 in St. Louis, Missouri. Over the decades, the company and its products have evolved through innovation and new technologies, but the commitment to quality and service remains steadfast. FS-Curtis manufactures a complete line of single-stage and two-stage reciprocating air compressors from three to 125 hp, as well as single-stage and two-stage rotary screw air compressors from five to 350 hp. In addition, FS-Curtis offers a full line of air treatment and ancillary equipment. For more information, visit us.fscurtis.com.

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Wednesday, September 23

10:00AM: First Wave of Pre-Recorded Sessions

1:00PM: Live Keynote Presentations

Thursday, September 24

10:00AM: Second Wave of Pre-Recorded Sessions

1:00PM: Live Keynote Presentations

3:00PM: Live Discussion Forum

Note: All times listed are U.S. EST

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QUALITY, SAFETY & RELIABILITY

Is Your Controller a BLAST FROM THE PAST?

By the Compressed Air & Gas Institute

What kind of mobile phone are you using? Look around. Is anyone using the original "brick phones," or Blackberries or even Palm Treos? Can you remember seeing any of these classic phones in recent years? Sure there are a few diehards still hanging on to their old phones, but the vast majority of people are using some brand of the latest smartphone.

Why are we continually switching to new phones? The answer is simple. Advances in phone technology dramatically improve their function and our experience. More storage, faster speeds, enhanced communication options, bigger and brighter display…. and so on. As a result, today's phones are significantly more powerful – improving our productivity and changing our lives. As for the technology laggards, obsolescence eventually prompts change. Repairing or replacing parts and accessories on the old phones is an increasing challenge. Eventually they have to succumb to technology.

What is interesting is that while individuals have embraced new technology for personal use, many of these same individuals work for companies that operate air compressors that have antiquated and often, obsolete controllers. Just like cell phones, air compressor controls have advanced over the years – providing similar benefits.

New air compressor controls deliver differentiated benefits that can include productivity, reliability, ease of use and system integration. The parallels to mobile phone advances are obvious.

CAGI Compressed Air & Gas Institute
www.cagi.org

Retro air compressor controller.

Modern air compressor controller.

- Enhanced displays: Larger displays, brighter colors and screens that are more intuitive give users easier access to key information. Navigation to additional screens and settings is very simple – saving time.

- Increased memory and processor speed: Having the ability to store more historical data enables better performance tracking and helps with potential troubleshooting.

- Critical communication: Keeping in touch with your air compressor remotely is effectively accomplished through web pages. Automated reporting and alert emails keep users informed of key parameters at all times.

- Expanded connectivity: Greater flexibility with multiple options to connect the air compressor with a customer's DCS, system controls, LAN/Web access, and technician service tool.

- Optimized efficiency: Improved algorithms and control logic ensure the air compressor efficiency is maximized at all times.

- Improved reliability: Maintaining existing obsolescent controls is a challenge and can affect reliability. Access to parts and repairs continues to diminish over time as components become obsolete. Upgrading to current controls removes that risk to reliability. Many manufacturers make it simple to upgrade to the latest controls with pre-engineered plug and play solutions. Retrofits can be completed in as low as four hours for some models. Perhaps easier than upgrading your phone with the cellular provider….no complicated billing plans or rigid contracts to sign! BP

The Compressed Air and Gas Institute (CAGI) is the united voice of the compressed air industry, serving as the unbiased authority on technical, educational, promotional, and other matters that affect compressed air and gas equipment suppliers and their customers. CAGI educational resources include e-learning coursework, selection guides, videos and the Compressed Air & Gas Handbook.

The Centrifugal Compressor Section consists of the following member companies:

- Atlas Copco Compressors
- FS-Elliott
- Hanwha Power Systems
- Ingersoll Rand
- Sullair Corporation

For more information, visit the CAGI web site at www.cagi.org.

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QUALITY, SAFETY & RELIABILITY

Air Receiver Tank Care Guide
SIZING, SAFETY AND STORAGE

By Derrick Taylor, PneuTech USA

Properly sized and maintained air receiver tanks will contribute to years of reliable and efficient compressed air system performance.

Your air receiver tank works hard to keep your compressed air system running at optimal efficiency. For best results and safe operation, it's important to make sure you have adequate storage capacity for your application. You also need to take proper care of your tank once it is installed. In this article we provide advice for air receiver tank sizing, safety and storage.

Air Receiver Tank Sizing

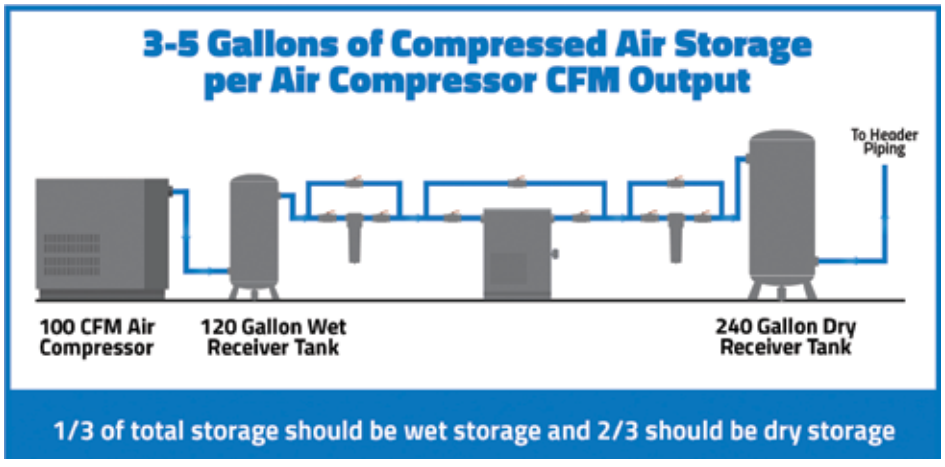
The volume of compressed air storage capacity needed by a facility depends on several factors:

- The air compressor capacity in cubic feet per minute (cfm).
- Peak cfm requirements at moments of maximum demand.
- The consistency of airflow.
- The diameter of the piping.

A good rule of thumb for most applications is to have three to five gallons of air storage capacity per air compressor cfm output. So if your air compressor is rated for 100 cfm, you would want 300 to 500 gallons of compressed air storage. As we'll explain in more detail below, 1/3 of the total storage capacity should be wet storage and 2/3 should be dry storage.

While the standard rule works well for many applications, you will also want to consider other variables in determining your compressed air storage needs. Flow consistency has a large impact on storage requirements.

- Facilities with very steady airflow, such as robotic facilities, typically don't need as much stored air. That's because they don't have frequent high bursts of demand that rely on stored air. In this case, air storage can be reduced to two gallons per cfm of air compressor capacity. All storage should be wet storage in this case.
- Facilities with high variability in airflow and large peaks in demand may require



larger volumes of stored air. This extra capacity will ensure that the system will be able to keep up with periods of high demand. Testing to determine cfm at peak demand will be needed to calculate air storage requirements.

The final consideration in determining compressed air storage requirements is the size of the pipework in the system. The pipes also store air for your compressed air system, and the larger the pipes, the more storage they provide. For systems with pipework of two inches or greater diameter, it may be worthwhile to consider that volume in the calculation.

Wet Versus Dry Compressed Air Storage

When shopping for an air receiver tank, you may be asked whether you want "wet" or "dry" compressed air storage. The difference is in the location of the air storage tank in your compressed air system; there is no difference in tank construction or design.

- "Wet" storage tanks are located before the air drying system. Air flows through the tank in this configuration, entering through the bottom port from the air compressor and exiting out the top to the dryer.

- "Dry" storage tanks are located after the air dryers to store compressed air that has already been dried and filtered. It is not necessary to flow the compressed air through the tank for dry storage.

Wet and dry storage have different benefits for your system.

- Wet storage increases the efficiency of your air dryer and prolongs the life of the pre-filter element by allowing excess water and lubricant to condense out of the system before it hits the filter and dryer. This also reduces pressure drop on the air dryer side of the system and provides a steadier pressure signal to the compressor controller.

- Dry compressed air is ready to use right out of the tank. This reduces the risk that the air dryer will become over-capacitated during high-demand events.

For most applications, it makes sense to have a combination of wet and dry storage.

The ideal ratio of compressed air storage for most applications is 1/3 wet to 2/3 dry capacity. For example, if you have a total of 1,200 gallons of compressed air storage, 800 gallons should be dry storage and 400 gallons should be wet. Dry air is ready to use on demand. The wet air tank increases the efficiency of the dryer and acts as a secondary reserve when dry air is exhausted. Dry air storage needs to be greater than wet storage to minimize the risk of over-capacitating the air dryer during periods of high demand.

An exception to this rule is for applications that have steady airflow without sharp peaks in demand. In this case, there is no need for a dry storage tank because air will simply flow through it without being stored up. This is often the case in robotic manufacturing facilities where airflow is consistent and predictable.

AIR RECEIVER TANK CARE GUIDE: SIZING, SAFETY AND STORAGE

The Importance of ASME Certification and Safety

The American Society of Mechanical Engineers (ASME) has developed a set of codes and standards for pressure vessels, including air receiver tanks. The ASME Boiler and Pressure Vessel Certification Program sets rules governing the design, fabrication, assembly and inspection of pressure vessel components during construction. These rules include engineering standards for the thickness of the tank body, welds and joints, connections and other components of the tank. Tank manufacturers must conform to all of the rules to obtain ASME certification.

All air receiver tanks used in industrial applications must be certified by ASME for safety and performance. Non-code air receiver tanks should never be used, especially for industrial applications.

Some big box stores carry non-code air receiver tanks. While these may be cheaper, they have not undergone the rigorous manufacturing processes and quality testing needed to ensure that they are safe and reliable. Using a non-code air receiver tank could put your life and the lives of your coworkers at risk.

Air receiver tanks hold air under immense pressure. This creates safety hazards if the tank is not up to code or is not maintained properly.

Pressure vessels must be built to withstand high internal pressures over a long period of time. Over time, corrosion, stress and fatigue can make tank failure more likely. The most common causes of air receiver failure are:

- Faulty design/use of non-code tanks.
- Operation above maximum allowable working pressure (over-pressurization).
- Improper installation.
- Corrosion.
- Cracking.
- Weld failure.
- Improper repair of cracks/leaks.
- Exposure to extreme environmental conditions (freezing or overheating).
- Safety valve failure.

The high internal pressures within an air receiver tank make failure extremely hazardous. Cracking or weld failure can cause the tank to burst with explosive force, projecting large pieces of metal or fragments of shrapnel at high speed. Air receiver tank failure may result in extensive damage to the facility and nearby equipment and severe injury or death for nearby workers.

Air Receiver Tank Maintenance and Inspection

A well-maintained air receiver tank can last for many years. To get the most out of your investment, it is important to follow all operating guidelines, perform regular maintenance and inspection, and protect the tank from climate extremes.

For safe operation, it is essential to follow all safety guidelines listed in the owner's manual

for your air receiver tank. To improve tank safety, be sure to:

- Only use ASME-certified air receiver tanks.
- Never over-pressurize the tank; follow operating guidelines for maximum pressure.
- Make sure the tank has a pressure gauge and it is functioning correctly.
- Periodically inspect the tank for corrosion, signs of weld seam stress, cracks, thinning of the vessel walls, and other defects. Any signs of corrosion should be addressed immediately to maintain the integrity of the tank.
- Make sure that the tank has an ASME-certified safety relief valve and the valve is working correctly.
- Drain the tank frequently to prevent liquids from accumulating inside the tank.
- Have all alterations or repairs completed by ASME-certified professionals to ensure that the repair meets quality standards.
- Provide safety training for air receiver tank operators.

Consult the OSHA guidelines for pressure vessel safety for more information.

If you are not sure whether or not your air receiver tank meets code requirements, you should have it inspected. Your local fire marshall may provide this service. They will stop in and test your tank with ultrasonic metal thickness testing technology. If your air receiver tank does not pass the inspection, it should be decommissioned and replaced immediately.

All air receiver tanks must also be inspected periodically once they are installed. OSHA does not mandate a specific testing interval, but it is recommended that all air receiver tanks be inspected at least annually. Your insurance company or local governing board may have different requirements. OSHA requires that formal inspections be performed by an inspector holding a valid National Board

AIR RECEIVER TANK CARE GUIDE: SIZING, SAFETY AND STORAGE

Commission and in accordance with the applicable chapters of the National Board Inspection Code. Manufacturers are required to keep records of formal inspections and make them available to OSHA representatives upon request.

The inspector will review the current operating certificate and perform an overall assessment of the air receiver, piping and other systems. This will include visually inspecting the vessel walls and all support and mounting bracket attachment welds for evidence of corrosion, cracking, denting, gauges, punctures or weld failures. Internal inspection of the vessel walls may be conducted using cameras or sensors. Where visual internal inspection is impractical, inspectors may instead perform thickness readings using an ultrasonic sensor to look for signs of vessel wall thinning. In addition, the inspector will check:

- Pressure relief system.
- Automatic condensate drain or manual drain valve.

Follow all operating guidelines, perform regular maintenance and inspection, and protect the tank from climate extremes to get the most out of your air receiver tank.

The decision to store air receiver tanks inside, or outside of a facility are driven by multiple factors, including space considerations and the local climate.

- Connected piping.
- Proper securing of the tank by bolting it to a solid structure or concrete floor.

In between formal board inspections, companies should conduct frequent visual inspections of the air receiver tank to look for signs of corrosion, damage or weld failure. Check drains daily and pressure relief valves quarterly to make sure they are operating correctly. Contact your compressed air system manufacturer or installer immediately if you see any signs of problems with your air receiver tank.

Outdoor or Indoor Air Receiver Tank?

Air receiver tanks can be installed either inside or out, depending on climate and space considerations.

Compressed air receiver tanks can be bulky, so many compressed air system owners would prefer to store them outside. Outdoor storage saves precious floorspace in the facility. It also helps to reduce strain on your HVAC system in warm weather. The compressed air storage tank radiates heat as hot air from the air compressor cools within the tank. Storing your tank outside avoids excess heat buildup in the air compressor room and also helps the storage tank perform its secondary job as a heat exchanger more efficiently.

On the other hand, outdoor storage leaves the air receiver tank vulnerable to temperature extremes and moisture damage. Make sure your climate is suitable for outdoor placement of your compressed air tank. Outdoor storage of the air receiver tank is only appropriate for environments that stay above freezing year-round. In freezing temperatures, outdoor tanks can ice up and even rupture – a costly and potentially dangerous outcome. If your area experiences freezing temperatures during part of the year, it is safest to keep your tank indoors.

If your area is subject to cooler temperatures with an occasional risk of icing, take special care of your tank in cooler weather. The tank will generate some heat on its own. However, if temperatures drop too far, the tank is still at risk of freezing. Insulating your tank and providing auxiliary heating during cold weather may be necessary to prevent damage.

Some other things to keep in mind when locating your air receiver tank:

- The tank should be located so that the entire outside surface can be easily inspected.
- The air receiver tank should not ever be buried.

- Make sure all drains, valves and gauges can be easily seen and accessed.
- Make sure that there is good airflow all around the tank to dissipate excess heat.
- Do not locate the tank near equipment, materials or products that could be damaged by heat radiating from the air compressor.
- If you are storing your air receiver tank outdoors, be sure to conduct frequent inspections to monitor for corrosion.
- Make sure the tank is not subjected to excessive vibration or at risk of impact by vehicles or manufacturing equipment.

Reliable and Safe Operation for Years to Come

Following safe operation, maintenance, inspection and storage guidelines will extend the life of your air receiver tank and ensure that people working with or near the tank remain safe. With proper care, your air receiver tank will continue to operate safely for many years to come. BP

About the Author

Derrick Taylor is co-founder and General Manager of PneuTech USA, email: Derrick.taylor@pneutech.com, tel: 888-966-9007, Ext. 4000. He brings more than 20 years of direct experience in compressed air service, installation, sales and system design. Taylor is also co-owner of Fluid-Aire Dynamics, a leading distributor of industrial compressed air equipment in the Chicago, Milwaukee, Minneapolis and San Antonio markets.

About PneuTech

PneuTech is a global manufacturer of air compressors, air dryers and compressed air equipment. For more information, visit https://pneutech.com/usa/.

All photos courtesy of PneuTech USA.

To read similar articles on ***Compressed Air Storage System Assessments***, visit https://airbestpractices.com/system-assessments/piping-storage.

QUALITY, SAFETY & RELIABILITY

Dutch Glass Container Plant Compressed Air System Makeover Increases UPTIME AND ENERGY SAVINGS

By Mike Grennier, Compressed Air Best Practices® Magazine

A global glass container manufacturer in the Netherlands leaves no stone unturned when it comes to product quality, plant uptime and energy conservation. That's why it upgraded its compressed air system used to produce more than one billion glass bottles and containers per year.

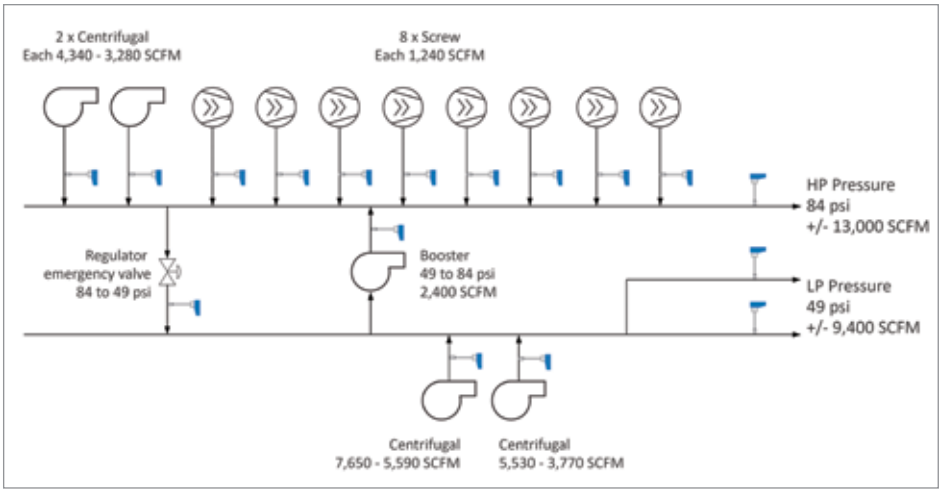
To improve the delivery of compressed air at the plant, which is supplied by low-pressure and high-pressure compressed air systems, the manufacturer took an important first step by using airflow meters to monitor and measure the performance of both systems. Subsequent planning based on actionable data led to a unique compressed air system upgrade that increases the plant's ability to maintain peak production of high quality glass bottles and containers at all times – while saving $150,000 per year in energy costs. The project also delivered a payback of less than two years.

Hot and Cold Machine Bottling Processes

The Dutch division of this multinational company, which is one of the top producers of glass containers in the world, operates several glass manufacturing plants in the Netherlands. The main plant that needed to address its compressed air system operates twenty four hours per day, seven days a week to produce 1.3 billion glass beer bottles per year. The pristine bottles are shipped to leading beer brands and small breweries in the Netherlands and elsewhere throughout the world. The facility also supplies compressed air to an adjacent glass plant, which makes wine glasses.

The plant's bottling process begins with the hot-end process where furnaces convert glass feedstock into molten glass. At temperatures of up to 1,200°F, the glass enters a plastic stage so it can be cut into a cylindrical gobs, which are eventually formed into glass bottles and other containers. An automated blow-and-blow process involving multiple IS machines is then used to form the beer bottles.

Within each IS machine, compressed air is used to force the gob into a mold, which converts it into a "parison," which is the name of the initial shape of the beer bottle neck and the bottle itself. After the parison is formed, it is flipped to the other side of the machine where valves open to allow compressed air to blow the parison into the desired bottle shape. Once cooled, the bottle is automatically removed from the IS machines and conveyed to



The glass manufacturer's high-pressure compressed air system (top) and low-pressure compressed air system (bottom) incorporates the use of a compressed air booster to achieve energy efficiency and pressure stability.

the cold-end process of the factory where the bottles are inspected and packaged.

Low- and High-pressure Systems Vital to Production

The plant's compressed air system is comprised of two complete systems. A low-pressure system delivers 9,400 scfm of air at stable 49 psi, while the high-pressure system provides up to 13,000 scfm of compressed air at 84 psi. Both have been updated throughout the years with a variety of equipment to enable the plant to keep pace with steady growth.

The low-pressure compressed air system includes two, three-stage centrifugal air compressors with drying provided by individual refrigerated dryers. One 1,300 hp unit delivers 5,590 to 7,650 scfm of air, while the second, 1,050 hp machine provides 3,770 to 5,530 scfm of air.

The critical nature of glass blowing requires the low-pressure system to maintain stable pressure of 49 psi with a deviation of plus or minus 0.7 psi without fail. Otherwise, too much air could cause significant problems, such as unwanted air bubbles in the glass. Too little air pressure by the slightest of margins would not allow glass bottles to properly form within the IS molding machines.

The high-pressure system features two, 1,000 horsepower (hp), four-stage centrifugal air compressors, each of which delivers 3,280 to 4,340 scfm of compressed air. The system also includes eight, oil-free rotary screw air compressors. Each 340 hp rotary screw air compressor provides up to 1,240 scfm of air. The centrifugal air compressors use desiccant dryers and the rotary screw air compressors use rotary drum dryers to provide a continuous supply of instrument-quality air.

The high-pressure system powers the IS molding machines, as well as the plant's conveyors and production machines used in the plant's cold-end packaging operation. Additionally, it supplies air used for the production of wine glasses and vegetable jars in the adjacent glass plant.

Measuring Compressed Air System Performance

The glass manufacturing facility always strove to conserve energy based on its own sustainability goals and those of its customers. A focus on energy conservation drove regular updates to the compressed air system, such as the use of an eight hp blower to provide air to an area of the plant that only needed low-pressure air. The blower, which replaced the need for the compressed air system to provide the air, resulted in energy savings.

Despite ongoing improvements to the system, however, decision-makers knew they could do more to reduce the electrical power consumption of the operation's compressed air system, sparking the need to more closely monitor and measure the efficiency of the entire system. Yet first and foremost any changes to the system also needed to address the need of optimal plant uptime.

To accurately gauge compressed air waste and improve performance, VPInstruments (https://www.vpinstruments.com/) installed a total of 20 airflow meters on the compressed air system to measure and compare the amount of compressed air produced with the amount of power consumed by the air compressors.

On the rotary screw air compressors, meters were installed on the outlet, just after the built-in drum driers. On the centrifugal machines, the flow meters were installed downstream of their individual desiccant driers. Meters were also installed in key locations of the piping system.

On the low-pressure system, flow meters showed each centrifugal air compressor

DUTCH GLASS CONTAINER PLANT COMPRESSED AIR SYSTEM MAKEOVER INCREASES UPTIME AND ENERGY SAVINGS

consistently provided air to the glass-blowing process at a pressure of 49 psi. On the high-pressure system, meanwhile, two centrifugal air compressors operated continuously at full load to provide air at 84 psi. The plant also ran anywhere from three to four rotary screw air compressors in a load/unload fashion to provide additional air needed based on demand. Each rotary screw air compressor operated at approximately 70 to 80 percent load. Together, the high-pressure system provided compressed air at 84 to 87 psi.

Further analysis of the low-pressure system showed the system needed attention. Each air compressor operated independently and without load sharing based on input from a single pressure transmitter. As such, one air compressor operated at full load, while the other unit ran at minimum load to provide air needed, resulting in blow-off and wasted energy to prevent the air compressors from entering a surge condition.

An assessment of the high pressure system also revealed additional energy waste. The assessment during one month of normal operation demonstrated a significant number of unloaded hours and start/stops on two of the rotary screw air compressors on the high-pressure system.

Based on the assessment, the glass container manufacturer partnered with Stork (https://www.stork.com/en/) to improve the performance of the compressed air system. Stork, which is a division of the worldwide engineering firm, Flour Corporation, provides brand-independent turbo air compressor air compressor services, including inspection, repair, maintenance, modification and engineering.

System Upgraded Features Air Compressor Booster and Controls

To address the critical need to maintain pressure in the low-pressure system at 49 psi – and at the same time – reduce energy waste associated with the compressed air system, Stork installed a single-stage, 200 hp centrifugal booster air compressor rated to deliver up to 2,400 scfm at 84 psi. It also installed a master controller to allow the compressed air system to work together as a single cohesive network using data supplied by airflow meters and controllers.

Flow meters installed on the glass manufacturer's compressed air system pointed to energy-savings opportunities.

Additionally, Stork replaced the single-pressure transmitter with two transmitters on the low-pressure system to better measure air pressure and facilitate load sharing and control of the centrifugal machines. On the same system, it also replaced the controllers on each of the centrifugal air compressors with synchronous controllers. The local controllers are equipped with hour counters to measure blow-off of the centrifugal units.

The new master controller monitors the entire compressed air system and determines where the limits are in the different air compressors and automatically adjusts them to efficiently provide air to both processes, while allowing for stable pressure on the low-pressure system. The booster air compressor, meanwhile, plays an equally vital role in system stability and reliability.

System Delivers Stable and Efficient Air Supply

Today, the two centrifugal air compressors on the low-pressure system run at full load to supply air to the glass-blowing process. In addition, the same machines supply air at 49 psi to the booster air compressor. The booster, which also normally operates at full load, increases pressure from 49 psi to 84 psi and supplies air to the high-pressure compressed air system. Doing so allows the plant to meet the primary objective of maintaining at stable pressure of 49 psi when supplying air to the glass blowing operation since any excess air from the centrifugal air compressors is fed to the booster air compressor. Yet, the new configuration also eliminates blow-off of the centrifugal machines on the low-pressure system since excess air is fed to the high-pressure system.

To further ensure a consistent and reliable supply of compressed air at 49 psi to the glass-blowing operation, Stork installed an emergency valve in the piping system

The compressed air system's master controller is used to optimize the performance of the plant's low- and high-pressure compressed air systems.

between the high-pressure and low-pressure compressed air systems. The valve allows air to flow from the high-pressure system to the low-pressure system if one of the low-pressure centrifugal air compressors fails or is down for service. All the while, the master controller ensures the air supplied to the glass-blowing operation is maintained at 49 psi, even if it's supplied by the high-pressure system and the functioning centrifugal air compressor on the low-pressure system.

The upgrade also ensures highly efficient operation of the high-pressure compressed air system. As before, the plant operates the two centrifugal air compressors at full load. However, now with supplemental air from the booster air compressor it only normally needs to run two rotary screw air compressors at near capacity to efficiently and reliably supply air to the high-pressure system feeding the plant's remaining production processes. If the plant requires even more air, the system will automatically add one or more rotary screw air compressors. Doing so eliminates energy waste created in the past by loading and unloading as many as four rotary screw air compressors to meet the needs of the high-pressure system.

Uptime Plus Energy Savings Equal a Win

The recent compressed air system upgrade allowed the global glass bottling and container manufacturing plant to achieve its No. 1 goal: To ensure a reliable and stable supply of compressed air to its glass-blowing operation – which in turn – further strengthens its ability to profitably produce high quality glass bottles and containers with maximum plant uptime. The upgrade has also allowed the plant to meet an equally important goal of saving energy and costs. To date, the plant saves $150,000 per year on its energy bill thanks to the newly designed system. The project also delivered a payback of less than two years.

The plant manager at the glass container operation said the ability to measure and monitor the compressed air system was crucial to demonstrating the energy-savings potential to the management team and the value of investing in the system upgrade. Based on the results of the recent compressed air system project, the glass container manufacturer continues working with Stork and VPInstruments to gain additional energy savings through ongoing monitoring and measurement of the compressed air system with an eye toward additional strategies to further optimize system performance. BP

For more information contact VPInstruments at www.vpinstruments.com

All photos courtesy of VPInstruments and Stork.

To read more ***Compressed Air System Assessment*** articles, please visit https://www.airbestpractices.com/system-assessments

QUALITY, SAFETY & RELIABILITY

GMP COMPLIANT MONITORING OF Pharmaceutical Plant Compressed Air Systems

By Wolfgang Rudloff, gmp-experts and Simon Gleissner, SUTO iTEC

Compressed gases in direct use in the flow of medicinal materials and in process control require a high level of attention and consistent integration into a Good Manufacturing Practices[1, 2] system of cleanroom technology. If the supply of compressed nitrogen from a storage facility (gaseous in pressure vessels or as liquid nitrogen with subsequent evaporation) is still qualitatively secured by a Certificate of Analysis (CoA) from the nitrogen manufacturer, it becomes more difficult for the compressed air produced on site: The compression takes place using the ambient air as a resource, which can be very different in various locations or can be strongly affected by environmental influences which have a direct impact on the quality.

Only a purification in the further distribution can produce a suitable quality. To master these general conditions, a specification that is carefully related to the application, a valid processing and distribution technology and, above all, a usage-oriented monitoring of the specifications by monitoring with subsequent approval for use on or in the product is required.

This article is intended to show the relationships between risks and specifications, opportunities and responsibility in validation, and in particular, the use of modern and calibrated measurement technology in the sample chain.

Compressed Air in the Pharmaceutical Environment

Compressed air is an "expensive substance," not only when you look at the costs of using energy to operate a compressed air network in a reliable manner. Valuable also because compressed air often comes much closer to (or in) the product than expected.

In particular, this includes processes such as blowing out primary packaging, transporting products from the container to the filling needle under aseptic conditions, to drying containers, or venting after high-vacuum in lyophilizers or fermenters. Compressed air has an extremely narrow influence on the product and therefore requires a very high level of attention in the GMP[1, 2] system.

Shown is an automated filling station in a pharmaceutical plant.

In numerous reports on official inspections, it was often criticized that neither a clear specification, nor a sustainable qualification, or GMP management around the operation of compressed gases was carried out. In particular, the creation of a specification was not carried out or was carried out only inadequately.

The reason for this is certainly that, in contrast to the liquid media, such as aqua purificata or water for injections, there is no clear specification by the European Pharmacopoeia (Ph. Eur.). The specification, "Air Medicinalis," which is found in the Ph. Eur., is unsuitable for the specification of compressed air since it describes breathing air supplied to a patient with acceptance criteria.

The reference to ISO 8573[3] from the International Organization for Standardization is then only of limited use because here a classification of limit values for particle concentration, pressure dew point and oil content is defined, but it is not recommended in which pharmaceutical application and which class or specification is necessary and shall be used. ISO 8573 also says nothing about possible specifications for airborne germs analogous to Annex 1 of the European Union's GMP guidelines.

This fact has been taken into account as a trend in the recent months in the course of official inspections. The compressed gases nitrogen and compressed air have therefore become the focus of surveillance. Much more: The official opinion on the assessment of GMP obligations for compressed air systems was published in the "Aide memoire – Monitoring of Sterile Manufacturers" of the Central Office of the Federal States for Health Protection in Germany[4], which states:

"When specifying compressed air that comes into contact with the product or surfaces in contact with the product, the following must be observed: In addition to the type of products manufactured, the risk assessment must also take the system design and the quality of the outlet air into account."

In connection with the evaluation of hydrocarbons, it should be noted that contamination with oil within compressed air is a mixture of oil aerosols, oil vapor and other hydrocarbons. A definition of "oil" as a mixture of hydrocarbons with ≥ 6 C atoms (ISO 8573-1:2010) is therefore appropriate. Measuring methods and recorded oil components must therefore be clarified. Hydrocarbon monitoring is also necessary for oil-free air compressors, since the corresponding contaminants are also introduced via the intake air. The below purity parameters as described in ISO 8573 need to be considered:

- Limits for bacterial count / particles are expected.
- Online monitoring of water and hydrocarbons may be necessary, especially for systems that, due to the use of refrigeration dryers or air compressors with oil cooling, have a higher risk of non-compliance with the specification requirements.

With this clarification there are no limit values according to ISO 8573 as defined, but the direction is clear. In order to define the specification now it is advisable to make a classification based on the Association of German Machine and Plant Manufacturers (VDMA) depending on the application (criticality for the product). As an example,

GMP COMPLIANT MONITORING OF PHARMACEUTICAL PLANT COMPRESSED AIR SYSTEMS

when in use in the sterile area, "Direct contact of the compressed air with the material of a sterile packaging (process air)," is defined in the VDMA 15390[5] standard sheet with the following acceptance criteria:

- Maximum particle size and density of solid contaminants: Class 1, corresponds to 0.1 µm and 0.1mg/m³.
- Pressure dew point at ambient temperatures> + 10°C: Class 4, corresponds to + 3°C Td.
- Pressure dew point at ambient temperatures <+ 10 ° C: Class 2/3, corresponds to -40°C Td /-20°C Td.
- Maximum oil content: Class 1, corresponds to 0.01 mg / m³.
- Sterility: Yes

Bacteria culture development in a medium plate.

Contamination Risks in Compressed Air

As the main argument for safety in the use of compressed air in a GMP environment, it is repeatedly shown in inspection situations by auditors that the use "oil-free air compressors" are sufficient to ensure qualified and contamination-free compressed air. Unfortunately, this is a fallacy because the risk of contamination is often considerably greater than expected or known. Simplified, it can be divided into two areas:

- Active contamination in compressed air treatment.
- Passive contamination of compressed air by connected air consumer systems.

In the case of active contamination, the primary cause of contamination is found in the use of air compressors with oil cooling. But beyond that, one of the other contaminants needs to be searched for in the aspirated ambient air.

Depending on the position of the openings of the air intake, a considerable amount of particles and oil contaminants in the form of aerosols can be drawn in and compressed from the environment. The (mostly minor) contamination in the form of particles and oil content from the moving parts of an air compressor, especially after a long period of operation, must also be taken into account. In addition, a lot of moisture comes from the air and thus a potential entry of airborne germs into the system in operation and thus into the pipeline network.

In the case of passive contamination, the danger to the compressed air quality is that, due to unfavorable simultaneity factors or insufficient pipe dimensions, "large consumers" cause a reversal of the overpressure in the compressed airline system toward a vacuum system.

In the case of sterile ventilation using compressed air, e.g. containers that fall into the vacuum phase after the vapor phase has collapsed, after steam sterilization, or when the high vacuum of lyophilizers breaks when the valve opens to the compressed airline, the pressure conditions in the line system are reversed. The main risk here is that it can happen in "worst case" situations that such a large, temporary negative pressure can arise in the compressed air network that back-

Shown is the SUTO iTEC's S600/AirCheck4 compressed air quality analyzer with an additional sampling unit for isokinetic sampling of particles. The isokinetic sampling device is used to sample air carried particles according to ISO 8573 (3) guidelines.

contamination into the system can occur via the compressed airline from other operating areas.

When designing compressed air networks, this should be categorically risk-based checked and planned or taken into account in the in-house change control process before connecting new consumers. To avoid such effects, the use of the so-called "block & bleed circuits" and/or the installation of check valves in the compressed airline could be considered. In any case, this fact should also be checked as part of the Installation Qualification (IQ)/ Operational Qualification (OQ) qualification of the network subject to GMP.

Whether active or passive contamination: In the often very widely branched compressed air networks within a pharmaceutical plant, the principle applies: "What is in the network remains in there!"

In the majority of cases, cleaning is not possible, or will be often not intended in the course of airline planning. In order to make the level of contamination within the compressed airline visible/controllable at all, it is therefore recommended that a so-called "inspection pipe" is installed, i.e. a section of approx. 50 - 100 centimeter (cm), which can be removed and inspected using tri-clamp connections as part of the planned maintenance. In extreme cases, the degree of contamination can then lead to a partial or total renovation or replacement of a compressed air network.

Qualification of Compressed Air Systems and Distribution

One of the most asked questions when considering compressed air systems is the need to fully qualify all components of compressed air generation and distribution. The first difficulty here is that, in contrast to a process plant (e.g. filling line for aseptic processes), GMP-compliant planning taking into account a "hygienic design" for an air compressor is almost impossible. Even if air compressors are occasionally offered by the manufacturer as "GMP-compliant," with reference to oil-free operation, this generally only refers to the absence of oil cooling and reduction of the lubricated/particle-releasing parts.

It is therefore a recognized GMP practice that the air compressor, including installation, is checked for its technical suitability under the rules of Good Engineering Practice (GEP), that all technically relevant documents are provided, and that successful commissioning is also documented. Against this background, a classic IQ/OQ qualification seems rather inappropriate. This should be listed or defined in the Validation Master Plan (VMP) of the GMP company under the aspect "GMP versus GEP"[6].

This approach was taken up by ISPE in 2014 and commented as follows in the International Society for Pharmaceutical Engineering (ISPE) "Good Practice Guide Process Gases" as follows:

"Gas production normally follows Good Engineering Practices (GEPs). For further information see the ISPE Good Engineering Practice. Gas is not a medicinal product and does not need to be produced following Good Manufacturing Practices.[6]"

GMP-critical, however, is the qualitative preparation of the compressed air, which is used intended not to have any negative impact to the selected specification and for use in the process area relevant to the product. The suitability of all components required for preparation and distribution in the course

GMP COMPLIANT MONITORING OF PHARMACEUTICAL PLANT COMPRESSED AIR SYSTEMS

of the Design-Qualification (DQ), IQ and OQ phases, including a sufficient Performance Qualification (PQ), is a mandatory part of the qualification/validation and is as a GMP consequence subject to the deviation or change management system.

In an analogy to the GMP/GEP approach, the distribution and processing of the compressed air, used exclusively for technical use outside the cleanroom, which means no direct or indirect product contact, can again be regarded as a GEP system and is therefore not subject to the rules of formal qualification.

In the course of qualification, special attention must be paid to the connected process equipment/consumers of air. Here too it must be ensured that potential overpressure or vacuum conditions within the process have no negative influence on the compressed air system to the internal piping of the system due to risk of backflow of contaminants into piping system.

The system boundary for qualification in the compressed air system should be the transfer point to the process system, e.g., the pressure monitoring sensor of a process system is also checked for qualification and should be subjected to regular calibration if necessary.

Quality inspection/Sampling

With the classification of compressed air as a critical medium in pharmaceutical use, a regular check of the compressed air quality in accordance with internal specification is an indispensable part of the validation system: As with pharmaceutical water systems, a sample drawing plan should also be drawn up as part of the PQ for ongoing operation after commissioning.

The number of monitoring points and the frequency of sampling should be determined and planned on the basis of a risk analysis. This can include, based on the application of compressed air, the complexity of the distribution system (e.g. length, branching) or connection to possible contamination risks.

In any case, the sample drawing should be carried out in such a way that it is safe in itself and without the risk of unwanted external contamination. The selected measuring method should be chosen so that the defined specifications can actually be determined in accordance with GMP. The last point in particular is not exactly easy, since for the individual parameters particles, moisture and oil content, as well as a safe sample for airborne germs. This requires a large number of different measuring technologies and sampling methods have to be used.

Given the challenges involved, it's important to use the appropriate measuring device for monitoring the physical parameters of compressed gas systems. As an example, a device developed by gmp-experts GmbH and SUTO iTEC enables the measurement of all relevant measurement parameters in compressed air monitoring under valid conditions including airborne germs with the addition of an air germ collector.

Ensuring the functionality of the sensors is one of the major challenges in dealing with measurement technology relating to the quality inspection of GMP-compliant gases. Here, too, it is an essential GMP requirement the measuring sensors used undergo regular calibration. Hereby it is important to ensure the traceability to the national standard in which

all measuring devices have to be traceable to this highest accuracy instance of a physical measured variable. All calibrations carried out have to comply with the requirements of the EU-GMP guidelines and have to be fully recorded in accordance with good documentation practice.

Ensuring Safe Manufacturing

GMP in compressed air systems is the risk-based interaction between the definition of quality parameters and their implementation in a suitable technology for production and distribution. But only GMP-compliant qualification and regular sampling can ensure that the risk of contamination of the pharmaceutical is avoided. BP

About the Authors

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About gmp-experts GmbH

Founded in 2008, gmp-experts GmbH is an internationally operating consulting company for the pharmaceutical, cosmetic and food industries with focus on GMP consulting, project management and GMP training. It specializes in evaluation and holistic improvement of active quality systems, optimization of process and logistics chains, deviation and change management, certified auditing of suppliers and service providers, and assumption of interim mandates. For more information, visit www.gmp-experts.de.

About SUTO iTEC

SUTO iTEC products play a vital role in applications of leading worldwide companies for the measurement and monitoring of compressed air and gas systems. Since its founding in 2005, SUTO iTEC formerly known as CS-iTEC) has never stopped innovating reliable measurement technology. Besides a few merchandise articles, all SUTO products are developed and manufactured in-house - with a strong focus on quality and customer benefits. For us, service implies being close to our customers, finding individual solutions and reacting quickly when needed. We achieve this service definition through our international presence - with main locations in Germany and China, as well as subsidiaries and long-term partners in 20-plus countries. We are able to bring together the German pursuit of precision and quality with the Asian drive for innovation and speed, four attributes that are essentials for any market leader. For more information, visit www.suto-itec.com.

All photos courtesy of SUTO iTEC.

References

1. EG GMP Guide, Annex 1 "Manufacture of Sterile Drugs," March 2009.
2. EG GMP Guide, Annex 15 "Qualification and Validation," October 2015.
3. ISO 8573-1:2010.
4. ZLG Aide Memoire 07120604 "Monitoring Sterile Manufacturers," January 2015.
5. VDMA standard sheet 15390-1, December 2014.
6. ISPE "Good Practice Guide Process Gases," July 2011.

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COMPRESSED AIR SYSTEM TECHNOLOGY NEWS

Atlas Copco Introduces the FD VSD 100-300 Refrigerant Dryer

Atlas Copco is expanding its variable speed drive (VSD) series by introducing the FD VSD 100-300, a new refrigerant dryer. Atlas Copco's VSD technology has revolutionized air compressors, and dryers, by making them notably more energy-efficient and significantly reducing the cost of ownership.

Atlas Copco's FD VSD 100-300 can deliver energy savings of 50% and higher.

Atlas Copco's FD VSD 100-300 with VSD technology matches power consumption to demand, translating into a lower cost of ownership. The FD VSD 100-300 will be available in six sizes ranging from 212 to 636 cfm, offering customers up to 50% savings on indirect energy costs and up to 70% savings on direct energy costs.

"The launch of the FD VSD 100-300 is in line with our engineering principles of continuing to bring improvements to our customers and take technology to the next level," said Trey Ragsdale, vice president of industrial air for Atlas Copco Compressors USA. "Our customer and application-geared focus led to the development of this product, and the comprehensive nature of our complete range means we can be confident in having the right product for the right application with no need to compromise."

The implementation of Atlas Copco's VSD technology into its refrigerant dryers improves the working process used by most refrigerant dryers – also known as "thermal mass dryers" or "cycling dryers". As opposed to running at full load to cool a thermal mass, stopping, and then relying on that mass to complete cooling, the VSD process allows for a fluctuating air demand, made possible by an inverter that allows the refrigerant dryer compressor to match its motor speed to the user's demand.

A thermal mass dryer also has a dew point that rises and falls. A VSD dryer, alternatively, provides users with a low, stable dew point and high-quality air always (purity class -;4; - according ISO 8573-1:2010). Further, the VSD dryer is equipped to perform in any condition, while thermal mass dryers can struggle to generate significant energy savings in high ambient temperatures.

Atlas Copco's new FD VSD 100-300 series is more compact than a typical thermal mass dryer, and its service costs are lower, as it does not require a thermal mass heat exchanger. In addition, the FD VSD 100-300's high-efficiency heat exchanger was engineered specifically to reduce the pressure drop in the incoming air and eliminate any pre-cooling inefficiencies.

The new FD VSD 100-300 comes with a sophisticated Elektronikon® Touch controller. It is easy to operate, and users can obtain all the information they need to know immediately. Combined with an ethernet connection and SMARTLINK remote monitoring, the dryer's air-system performance and maintenance intervals can be optimized from anywhere in the world.

About Atlas Copco Compressors

Atlas Copco Compressors LLC is part of the Compressor Technique Business Area, headquartered in Rock Hill, South Carolina. Atlas Copco Compressors provides innovative solutions including world-class compressors, vacuum pumps, air blowers, quality air products and gas generation systems, all backed with full service, remote monitoring, and auditing services. With a nationwide service and distribution network, Atlas Copco Compressors is your local, national, and global partner for all your compressed air needs. Learn more at www.atlascopco.com/air-usa.

Kaishan Expands Range of KRSD Direct Drive Compressors

Kaishan Compressor USA has recently expanded its KRSD series of direct drive rotary screw air compressors. The product range now extends from 15-200HP in the product portfolio. The latest editions include 15, 20, and 40HP models that enable Kaishan to offer products in this size range to a wide array of customers and applications. All models in the series are offered in both fixed speed and variable speed drive configurations throughout the lineup.

Fixed speed models have convenient pressure flexibility ranging from 100 to 125 psig full load operation. A pressure variation is accomplished by a simple change in the microprocessor controller, and an adjustment of a proportional valve, to raise or lower the operating compressor to the desired level. This makes the KRSD product an excellent candidate for distributor inventory by reducing the number of machines needed in stock. Variable speed drive versions can operate at pressures ranging from 100 to 150 psig full load by changing the speed of the compressor.

Kaishan Compressor USA has recently expanded its KRSD series of direct drive rotary screw air compressors.

Soon, the 15-30HP segment will have the option to be tank mounted as well.

All models come with a standard factory warranty of 10 years on the airend and 5 years on all major components (drive motor, cooler, reservoir, controller, vsd drive). Extended warranty compliance is simple and only requires the use of genuine Kaishan parts and fluid along with taking fluid samples at regular intervals. No contracts or annual kit purchases are required for coverage. The product is supported with a full inventory of replacement parts and service 24 hours a day from the Kaishan USA headquarters in Loxley, AL.

The KRSD product is just a portion of the wide breadth of products offered by Kaishan USA. Other rotary screw product lines include the KRSB 5 – 50HP belt driven product, KRSP 40 – 500HP direct drive single stage, and the KRSP2 100-600HP two stage energy efficient series.

About Kaishan Compressor USA

Kaishan Compressor USA (KCA), is headquartered in Loxley, AL in a new 65,000 ft2 state of the art manufacturing facility that was formally opened in October 2019. Kaishan is a vertically integrated company that procures 85% of its rotary screw compressor product content from within their own company subsidiaries. Kaishan is also performing complete machine assembly, modification, and testing of rotary screw compressors from 5-600 horsepower in the new factory. To learn more about Kaishan USA and becoming part of a rapidly expanding company as a team member or distributor, visit www.KaishanUSA.com.

nano Introduces STR Open-Frame Refrigerated Process Dryers

nano's new range of STR open-frame refrigerated process dryers provide clean, dry compressed air, a super low pressure drop and consistent dew point performance. With dew points ranging from 35 to 39°F, the shell and finned tube heat exchanger boasts not only very low pressure drops, but an extended five-year heat exchanger warranty. Additional features include efficient and reliable compressors and a 'no sweat' insulation to provide cool surfaces against an unwanted moisture which could damage the system piping.

Utilizing a direct expansion design, the most efficient form of heat transfer used in dehumidifying compressed air, the units remove moisture from compressed air by transferring heat from the air to the refrigerant by coming into direct contact with the refrigeration circuit through the novel shell and finned tube heat exchanger.

Manufactured in nano's New Bethlehem, PA facility and backed by more than 40 years of manufacturing and engineering expertise, the range includes flows from 1,250 to 7,500 scfm and beyond in both air-cooled and water-cooled configurations.

A look inside an STR open-frame refrigerated process dryer from nano.

For more information, visit www.n-psi.com.

COMPRESSED AIR SYSTEM TECHNOLOGY NEWS

EXAIR Introduces New Pressure Sensing Digital Flowmeters

EXAIR's new Pressure Sensing Digital Flowmeters provide a way for plant personnel to monitor pressure throughout a compressed air system along with flow. A pressure sensor is mounted between the two flow sensing probes and the display can be configured to show air pressure or air flow. A transistor output can also be configured to provide a low-pressure alarm to protect your processes and/or equipment. Pressure values are capable to display PsiG or BarG. Measuring compressed air is the first step toward identifying high compressed air use areas, compressed air leaks and optimizing air use.

EXAIR's new Pressure Sensing Digital Flowmeters Monitor Pressure and Flow.

Each meter ships with the necessary hardware and tools for installation including drill bit, drill guide, and hex wrenches. The Pressure Sensing feature is available on 2 inch and 50 millimeter or larger flowmeters. They are available in standard units which display airflow values on a bright LED screen, with optional data logger to capture and manipulate the data. The pressure signal is also available through optional wired and wireless serial outputs. Airflow values are expressed in Standard Cubic Feet per Minute or Cubic Meters per Hour.

Pressure Sensing Flowmeters for schedule 40 iron pipe and Type L Copper and nominal millimeter sizes are now available. They are CE and RoHS compliant and join EXAIR's full line of Digital Flowmeters for air lines from 1/2" through 8" including Hot Tap, Wireless and Data Logging flowmeters. Prices start at $1343.00. For more information, visit www.exair.com.

PREVOST Introduces New ½" Composite Body Safety Coupling

Prevost Corporation, an international manufacturer of pneumatic equipment recently added a new ½" composite body safety coupling to their line. With a larger ½" passage, service shops who maintain fleet or heavy-duty vehicles and industries, which require higher air requirements, will benefit from the increased flow rate capacity to power larger pneumatic tools and machinery.

Available for industrial, automotive and high flow profiles, the ½" Composite Body Safety Coupling is ISO 4414 compliant and is equipped with a one push, anti-hose whip technology for ultimate user safety. It is also guaranteed to be leak-free for three years

The New ½" Composite Body Safety Coupling from PREVOST.

when used with a PREVOST plug. The anti-scratch body protects production pieces and surrounding equipment. In addition, the coupling is anti-static, ideal for painting applications and is manufactured silicone-free. Lastly, it is ergonomic, lightweight and comfortable for all day use.

Technical Specifications:
Body: Polyamide composite
Flow under 87 psi: 974GPM (ΔP= 8.7 psi)
Weight: 6.25 oz.
Pressure: 29 to 174 psi

About PREVOST
For over 40 years, PREVOST has been designing and manufacturing a comprehensive range of products for compressed air and fluid distribution systems. Innovation has always been the central pillar of PREVOST's strategy and why we strive to develop top quality, safe and sustainable products. PREVOST specializes in safety couplings, blowguns, piping networks, air preparation and pneumatic equipment. For more information, visit www.prevostusa.com.

Guardair Introduces Syphon Spray System to Combat COVID-19

Guardair Corporation, a leading manufacturer of Occupational Safety and Health Administration (OSHA) compliant safety air guns and pneumatic accessories, has developed an innovative product to spray cleaning solutions and disinfectants onto workplace surfaces to keep employees safe from infection.

Guardair's compressed air powered Syphon Spray System sprays cleaners and disinfectants.

Powered by compressed air, the Syphon Spray System is a cost-effective alternative to hiring expensive sanitizing services. Ideal for industrial facilities with in-plant

COMPRESSED AIR SYSTEM TECHNOLOGY NEWS

air compressors, the Syphon Spray System provides wide-area spray capability to thoroughly disinfect floors, walls, and workbenches, as well as tools, machinery and equipment.

Featuring a 12" Syphon Spray Gun, the Syphon Spray System delivers up to 16 gallons of liquid per hour. Adjustable nozzle tip controls flow and spray pattern from a steady stream to a light mist. Rugged 20-gallon steel canister stores cleaning solutions with a secure lid to avoid spillage while rolling.

The easy to maneuver Syphon Spray System is dolly mounted and comes complete with push handle. Reach remote locations with 20' syphon hose assembly. All components are suitable for use with common, noncorrosive, disinfecting solutions.

"Performing proactive disinfection to ensure workplaces are safe is critical during these unprecedented times," said Tom Tremblay, President of Guardair. "Our Syphon Spray System offers an innovative solution to spraying disinfectants and reduces the risk of workplace COVID-19 infections."

About Guardair Corporation

Founded in 1942, Guardair Corporation is a world-class manufacturer of safety air guns, syphon spray guns, pneumatic vacuums, and shop accessories. Guardair products are designed to maximize power, performance, and operator comfort, while meeting all applicable OSHA Standards. To learn more, visit guardair.com.

Emerson Introduces AVENTICS RDD Air Dryers

Emerson introduced two new compressed air dryers designed to significantly extend maintenance intervals, minimize downtime and reduce energy costs in rail applications, including brakes and door control. Typically, air dryers have an average service interval of less than two years. The AVENTICS RDD (Roll-Up Desiccant Drying) and RDDmin air dryers, have a service interval of eight years or 25,000 operating hours. The new products feature a proprietary adsorption medium that removes humidity from compressed air systems more efficiently, reducing energy usage with a smaller envelope size and weight. The dryers' shock- and vibration-resistant design further enhances their reliability in tough rail applications.

Humidity in compressed air can cause corrosion and ice blockages at low temperatures, often disabling door systems or freezing valves in the brake control circuit. Until now, conventional dryer systems relied on a granular adsorption medium. The shocks and vibrations that occur during rail operations cause channeling, air bypass and dust generation, which leads to a significant loss in drying performance. Consequently, the dew point increases. High water loading can cause

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The AVENTICS RDD air dryer from Emerson.

a breakdown of the granulate bed resulting in frequent material changes and a reduced service life.

To solve these problems, Emerson's AVENTICS RDD technology uses adsorbent crystals immobilized in a durable polymer support structure, which is produced in a continuously embossed sheet and rolled up to tightly fit into a barrel-type housing for high shock and vibration resistance. Unlike competing products using desiccant beats, the AVENTICS dryers resist excessive water loading and fully recover afterwards. This ensures constant performance throughout the lifetime of the product and reduced life-cycle costs.

The RDD dryer is used for main air supplies on trains, whereas the RDDmini is used for auxiliary air supply, to driver seats for example. The efficient design means that the overall envelope size for both dryers is half that of other dryers currently available on the market, allowing for smaller envelope sizes and lower unit weight. The moisture uptake allows for a much higher efficiency air consumption rate of less than 15%, which reduces energy costs.

About Emerson

Emerson, headquartered in St. Louis, Missouri, is a global technology and engineering company providing innovative solutions for customers in industrial, commercial, and residential markets. Our Automation Solutions business helps process, hybrid, and discrete manufacturers maximize production, protect personnel and the environment while optimizing their energy and operating costs. Our Commercial and Residential Solutions business helps ensure human comfort and health, protect food quality and safety, advance energy efficiency, and create sustainable infrastructure. For more information, visit www.Emerson.com.

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