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COLUMNS

FROM THE EDITOR | System Assessments

Summer and our economy are both slowly getting into gear. Our team here wishes all of our readers safety and sanity during this unique period in our lives. Our team is working from home very productively and have identified projects, we hope to look back upon, as having improved our processes.

Quality, Safety and Reliability

You can't get enough training in fundamentals. The Compressed Air & Gas Institute has sent us an excellent article titled, "The Basics of Sizing a Centrifugal Air Compressor." Visit www.cagi.org for more training materials.

Finding and fixing compressed air leaks remains one of the "low hanging fruit" opportunities in most manufacturing plants. Computers and technology may help us with this chronic issue. SONOTEC has sent us an article on the topic titled, "Leak Detection Technology Transitions Toward Maintenance 4.0."

Productivity, Sustainability & Energy Conservation

Saint Gobain North America allowed our own Mike Grennier to learn more about how they challenge team members to find energy conservation opportunities – and have fun doing it! I know you'll enjoy this article.

Bay Controls has been optimizing "big air" systems for a long time. This month they have sent us a perfect example of what they do in an article titled, "Tier 1 Automotive Supplier Saves Energy Upgrading Centrifugal Air Compressor Controls."

Ron Marshall shares an audit story with us, about a Canadian paper products company. It's a perfect example of how system assessments find benefits beyond energy savings. The three main energy efficiency measures found would reduce compressed air costs by 33% – saving $79,000 in electrical costs and $60,000 in maintenance costs.

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

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INDUSTRY NEWS

Hitachi Announces Establishment of Hitachi Industrial Holdings Americas, Inc.

Hitachi, Ltd. announced that it established Hitachi Industrial Holdings Americas, Inc, to strengthen its industry business in North America. With two U.S. headquartered companies, Sullair, LLC, which engages in the air compressor business, and JR Technologies Group, LLC mainly operated by JR Automation Technologies, LLC , which conducts the robotic SI business placed under its umbrella, Hitachi Industrial Holdings Americas will operate under Hitachi's Industry sector and undertake integrated business operations in North America.

Through such operations, Hitachi will promptly respond to the dynamic market changes and the diversification in demand that are taking place in the industry and distribution areas in North America, while establishing a business base in collaboration with Hitachi group companies in North America to provide total seamless solutions in which total optimization is achieved through digital technology-based connection between workplaces and management. By doing so, it will contribute to not only improving its customers' management but enhancing the value of their businesses overall.

As set in the 2021 Mid-term Management Plan, Hitachi aims to transform from a global enterprise into a global leader by accelerating the Social Innovation Business that offers innovative solutions to issues faced by society and customers through digital technologies. Hitachi's Industry sector, which is one of the five growth business domains and a priority investment area, seeks to globally promote total seamless solutions to the issue of "boundaries," which exists between workplaces and management or in a supply chain, through digital technologies, and will create new business values according to its basic policy established in the 2021 Mid-term Management Plan.

In order to enter North America, a market in which high growth is expected in the manufacturing and distribution areas and progress is being made in the adoption of advanced technologies, Hitachi is in the process of accelerating business development through a range of initiatives, such as the acquisition of Sullair in July 2017, which was followed by the acquisition in December 2019 of JR Automation that engages in the robotic SI business, a business that not only responds to growing demand for automation, but gathers a large amount of data, which is critical on the manufacturing workplaces from an IoT perspective.

Hitachi Industrial Holdings Americas has been established under such background. With its operations based in Chicago, the center of the Midwest where many US-based manufacturers are concentrated, the company will draft strategies and play the role of a control tower not only for Sullair and JR Automation, but also for the overall industry business in North America, including the industrial product businesses, which handles products such as marking and drive systems. Furthermore, with cooperation with Hitachi Vantara LLC which provides Lumada Solutions, Hitachi will expand the digital solution business for the industry and distribution areas. Under this scheme, Hitachi seeks to provide total seamless solutions combining digital solution and products through mutual use of the robust customer bases and the abundant resources of Sullair and JR Automaton in North America. It aims to increase the total global revenues of its North American group companies in the Industry sector from approximately 73.0 billion yen in fiscal 2018, to 200 billion yen in fiscal 2021.

Masakazu Aoki, Executive Vice President and Executive Officer, Hitachi, Ltd said, "With the foundation of Hitachi Industrial Holdings Americas, following the acquisition of Sullair and JR Automation, I am confident that we have built a base to develop the industry business in North America. Going forward, by combining its products, operational technology, information technology and cutting-edge digital technologies, Hitachi will realize the creation of "leading-edge industry" for customers in North America, in which analysis of the cyber world and the results thereof are instantly reflected in real workplaces. We will aim to contribute to raising social, environmental and economic values."

About Hitachi, Ltd.

Hitachi, Ltd., headquartered in Tokyo, Japan, is focusing on Social Innovation Business combining its operational technology, information technology and products. The company's consolidated revenues for fiscal 2018 (ended March 31, 2019) totaled 9,480.6 billion yen ($85.4 billion), and the company has approximately 296,000 employees worldwide. Hitachi delivers digital solutions utilizing Lumada in five sectors including Mobility, Smart Life, Industry, Energy and IT, to increase our customer's social, environmental and economic value. For more information on Hitachi, please visit the company's website at www.hitachi.com.

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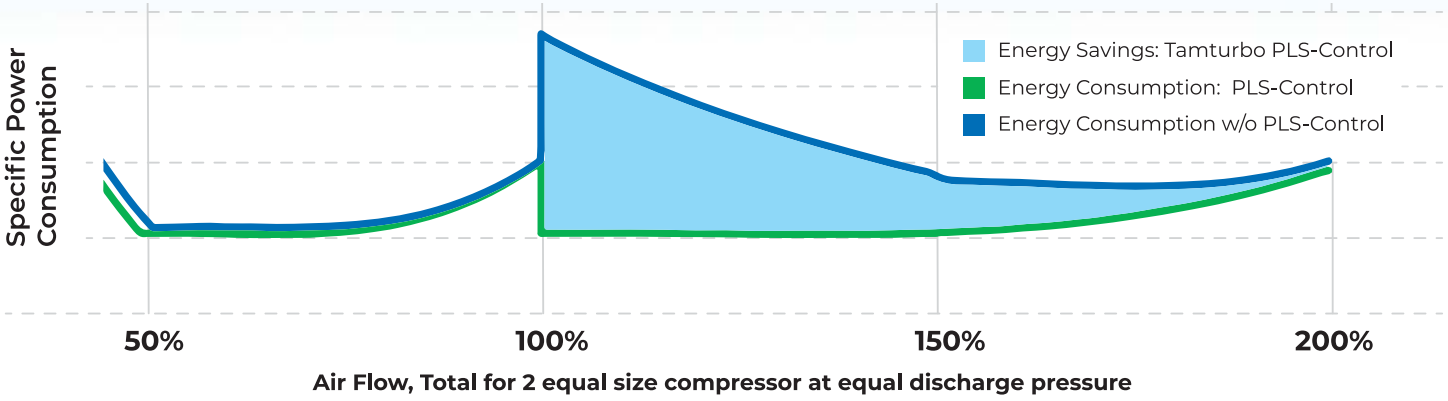

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INDUSTRY NEWS

Atlas Copco USA Supports Can'd Aid in Its COVID-19 Relief Efforts

Atlas Copco USA's employee-driven Water for All program has again teamed up with charitable organization Can'd Aid to support the distribution of fresh drinking water to the most in-need Americans. This time, the project supported Food Bank of the Rockies in its mission to make food security a reality for every Colorado family.

This is the fourth time that Atlas Copco has partnered with Can'd Aid to provide clean drinking water to an area with an immediate need for it. The essential drinking water was produced by Oskar Blues Brewery, which adapted its standard beer-production process to produce cans of fresh drinking water – a truly remarkable and community-spirited effort. Oskar Blues has done this several times at a number of its regional locations to help those in need, usually in response to large hurricanes or other natural disasters.

"As communities struggle to handle aspects of the novel coronavirus, it's humbling to be one of several partners coming together to provide needed water to the overlooked," said Diana Ralston, Executive Director of Can'd Aid. "We could not facilitate water donations to those in need during this crisis without the continued support and financial backing from Atlas Copco."

The sanitized water cans support everyone from local families and institutions to first responders. Since the COVID-19 outbreak, many more people have been forced to rely on emergency food networks like Food Bank of the Rockies for the first time. As a result, the need for the nonprofit's essential services has increased significantly.

2020 marks the 10-year anniversary of the Water for All organization in the U.S. The program originally started in Sweden in 1984. Through the dedicated and passionate work of volunteering employees at Atlas Copco, Water for All funds projects all around the world, providing access to clean drinking water, sanitation and hygiene. For every dollar an employee donates, the company adds another two dollars, making a double match.

Atlas Copco has partnered with Can'd Aid to provide clean drinking water to those in need.

Many projects are supported to bring access to clean drinking water to parts of the world where people and communities have never been afforded that luxury. The committee also provides funding to support water-focused programs during times of local and regional crises – such as the COVID-19 outbreak.

Over the last decade, Atlas Copco USA's Water for All program has donated over $1.8 million across 17 countries and helped thousands of people gain access to clean drinking water. This includes a $50,000 donation to Guatemala for World Water Day in March.

"None of this would be possible without the dedication and focus of our U.S.-based employees who support and fund the program," said Paul Humphreys, VP of Communications for Atlas Copco North America. "To know that we have made a difference to people on the national, regional and global levels is truly humbling, and our ability to support projects quickly in times of crisis is something that underpins the program."

To learn more about Atlas Copco and its Water for All program, please visit www.water4All.org.

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.

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INDUSTRY NEWS

Endress+Hauser Receives Top Rating for Sustainability

Since 2013 Endress+Hauser has been evaluated annually by EcoVadis with regards to sustainability, since 2016 the Group has regularly achieved Gold Recognition Level ratings. The company again scored well or very well in the areas examined, namely environmental protection, fair business practices, sustainable procurement, working conditions and human rights. This makes Endress+Hauser one of the best rated companies in the comparison group.

"The challenges of the future demand that we and our customers manage our businesses sustainably," said Matthias Altendorf, CEO of the Endress+Hauser Group. "We help our customers to increase their resource efficiency, reduce CO_2 emissions, avoid waste and improve the circular economy through outstanding measurement technology and automation solutions."

The company also makes its own contribution to keeping its ecological footprint as small as possible. For example, Endress+Hauser increasingly supplies buildings and infrastructure with sustainably generated energy or reduces travel, for example through virtual meetings. The EcoVadis report also highlights progress at management level, especially in dealing with issues such as environmental protection, working conditions and human rights and fair business practices.

EcoVadis uses 21 environmental, social, and ethical criteria to evaluate companies worldwide in terms of their sustainability. In addition to an industry comparison, companies also receive suggestions for improvement. They can also use an internet platform to assess their own suppliers accordingly. According to EcoVadis, this network now encompasses 60,000 companies worldwide.

About Endress+Hauser Group

Endress+Hauser is a global leader in measurement and automation technology for process and laboratory applications. The family company, headquartered in Reinach, Switzerland, achieved net sales of over 2.6 billion euros in 2019 with a total workforce of 14,000.

Endress+Hauser 'wind tree' for generating renewable energy.

Their devices, solutions and services are at home in many industries. Customers thus use them to gain valuable knowledge from their applications. This enables them to improve their products, work economically and at the same time protect people and the environment.

Endress+Hauser is a reliable partner worldwide. Its own sales companies in 50 countries as well as representatives in another 70 countries ensure competent support. Production facilities on five continents manufacture quickly and flexibly to the highest quality standards. They were founded in 1953 by Georg H Endress and Ludwig Hauser. Ever since, the company has been pushing ahead with the development and use of innovative technologies, now helping to shape the industry's digital transformation. 8,000 patents and applications protect the Group's intellectual property. For further information, please visit www.endress.com.

INDUSTRY NEWS

Festo Assigns Teams to Respiratory Ventilator Development

Festo North America and subsidiary Fabco-Air Inc., classified essential businesses, are continuing to supply pneumatic and electric drive technology to distributors, equipment manufacturers, and end users in North America.

"Festo has launched focused coronavirus mitigation projects," said Craig Correia, Director of Life Science & Process Industries, Festo North America. "Among several initiatives, the first is to ensure that orders for components and systems used in medical devices receive priority treatment and are processed and shipped rapidly."

"A large research and development team is working full time on a design for a quick-to-manufacture emergency respiratory ventilator. Another team alongside a partner firm is developing a concept for automated production of protective masks. This team envisions a complete production system that can be setup and shipped within a standard transport container."

Festo LifeTech Business Unit components are used in high-speed automated laboratory devices that are essential for the types of screening envisioned for sample analysis during the pandemic. Festo LifeTech components are also used by certified respiratory equipment manufacturers. Festo does not manufacture that equipment itself.

In addition to the medical and manufacturing sectors, Festo is keeping its overall production and logistics systems sound for the pharmaceutical, food and beverage, and packaging industries as well as for washing systems for hospitals and care facilities.

Festo encourages the use of the company's online resources, including the 24/7 online shop, for placing orders and checking delivery status, and online product configuration and engineering tools. The company continues to take measures to ensure continuity of production, while protecting the health and safety of employees, suppliers, and the public.

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.us.

High-speed automated laboratory devices are essential for the types of screening envisioned for sample analysis during the pandemic.

Compressed Air Systems Acquires New Facility

Compressed Air Systems finalized the purchase of an additional 83,000 square feet of manufacturing space in Mansfield, Texas. They look forward to the addition of the space bringing US manufacturing space up to 140,000 square feet and 10 acres of land raw land. The new facility will allow Compressed Air Systems to increase production capacity over 5 times the current capacity. They will be moving their main office to the new facility in Mansfield, Texas.

Compressed Air Systems New Facility in Mansfield, Texas.

About Compressed Air Systems

Compressed Air Systems was founded in 1980 originally as BS Trading Company. It has grown from our current CEO's garage to multiple facilities in the US and over 70 full time staff. In the last 10 years, they have manufactured over 40,000 industrial air compressors from 5-125 hp. For more information, visit www.compressed-air-systems.com.

PRODUCTIVITY, SUSTAINABILITY & ENERGY CONSERVATION

SAINT-GOBAIN MAKES SOLVING Sustainability Competitive and Fun

By Mike Grennier, Compressed Air Best Practices® Magazine

By engaging employees in a fun competition, Saint-Gobain North America identified potential compressed air energy savings of 26 Gigawatt-hours (GWh) of electricity and $2.5 million. Shown is the company's campus in Malvern, Pennsylvania.

Getting employees engaged with compressed air energy savings is a familiar challenge, especially for companies with numerous operations. Yet Saint-Gobain North America has solved the riddle by making it both competitive and fun.

Challenging teams of employees to generate energy savings while having a good time in the process is the idea behind Saint-Gobain's "Compress It," which is the name given to the company's competition and ongoing effort to reduce compressed air energy and costs. The initiative, which Saint-Gobain rolled out to manufacturing plants throughout North America in 2018, has been met with success. Compress It identified potential energy savings amounting to 26 Gigawatt-hours (GWh) of electricity and $2.5 million. And there's more to come.

"We've had a lot of success with the program," said Blair Sturm, Process Sustainability and Energy Manager at Saint-Gobain (https://www.saint-gobain-northamerica.com/). "In fact, we're snowballing our success into another competition that will not only include compressed air but go beyond it to capture other areas for energy-savings, as well as water and waste opportunities. Sustainability requires an ongoing focus."

Saint-Gobain, which was originally a mirror manufacturer, also produces a variety of high-performance materials and construction products found in a wide range of industries worldwide.

Manufacturing with Minimal Environmental Impact

Saint-Gobain is one of the world's largest building materials companies and manufacturer of innovative material solutions. It operates roughly 130 manufacturing plants throughout the United States and Canada. The company, whose North American headquarters are located in Malvern, Pennsylvania, is part of Saint-Gobain, a maker of materials and construction products found in buildings, transportation, and infrastructure applications, as well as a wide range of industries. Based near Paris, France, Saint-Gobain employs more than 180,000 with operations in 68 countries.

Saint-Gobain is also a Department of Energy (DOE) Better Plants Challenge Partner. In 2019, it received a Better Practice Award from the DOE for its Compress It challenge.

Saint-Gobain's goal is to enhance people's comfort and well-being while contributing to a robust economy with as little environmental impact as possible. The company has committed to reducing company-wide energy consumption by 15% by 2025 with a reduction in CO_2 emissions by 20% during the same period compared with its 2010 baseline. Additionally, it aims to reduce the carbon footprint of its production to net zero carbon by 2050.

Finding ways to reduce energy consumption at manufacturing operations and achieving sustainability goals is of the utmost importance, said Sturm.

"Since we manufacture materials used in places where people live and work, we want to ensure we not only add to the comfort and well-being of people but do so in a sustainable manner. That includes being responsible in terms of how efficiently we make our products. Using less energy, less water and creating less waste offers a lot of unique challenges and opportunities," he said.

Survey Points to Compressed Air Energy Savings

To identify opportunities for continued progress in sustainability throughout its operations worldwide, Saint-Gobain developed and disseminated an internal survey in 2017. Among the top areas with the most promise for energy savings: Compressed air.

The survey pointed out that 91% of the company's operations operate compressed air systems, which are used for virtually every aspect of production. However, 48% of the sites lacked air leak tracking systems. Additionally, 37% of the operations requested a compressed air audit. The survey also showed that 40% of the compressed air systems were nearing their end of life.

"In many of our plants, compressed air is one of the bigger pieces of the facility's energy footprint, but it can be a big source of energy waste," Sturm said, adding that it didn't take long for the Saint-Gobain energy management team to zero in on a program to find and fixed compressed air leaks. "There are always going to be compressed air leaks and there are always going to be uses of compressed air that aren't the most efficient, so we needed to introduce a program to engage employees and ensure a continuous focus to identify and address these challenges."

The need for focus, in turn, drove the need to do something creative, he said.

SAINT-GOBAIN MAKES SOLVING SUSTAINABILITY COMPETITIVE AND FUN

"You can send a document out to employees that describes compressed air best practices, but we wanted to do something more engaging. By providing people with best practices in a fun, competitive way, we knew we'd be able to gain more traction and achieve greater results," Sturm said.

Compress It Competition Kicks Off

Before long, the Saint-Gobain sustainability and energy management team developed the idea of the Compress It compressed air challenge.

The three-month, voluntary competition was introduced to North American operations in 2018 to see which operation could identify and fix the most leaks – and make the most improvements in the operation and management of their compressed air system.

To further facilitate engagement in both the challenge and Saint-Gobain's ongoing sustainability efforts, participants in the competition were encouraged to leverage the company's Sustainability Network. Developed by Saint-Gobain's corporate team years before the competition, the Sustainability Network is the company's premier initiative dedicated to sustainability networking. Hosted on an internal web portal, the Sustainability Network offers a wide range of helpful information and a host of resources and tools associated with sustainability best practices, including opportunities to participate in sub-groups, join webinars, attend annual summits and more. It also serves as a place where operations can exchange ideas for improvements in sustainability.

In all, 19 facilities signed up for the competition. Participating sites formed teams of approximately five employees per team. The efforts of each team, which often included team members with diverse job responsibilities, were judged on key criteria within various categories of the competition. Points were then awarded for each category. The winner would be chosen based on the amount of air leaks identified and fixed, and the energy savings realized. Categories and points included:

- Team name and photo – worth five points.
- Completion of a compressed air audit during the past two years – worth 20 points.

- Formation of a compressed air team and/or a leak detection and repair program – worth 30 points.
- Use of a compressed air monitoring system – worth 10 points.
- Use of compressed air resources available through the Sustainability Network – worth 20 points.
- Finding and fixing leaks – worth 10 points per leak.

Teams were also awarded bonus points for innovative efforts to engage employees, whether it involved friendly competitive videos, t-shirts, unique presentations, or other creative ideas. Prizes were awarded bi-weekly based on mini-competitions to encourage participation throughout the duration of the program. Prizes included sustainability-related items such as solar-powered backpacks, voice-activated speakers, smart plugs, smart lights, and power banks. Teams were also awarded with mugs and tumblers.

Saint-Gobain leveraged the Sustainability Network to promote the competition and track the progress of each team's progress. It also sent out a monthly newsletter to promote the success of the program and further encourage competition.

No Shortage of Enthusiasm and Creativity

Knowing points would be awarded for innovation, the teams involved in the competition let their creative juices flow.

Among the unique names of Compress It challengers was "Weeki Leaks" for the team in Oxford, North Carolina. Another was "Full of Hot Air" for the Ennis, Texas team, and "The Avery Avengers" for the team in Avery, Ohio, to name just a few.

Some manufacturing sites even introduced their own internal competitions. As an example, team "Leak Stoppers" from Jackson, Michigan held a competition by letting employees know the plant would award them certificates to have their vehicles serviced at local automobile repair shops. The team supported the competition with the slogan, "Help us fix our leaks, and we'll help you fix yours."

Other sites decided to have fun in other ways. As an example, the "Full of Hot Air" team developed an "epic and suspenseful" video that depicted compressed air loss as a "villain" to illustrate the need to better manage compressed air.

Sturm said the competition clearly caught on with employees, in turn, demonstrating the value of a unique approach to encourage employee engagement.

"We're a huge business," he said. "That requires results driven not only by the direction of leadership, but also teams of people from across the country who decide to engage in what we're trying to accomplish. It requires people to say, 'Oh, I get it. This is a valuable way to make our processes more sustainable and efficient, and to save money and improve the business.'"

SAINT-GOBAIN MAKES SOLVING SUSTAINABILITY COMPETITIVE AND FUN

The vast majority of Saint-Gobain's operations use compressed air systems for production, presenting the company with significant opportunities for energy savings.

Driving Change in Compressed Air Management

When the results of the Compress It competition were tallied, there was little question as to the program's success.

Of the 19 manufacturing plants that participated in the program, 13 sites finished the competition with more than 100 points each – with two teams scoring more than 1,000 points. Team Weeki Leaks was named winner of the competition based on the identification of 146 leaks and work to fix 86% of them. Team Leak Stoppers came in a close second based on the identification of 100 leaks and efforts to fix 96% percent of them.

The competition also generated other significant results, including:

- Three operations that scheduled compressed air system audits.
- Four sites that formed compressed air teams and continuous air leak tracking systems.
- Six sites that used the Sustainability Network resources and became familiar with the tools and resources it offers.
- A total of 24 operations attended a webinar through the network to learn about the competition and compressed air best practices.

In addition, participants in the competition established leak management best practices other Saint-Gobain manufacturing facilities can apply as they set out to upgrade their aging compressed air systems.

By the end of the competition, the participants identified 824 compressed air leaks and fixed 47% of them. The total number of fixed leaks represent a potential savings of 26 GWh of electricity, which represents $2.5 million in electricity costs and 5% of the total annual energy spend for the participating plants. Five of the top performing sites decreased their energy intensity by 0.2% compared with the company's 2010 baseline.

"This ended up as a great way of getting people engaged in compressed air management, as well as turning energy-savings opportunities into action," Sturm said.

Moving the Needle in a Positive Direction

While the numbers demonstrate the success of the Compress It compressed air challenge, Sturm said the program also serves as a platform for ongoing efforts for compressed air management and other initiatives aimed at reaching the company's aggressive sustainability goals.

"The competition is one piece of how we're driving toward those targets," he said. "Fun initiatives like this drive engagement and find opportunities for sustainability, even if they're small ones. Of course, our efforts also require significant investments to reach our goals. It's about all of these things combined and doing what we can to move the needle. There's always more work to be done." BP

All photos courtesy of Saint-Gobain North America.

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QUALITY, SAFETY & RELIABILITY

THE BASICS OF SIZING A Centrifugal Air Compressor

By the Compressed Air & Gas Institute

Properly sizing a compressed air system can help determine if your facility has enough air to adequately supply your production equipment. Designing a cost effective system that minimizes any interruptions to productivity requires thoughtful planning and design. Typically, the desired outcomes of such a system focus on stable pressure and efficient operation, though it is important to note that each of these elements requires a unique solution.

Beyond those criteria, choosing the right equipment and how the air will be used are important considerations in determining the *size* of the air system.

For example, when an air compressor is too large for a given application, it operates at a reduced load, consuming more energy than necessary. Alternatively, air compressors that are too small for a given application are incapable of delivering the proper air supply to fulfill your needs. This can impact production time and require the purchase of another air compressor to meet demand.

When designing a system, consideration should be given to minimum, normal and maximum air demand – because your demand will likely change over time. For the highest efficiency, normal demand should be approximately 65 to 100 percent of peak output. If you know the air demand will increase dramatically, then you need to determine if the air compressor can be uprated to meet the increased demand.

As a rule of thumb, the larger the air compressor, the more efficient it is. Therefore, two units, each sized for 50% of total demand, may be less efficient than one larger air compressor running at the full load rating. If air demand is likely to be less than 50% capacity for extended periods of time then one of the smaller air compressors would likely be shut down for long periods of time, making this combination more efficient.

> "As a rule of thumb, the larger the air compressor, the more efficient it is."
>
> — The Compressed Air & Gas Institute

This article will provide guidance in proper selection considerations and suggest when a centrifugal air compressor may be ideal for your needs.

Centrifugal Technology Defined

Let us first start with the definition of centrifugal technology.

A centrifugal air compressor is a member of the dynamic-type compression technology. In dynamic compression, air is drawn between the blades on a rapid rotating compression impeller and accelerates to high velocity. The air is then discharged through a diffuser, where the velocity is transformed into static pressure.

Before selecting the right technology, the first consideration is to determine if the process needs oil-free air since many applications require that the air be entirely oil-free.

Specifying Air Compressor Performance Requirements

The end user should specify the flow requirement – either mass flow rate or volumetric flow rate – scfm or acfm-Free Air Delivered (FAD).

There are several methods to rate the capacity/flow of an air compressor:

- Inlet cubic feet per minute (icfm) – At the intake which is referred to as the inlet volume flow or intake volume.
- acfm/cfm-FAD – Free air delivery as measured at the delivery point, after the after-cooler and is referred to the ambient conditions of the air compressor, but unaffected by it.
- scfm, or Nm^3/HR – Standard or normal flow, measured at the delivery point and referred to as STP (Standard Temperature and Pressure) or NTP (Normal Temperature and Pressure) conditions.

While specifying the flow, it is also important to specify both the design inlet conditions and the reference/standard conditions for scfm and Nm^3/hr. There are various reference/standard conditions as shown on the following page.

THE BASICS OF SIZING A CENTRIFUGAL AIR COMPRESSOR

Reference conditions for scfm:

- 14.7 psi, 60 °F, 0% (Relative Humidity) RH
- 14.7 psi, 68 °F, 0% RH
- 14.7 psi, 70 °F, 0% RH

Reference conditions for Nm³/hr:

- 1.01325 bara, 0 °C, 0% RH
- 1.01325 bara, 15 °C, 0% RH
- 1.01325 bara, 20 °C, 0% RH

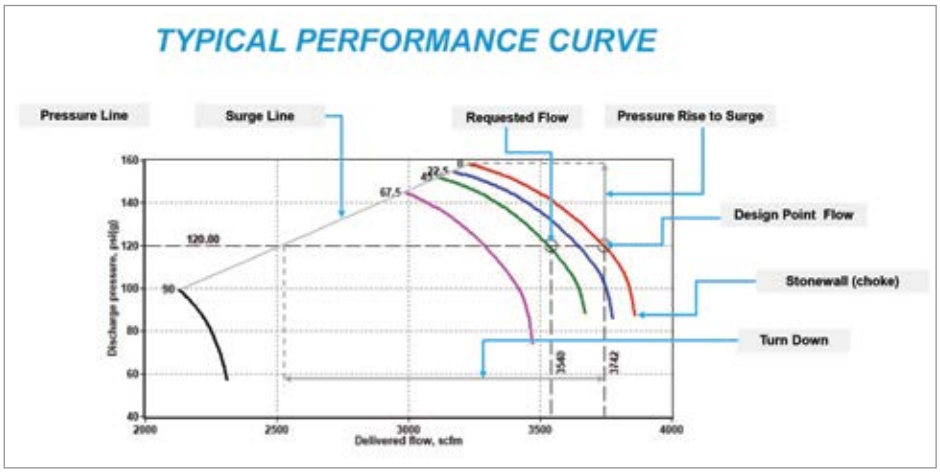

Figure 1. (Image courtesy of the Compressed Air and Gas Institute.)

Reference conditions will affect the flow, so it is noted as a best practice to specify the reference condition with your compressed air partner.

The four variables that influence the performance of centrifugal air compressors are:

- Inlet temperature
- Inlet pressure
- Relative humidity
- Cooling media temperature

It is necessary to specify the maximum/minimum and average site conditions in order to gauge performance. With dynamic compression technology, the performance will change based on inlet conditions, as will the turndown or throttle range.

Discharge pressure can be specified in psig/psia or other metric units, such as bar or kg/cm². With respect to the discharge pressure of the air compressor outlet, a user needs to

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 Air Compressor Section of CAGI consists of the following member companies:

- Atlas Copco Compressors
- FS-Elliott
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- Ingersoll Rand
- Sullair Corporation

also consider that the pressure will drop in any downstream components such as a dryer, receiver tank, piping, filters that may be installed after the air compressor.

Once the flow and pressure parameters are confirmed, you need to look at the flow demand/load as this will help to size the right air compressor and avoid unload or blow off operation in order to make the air compressor run more efficiently.

Centrifugal Air Compressor Performance Curve Terminology

Figure 1 shows a typical performance curve at given inlet conditions, showing flow on the X axis and pressure on the Y axis. Each color curve shown above is the performance of the centrifugal air compressor at a certain inlet valve or guide vane position. For example, the red curve is at full open inlet valve (IGV) and the blue and other color curves shows performance at different position of the IGV.

- *Design point* is the point at which the air compressor delivers maximum flow of the chosen air compressor at chosen design conditions.
- Operating pressure and *requested flow* is the flow requirement specified by the end user.
- *Choke* notes where the system pressure continues to decrease, air delivery from the air compressor increases, and at that point no further increase in flow is possible.
- When air system pressure increases, the air compressor supplies less air until the throttle *surge* point is reached. At this point, the air compressor is unable to maintain a steady flow of air into the system. When this point is reached, backflow from the system through the air compressor occurs until a momentary equilibrium is established between the air compressor and the system. This backflow is referred to as surge and the line joining all the maximum pressure points of performance curves is called surge line.
- *Turndown* is defined as the relative difference between the maximum flow (at the design point) and minimum flow before blow-off (on the surge line) or difference between the requested flow and minimum flow before blow-off.
- The pressure rise to *surge* is the difference between design pressure and maximum pressure of the air compressor before going to surge.

Conclusion

When sizing an air compressor, a user should select an air compressor with a minimum turndown of at least 20% and pressure rise of a minimum of 10% to avoid blow-off and guarantee an optimal energy efficient operation of the unit.

After all the inlet design data is available, a compressed air partner can help size the most optimum compressed air system to meet your flow and pressure requirements. BP

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

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PRODUCTIVITY, SUSTAINABILITY & ENERGY CONSERVATION

TIER 1 AUTOMOTIVE SUPPLIER SAVES ENERGY
Upgrading Centrifugal Air Compressor Controls

By Stephen Parry, Bay Controls

The Tier 1 automotive supplier's compressed air system features three centrifugal air compressors.

A Tier 1 automotive supplier was concerned its compressed air system was not operating as efficiently as it could be. The situation called for a site visit and metering and evaluation of the company's air compressors to generate a representative data sample that accurately captured the compressed air needs during typical production and non-production periods. Using the data collected, Bay Controls recommended a control system upgrade that would enable the automotive supplier to significantly reduce its energy costs by providing improved pressure control and automatically shutting air compressors off during periods of low demand. Based on the company's production profile and electricity costs, the assessment showed the upgrade would generate annual savings of approximately $61,000. When combined with incentive payments from the local electric utility, the project would achieve a simple payback of 12 months.

> "Based on the company's production profile and electricity costs, the assessment showed the upgrade would generate annual savings of approximately $61,000."
>
> — Stephen Parry, Bay Controls

Air Compressor Assessment Moves Forward

After an initial discussion the Bay Controls team arranged to visit the supplier's facility to conduct an initial site survey. Doing so provided an opportunity to learn about the automotive supplier's production process and compressed air needs and also verify the equipment in use, which included one 550 horsepower (hp) three-stage centrifugal air compressor; one 350 hp three-stage centrifugal air compressor and one 300 hp three-stage centrifugal air compressor.

Discussions with the facilities manager and plant operators determined the company's production schedule consisted of three weekday shifts and two weekend shifts. While plant operators believed all three air compressors ran almost fully loaded during most weekday production shifts, there was a question about how often the air compressors ran during the weekend shifts.

To fully understand the plant's needs and generate accurate data for compressed air demand and compressor performance and potential savings opportunities, Bay Controls proposed a metered site assessment as a next step. It subsequently installed a short-term metering solution comprised of the following:

- Three current transformers to measure the motor power of each air compressor.
- Three pressure transmitters to measure the discharge pressure at each air compressor.
- One pressure transmitter to measure the compressed air system pressure downstream of the air compressors.
- Three Bay Controls Bay System Integrators to receive and convert the analog

The Bay Controls Bay View Gateway is a data storage device used to collect and store air compressor data for analysis.

TIER 1 AUTOMOTIVE SUPPLIER SAVES ENERGY UPGRADING CENTRIFUGAL AIR COMPRESSOR CONTROLS

TABLE 1. WEEKLY COMPRESSED AIR SYSTEM KPIS

	WEEKDAY SHIFTS			WEEKEND SHIFTS	
	1ST	2ND	3RD	SATURDAY	SUNDAY
Hours/week	40	40	32	32	24
Operating Energy (kWh)	660	660	660	425	375
Operating Pressure (psi)	105.0	106.5	106.5	106.0	108.0
Air Venting (blow-off) (% of loaded hours)	0.0%	0.0%	0.0%	5.0%	15.0%
Unloaded Energy (kWh)	154	154	154	154	154
Unloaded hours/week	0	0	0	24	24

TABLE 2. WEEKLY COMPRESSED AIR SYSTEM ENERGY USAGE

	WEEKDAY SHIFTS			WEEKEND SHIFTS	
	1ST	2ND	3RD	SATURDAY	SUNDAY
Total Energy (kWh)	26,400	26,400	21,120	13,600	9,000
Online Energy (kW)	26,400	26,400	21,120	9,904	5,304
Unloaded Energy (kWh)	0	0	0	3,696	3,696
Energy Lost During Air Venting/ Blow-off (kWh)	0	0	0	495	796

outputs of the current transformers and pressure transmitters to digital data. Bay System Integrators are proprietary I/O modules with a variety of analog (4-20 mA), RTD, and digital inputs for use with all types of air compressor instrumentation.

- One Bay Controls Bay View Gateway storage device to store data obtained from the system integrators, making it available for later analysis.

The hardware enabled the team to capture Key Performance Indicators (KPIs) during a two-week period, including air compressor motor power (kW), air compressor energy consumption (kWh), compressed air system pressure (psi), and air compressor "blow-off" (% of loaded hours).

After two weeks, the team removed the metering equipment and uploaded the data captured by the storage device to a Bay Controls cloud-based compressor monitoring and analytics platform for analysis. Using KPIs captured, the platform calculated the company's compressed air needs and energy usage as shown in Tables 1 and 2.

As the data shows, the company was fully utilizing its air compressors during the weekday shifts but was running them unloaded for long periods of time during the weekend shifts and the air compressors were venting air (blowing off) during the weekend shifts. In addition, the plant air pressure was actually higher during the Sunday shift than the weekday shifts (108 psi versus 105-106.5 psi).

Energy Reduction Opportunities Identified

Using the data captured, Bay Controls built an accurate model of the company's compressed

air usage and needs and shared it with the facilities manager. Until this discussion, the facilities manager had never seen his compressed air system data measured and modeled for the weekday and weekend shifts.

When the manager saw the discrepancies in loaded and unloaded operation between the weekday and weekend shifts, he immediately noted that although the system was operating at 106 and 108 psi on the weekends, the plant only needed 82 psi on the weekends. He also said the plant only needed 102 psi during the week (instead of 105-106.5 psi), but the air compressors could not consistently maintain that pressure without being set to a higher set point (105-106.5 psi).

Subsequently, Bay Controls used the data and the facilities manager's feedback to identify

TABLE 3. PRESSURE REDUCTION SAVINGS (WEEKLY)

	WEEKDAY SHIFTS			WEEKEND SHIFTS	
	1ST	2ND	3RD	SATURDAY	SUNDAY
Current Pressure (psi)	105.0	106.5	106.5	106.0	108.0
Proposed Pressure (psi)	102.0	102.0	102.0	82.0	82.0
Savings (kWh)	830	1,227	982	2,467	1,405

TABLE 4. UNLOADED OPERATING HOURS REDUCTION SAVINGS

	WEEKDAY SHIFTS			WEEKEND SHIFTS	
	1ST	2ND	3RD	SATURDAY	SUNDAY
Unloaded Operating Hours Reduction	NA	NA	NA	70%	90%
Savings (kWh)	0	0	0	2,587	3,326

TABLE 5. AIR VENTING (BLOW-OFF) REDUCTION SAVINGS

	WEEKDAY SHIFTS			WEEKEND SHIFTS	
	1ST	2ND	3RD	SATURDAY	SUNDAY
Air Venting (Blow-off) Reduction	NA	NA	NA	70%	90%
Savings (kWh)	0	0	0	396	716

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"We're not just picking low-hanging fruit, we're walking on the fruit because compressed air represents such a major opportunity for energy reduction."

— Darren Borden, P.E., CEM, Energy Management Engineer, Corporate Health, Safety and Environment, Weston Foods

"We are committed to the protection of the environment and the conservation of natural resources, as well as quality. We knew a better way to approach compressed air would be one of the best ways to meet our goals."

— Carroll Bruckner, Maintenance Engineer, SumiRiko Tennessee

"Demand Side" and "Supply Side" information on compressed air technologies and system assessments is delivered to readers to help them save energy. For this reason, we feature Best Practice articles on when/how to correctly apply **air compressor, air treatment, piping, storage, measurement and pneumatic control technology.**

Industrial energy managers, utility incentive program managers, and technology/system assessment providers are the three stakeholders in creating energy efficiency projects. Representatives of these readership groups guide our editorial content.

"Implementation of the compressed air automation and data acquisition platform in combination with the upgrades to the system reduces the facility's annual energy consumption by 6,098,619 kWh per year, resulting in yearly savings of $600,000."

— Pascal van Putten, VPInstruments, and Tyler Costa, ALD, Inc. (feature article in June 2019 Issue).

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TIER 1 AUTOMOTIVE SUPPLIER SAVES ENERGY UPGRADING CENTRIFUGAL AIR COMPRESSOR CONTROLS

three ways in which the company could significantly reduce compressed air energy use:

- Network the air compressors to enable more precise pressure control.
- Reduce system operating pressure to match plant needs during different periods.
- Reduce unloaded air compressor operation during periods of little or no demand.

The savings estimated for pressure reduction, unloaded operation reduction, and air venting reduction are shown in Tables 3-5.

The total potential weekly, monthly, and annual savings by implementing all three strategies are shown in Table 6.

To achieve these savings, Bay Controls proposed the company upgrade its air compressor controls with the Bay Controls Bay Compressor Controller with scheduling capability. These upgrades would enable the following operational improvements:

- System pressure reductions during both weekday and weekend production through precision pressure control and air compressor networking.
- Reduced unloaded air compressor run time.
- Reduced air venting with improved throttling range.

TABLE 6. TOTAL SAVINGS POTENTIAL

	ENERGY (KWH)	ENERGY COST REDUCTION ($0.085/KWH)
Weekly Savings	13,935	$1,184.51
Monthly Savings	60,553	$5,146.98
Annual Savings	726,633	$61,763.79

Utility Incentive Reduces Payback by Nearly 50%

Given the project cost and estimated energy savings of $61,763 annually, Bay Controls estimated a simple payback of 23 months if the project were paid for up front in cash without any added incentives or rebates. However, the local electric utility was offering an incentive payment of $0.08 for every kWh in project saving. Using the project's estimated annual saving of 726,633 kWh, the utility incentive would work out to $58,130.64, allowing for a simple payback period of 12 months. BP

About the Author

Stephen Parry, International Sales Manager for Bay Controls, works with customers in the Western United States and internationally to implement projects built around the Bay Controls suite of products, including air compressor controls retrofits, monitoring solutions, and HVAC integration, email: Stephen.parry@baycontrols.com, tel: 419-891-4390.

About Bay Controls

For 35 years, Bay Controls has been providing control and monitoring solutions to a broad range of industrial, commercial, and government customers in the United States and 60-plus countries across the world. The Bay Controls suite of cloud-ready hardware, and a state-of-the-art, cloud-based analytics platform deliver the actionable intelligence companies need to make smart, data-driven decisions about compressed air system operations, energy savings, and maintenance. For more information, visit www.baycontrols.com.

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QUALITY, SAFETY & RELIABILITY

LEAK DETECTION TECHNOLOGY Transitions Toward Maintenance 4.0

By Brian Kavanagh and Christian Schreiber, SONOTEC

Guided leak detection software allows users to quantify the size of a compressed air leak based on acoustic data.

Leak detection has developed significantly over the years. Interest in it first began to blossom with growing awareness of the energy saving potential it offers for a compressed air system and for obvious reason: It has a direct impact on a company's bottom line and also reduces their carbon footprint at the same time.

In our view, awareness and interest in leak detection only continues to grow thanks to a number of factors. What we have seen over the last 20 years is a more sustainable way of thinking, established international energy efficiency standards, reliable leak detection technology, and best practices to implement leak detection.

The transformation we experience now is driven by the needs of a digital society with the growing expectation that offline activities can be supported, eased or done by smart tools and software. In this article, we will delve into how leak detection has begun the transformation from an established, but individual, process into a fully integrated procedure for Maintenance 4.0, which describes the application of machine learning, automated processes and interconnectivity to maintenance activities.

Integrated Leak Detection Aligns with Maintenance 4.0

In the past, leak detection had quite a disjointed process. While there were major technological improvements, such as moving from bubble-testing to ultrasonic leak detectors, the entire process required separate micro-processes using multiple tools, such as clipboards, cameras, and leak tags. The leak auditor would need to find a leak, record it in his notes, (maybe) take a picture, and then fill out a leak tag. After the entire searching process was completed, the auditor would then need to write up a complete report with every leak detailed. This led to a cumbersome and time-consuming process.

By having a process with disconnected micro-processes, it is in turn, less automated. By connecting each step of the leak detection process, we can create a more integrated solution that is in-line with the goals of Maintenance 4.0.

Today, manufacturers have created new and improved leak detection tools that incorporate both hardware and software to make the leak detection process more efficient and automated. These improvements can be placed in five categories:

- Technology Improvements
- Simplified Application
- Implementation of Data Collection Tools
- Implementation of Reporting Tools
- Implementation of Planning and Trending Tools

Technology Improvements

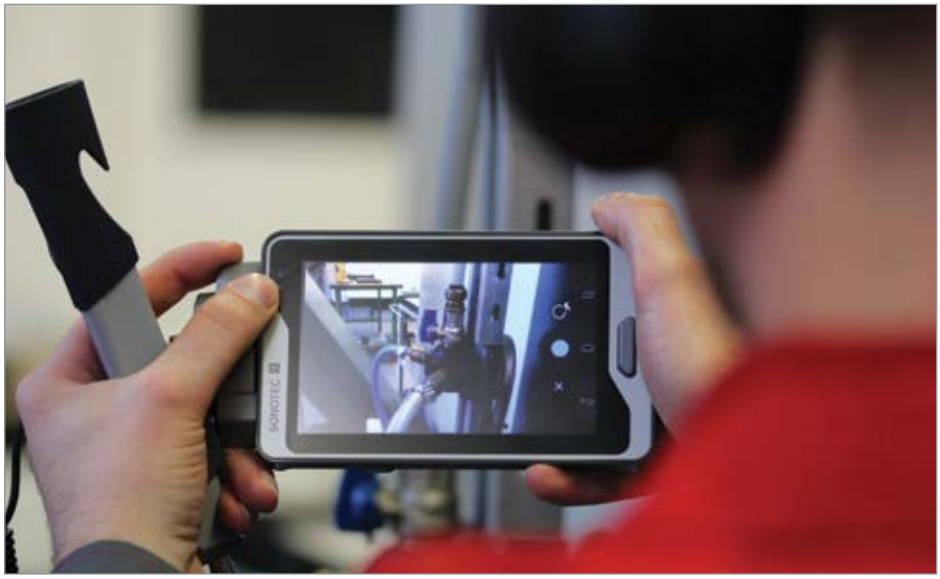
Recently, there have been major improvements in the sensors that ultrasound instruments use. Companies have moved from analog probes, using piezo ceramic capsules centered at 38 to 40 kHz, to digital broadband ultrasonic sensors that use, for example, a Micro-electromechanical System (MEMS) microphone array.

This improvement can be compared to having an audio speaker that outputs only bass versus a speaker that outputs the whole range of sound. While also being more sensitive in the higher and lower ultrasound frequencies, these new sensors allow for significantly more powerful digital data processing, and much more signal information, in the form of ultrasound, being captured by the sensor. This paves the way for new features, such as a better leak-rate estimation, being able to easily deal with extraneous ultrasound through viewing a large range of ultrasound simultaneously, and acoustic leak-detection cameras.

Simplified Application

New user guided leak detection software also helps to simplify the entire leak detection procedure. Software has been integrated into handheld leak detection tools to help walk the user through the leak detection processes. It prompts the user at each step of the process to input important pieces of information, such as taking a photo, typing in location information, adding text notes and what the pressure in the compressed air line is, and so forth.

This advancement leads to less training needed to operate the device and find leaks, as well as minimizing the number of mistakes that could be made by the operator. One example of a common mistake is the over or



Data collection tools, such as cameras, are often integrated into ultrasonic leak detectors.

LEAK DETECTION TECHNOLOGY TRANSITIONS TOWARD MAINTENANCE 4.0

underestimation of the size of a leak. Some newer leak detection software now contains algorithms that automatically estimate the size of a leak based on the pressure in the compressed gas pipe and the acoustic characteristics.

Where an experienced leak tester may be able to provide an estimate of the size of a leak based off known variables, newer software eliminates the need for guessing and prior knowledge to develop this estimate.

Implementation of Data Collection Tools

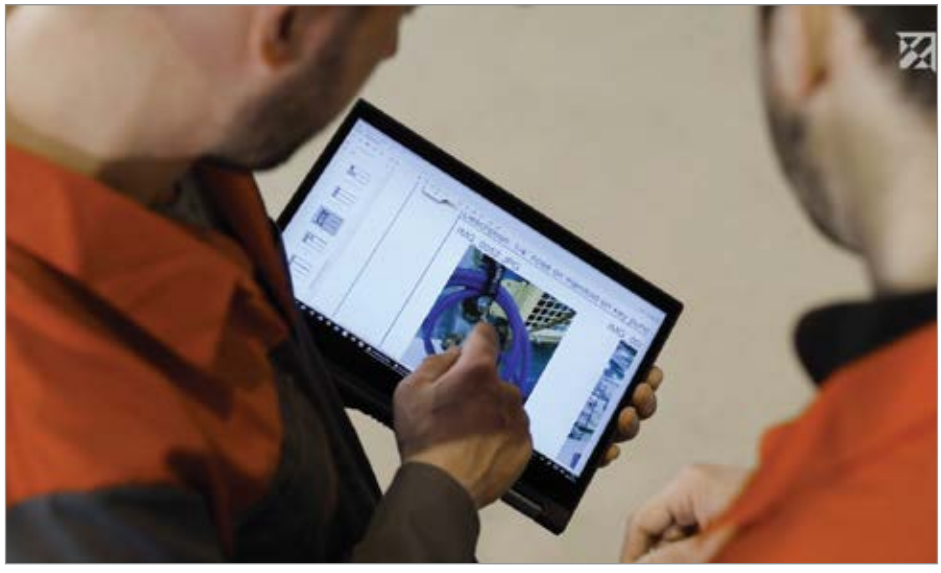
Data collection plays a vital role during leak detection. Both software and hardware have been integrated into the leak detection procedure to help capture the most important parts of the inspection. This includes data points such as pictures, location of the leakage, leakage priority, when to fix the leak, etc. By incorporating data collection tools like a camera, notepad, and leak detector all in the same device, the user saves time, the process is further simplified, and the reporting is completed much faster.

With this integration, users do not have to switch from tool to tool in the process of reporting each leak. Rather, they can collect all the information with a single device and store it all in one place. This adds value as the total number of leaks is now linked and located to each machine, department or build in the plant, that helps to identify them easier than ever before.

Implementation of Reporting Tools

Everyone who has completed a leak audit will tell you the most tedious part of the entire leak detection process is the final report after the inspection is complete. Depending on the size of the facility, it can take hours, sometimes days to put together a report. Compiling all the gathered data, such as pictures, location, leak size, and other relevant information is time consuming, particularly if you have hundreds of leaks.

By implementing improved reporting tools, there is a significant amount of time saved. Today, there are phone applications, as well as software built directly into leak detecting devices, that allow users to output reports on



Improved reporting tools can save users a significant amount of time as part of the leak detection process.

collected data. These reporting tools allow the users to output a report from all the data they collected while in the field in an easy-to-read format, which can include graphs, photos, and even an estimated total cost for the power-draw from the air compressor(s). While most of these reports are in the form of a PDF or Excel file, some are even able to sync with their companies' Computerized Maintenance Management system (CMMS) software for further trending and analysis.

Implementation of Planning and Trending Tools

The implementation of asset management tools helps streamline the planning phase of leak detection. By incorporating planning and trending tools similar to a CMMS system in the leak detection process, inspection routes can be easily planned and leaks and savings can be trended over time.

When it comes to inspection routes, someone such as a maintenance manager can plan when and where particular locations are inspected. This allows for better control over the entire process. Trending leaks can also be extremely valuable, as this can lead to finding important information such as incorrectly installed compressed air system parts, where the most leaks occur, and finally how much money the entire leak detection process has saved.

Leak Detection Has Never Been Easier

With the new tools available today, the entire leak detection process has never been easier. New developments in both hardware and software have been integrated into existing leak detection solutions, saving time and giving users more, and higher quality, information for better decision making on maintenance issues.

While we are still in the early stages of incorporating leak detection into Maintenance 4.0, there have been significant improvements to the process. This includes new leak detection technology, simplifying certain aspects of the application, and the implementation of data collection, reporting and planning tools. BP

About the Authors

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About SONOTEC

Founded in 1991, SONOTEC GmbH has developed into one of the world's leading product and solution specialist for innovative measurement technologies. With more than 180 employees and a modern corporate structure comprising three independent business units – Preventive Maintenance, Non-destructive Testing and Non-invasive Fluid Monitoring – the technology leader operates its global sales activities from the Halle (Saale) based German headquarters. The distributed portfolio includes customized ultrasonic transducers and sensors as well as testing devices and measurement solutions for a variety of different industries. For more information, visit www.sonotec.eu.

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PRODUCTIVITY, SUSTAINABILITY & ENERGY CONSERVATION

PAPER PRODUCTS PLANT STANDS TO SAVE with Compressed Air System Upgrades

By Ron Marshall, Marshall Compressed Air Consulting

A Canadian paper products company is struggling with their compressed air system amid a downturn in their product demand. The compressed air system is the life's-blood of the plant, supplying critical energy to their production processes, yet the failure of any one of their four air compressors will take down the plant. Plant management was seeking answers as to why their compressed air loading had increased to consume their full capacity in the past few years. This article discusses the findings of a recent compressed air assessment and some possible potential improvements.

Air Compressor Maintenance Costs Add Up

The facility has a compressed air system consisting of four, 200-horsepower (hp) two-stage water-cooled lubricant-free reciprocating air compressors (Figure 1). The air compressors are controlled individually with local pressure switch controls connected to a common pressure sensing point. These air compressors have been operating since the mid-1960s and are very difficult and expensive to maintain because parts are scarce and service companies with experience servicing this type of air compressor are difficult to find.

The compressed air system is configured into two systems, undried mill air and filtered and dried instrument air. One 1,900-cfm heated blower purge air dryer is installed to condition the instrument air.

> "It is estimated these energy efficiency measures would reduce the compressed air costs by 33%, saving about $79,000 per year in electrical costs and $60,000 in maintenance costs."
>
> — Ron Marshall, Marshall Compressed Air Consulting

The air produced by the air compressors first runs through a large 4,000-gallon wet receiver and then splits to the mill and instrument systems. The compressed air is transmitted throughout the plant through a system of steel piping, with the mill air a 6-inch supply size, instrument air a 4-inch supply. The piping consists of radial feeds running to various areas in the plant.

In recent years the plant has been experiencing capacity problems. In the past, only three air compressors were required during full production, with one spare, but now all four air compressors are required, and even then, there are periods of time where the pressure falls to low levels because the plant demand exceeds the air compressor capacity.

The plant's instrument air system has, in recent years, been suffering from low pressure, even though the plant air compressors are apparently producing air at an adequate pressure.

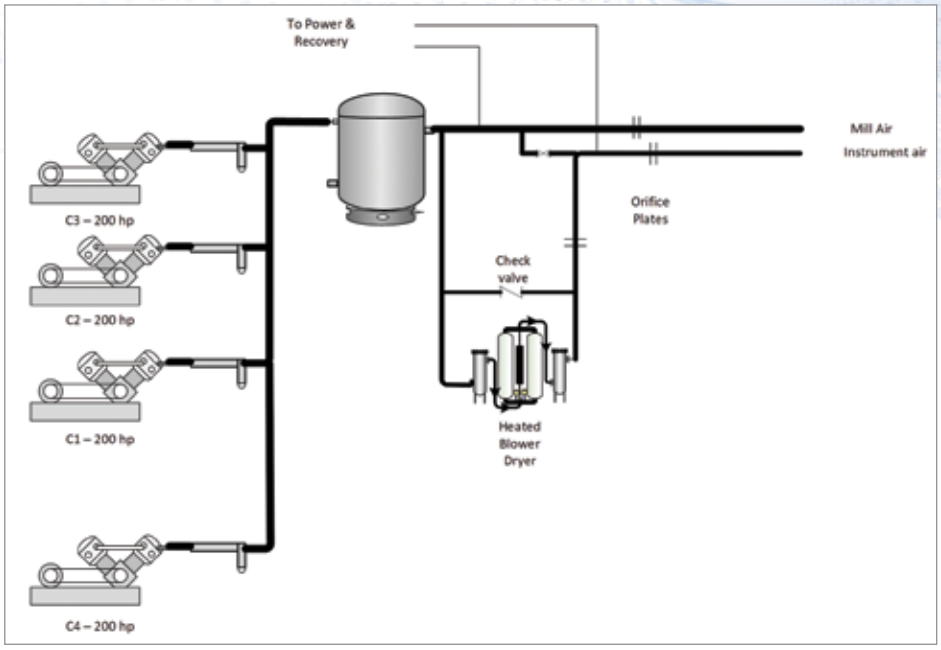

Figure 1: The compressed air system consisted of aging high maintenance lubricant-free reciprocating air compressors and a troublesome heated-blower desiccant air dryer.

Key Measurements Establish System Baseline

Plant management decided to call in a compressed air auditor to measure their system. Data loggers were placed on all the air compressors and the dryer to measure power, with pressure loggers located at various locations throughout the plant to assess the pressure gradient. The existing plant flow meters were also monitored by the same data logging system to capture plant flows. This information was all combined into a single database so the system baseline could be determined.

Part of the assessment included leakage detection and an assessment of various end uses of compressed air. This was done using an ultrasonic leak detector, with all leakage tagged and entered into a database, including photographs of the locations to assist

PAPER PRODUCTS PLANT STANDS TO SAVE WITH COMPRESSED AIR SYSTEM UPGRADES

Item	Units	Average	Annual kWh
Mill @ Dryer	psi	97.6	
Mill @ P&R	psi	97.3	
Mill @ EOL	psi	97.4	
IA @ Dryer	psi	92.0	
IA @ P&R	psi	86.0	
IA @ Shop	psi	72.6	
IA @ EOL	psi	71.3	
C1	kW	139.2	1,218,962
C2	kW	141.0	1,235,449
C3	kW	162.5	1,423,876
C4	kW	128.3	1,124,313
Dryer	kW	23.0	201,480
Total	**kW**	**594.1**	**5,204,080**
Mill flow	cfm	1609	
IA flow	cfm	1225	
Total flow	**cfm**	**2834**	
Sp Power	kW/100	21.0	
Cost electrical	$		$ 233,177
Cost Mtce	$		$ 208,772
Total Cost	**$**		**$ 441,949**

Figure 2: The system baseline showed excessive pressure differential and higher than normal maintenance costs. System efficiency and operating costs could be improved by lowering discharge pressure and using more modern and more efficient air compressors.

maintenance staff in finding them when repairs are done. Based on the current electrical costs the following baseline was captured (Figure 2).

The baseline showed a very significant pressure drop between the inlet of the air dryer and the end of line of the instrument air system.

For this site, the maintenance costs for the air compressors and air dryer have been tracked for a number of years. The typical rule-of-thumb maintenance cost component for a compressed air system running full time should be in the five to 15 percent of electrical cost range. In this case, the average annual costs to maintain the equipment was near 90% of the electrical costs. For this site the electrical costs are actually quite low, about 4.5 cents per kWh, which by default changes the operating cost percentage compared to a plant with 10 cents per kWh. But, the age of the air compressor, travel time to this fairly remote site, and high parts costs have driven the annual cost to operate these obsolete air compressors very high.

The readings and observations during the measurement period showed the air compressors (including dryer) are producing compressed air at acceptable efficiency (21 kW/100 cfm), but that improvements could likely be made if newer, more efficient air compressors were used. Plant loading has increased so much in the past years that all four air compressors must run to carry the total flow, three fully loaded with the fourth operating in trim duty, this represents a risk to production should one air compressor fail.

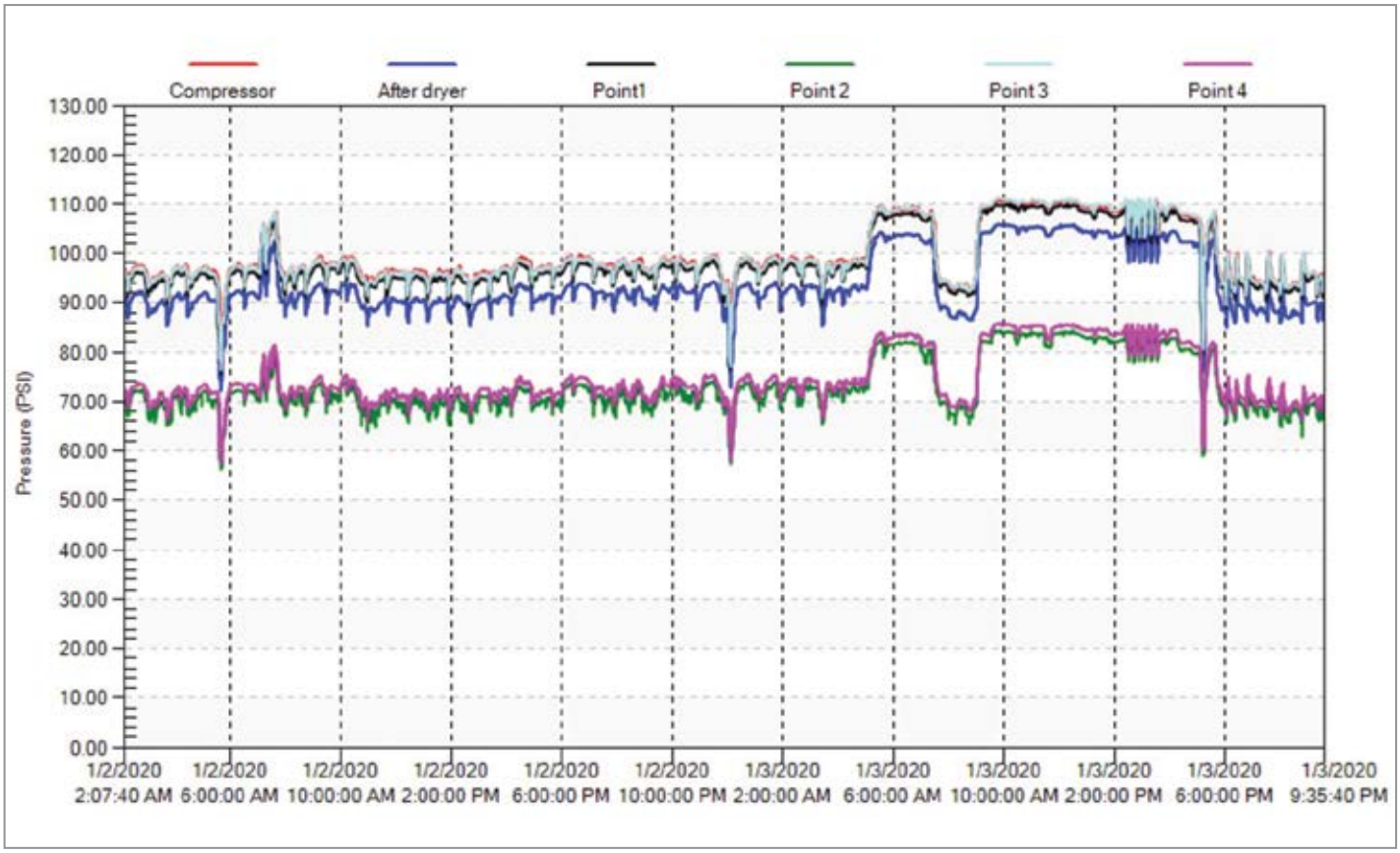

Figure 3: The pressure profile taken during the assessment showed excessive pressure loss on the instrument side. The green and the magenta traces show a large differential from the discharge of the air dryer (blue trace). All other readings track the air compressor discharge pressure because they are on the upstream side of the air dryer and filters.

The mill air pressure is higher than required due to uncoordinated air compressor control, the need to boost discharge pressures to correct low instrument air pressure, and to ride out transient high flow events that pull down mill air pressure to as low as 70 psi, with instrument air pressures falling to 50 psi. Significant improvements on the supply side are possible by adding more efficient base air compressors, changing the way the air compressors are coordinated, reducing discharge pressure, changing dryer operation, and reducing air compressor area leaks.

On the demand side there is significant energy consumption wasted due to the flow consumed by blowing, electronic enclosure cooling and leakage. The instrument air pressure is very low due to a large pressure differential (10 to 15 psi) across the system. The study found there is a good potential for energy savings if some wasteful end uses can be reduced or eliminated, and that significant energy incentives are available to fund improvements if these projects are initiated.

Improvements to the low-pressure problems during high flow on the instrument air system can likely be achieved by using surplus storage receivers already located on site, and by reconfiguration of the piping on the discharge of the instrument dryer (adding a check valve to prevent back flow during transient events on mill air).

Pressure Profile Reveals Issues

The pressure profile taken during the assessment (Figure 3) showed a very surprising characteristic. The pressure at the instrument air dryer normally runs about 92 psi, yet the pressure at Point 2 and Point 4 on the chart is very low, running near 72 psi. The piping for this system is well-sized but Point 2 is not very far away from the dryer discharge, this indicates some unanticipated pressure restriction in this section of piping. Additional pressure test ports were installed for secondary readings, and the pressure loss traced to one specific point, an old flow meter orifice plate that was still installed in the instrument air piping.

During the investigation of the pressure differential some excessive pressure loss was also found across the air dryer discharge filter. The differential gauge on this filter was showing no pressure loss, however the data loggers showed about seven psid during high flows. The filter was replaced during the

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assessment, and the pressure differential fell to one psi.

Finding Inappropriate End Uses and Leaks

The ultrasonic testing found 31 significant leaks totaling about 150 cfm. The infrastructure of the plant is aging, and with it leaks seem to spring out of nowhere. The plant had purchased their own leak detector and was part way through a focus on leakage repair by the time this assessment was done.

Ultrasonic leak detection is also useful for finding inappropriate use of compressed air. Fairly recently the plant personnel started using compressed air-cooled cameras and installing vortex style coolers to condition sensitive electronic enclosures. A total of 23 air-powered coolers were found and measured with a portable flow meter, adding up to 445 cfm of compressed airflow. The plant was already using refrigerated style coolers in some of their enclosures, the power consumption of these is about 75% less than compressed air-powered coolers.

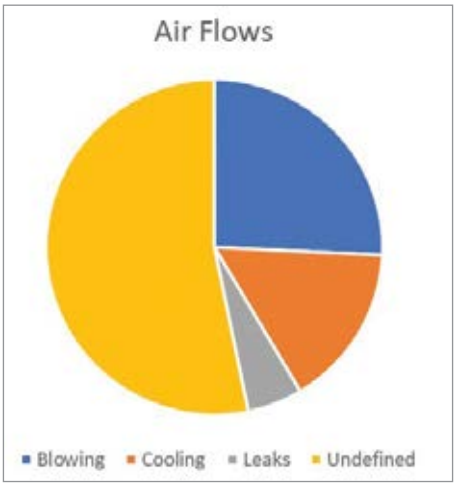

Figure 4: Compressed air demands classed as inappropriate uses consume almost half of the compressed air demand in the plant.

In addition to the leaks and cooling, some important pieces of process equipment had been fitted with numerous compressed air open blow nozzles to solve a process problem. Special testing was done during plant shutdown that showed the nozzles consuming about 730 cfm of compressed air making up about 25% of the total compressed air demand. Figure 4 shows the proportion of the inappropriate uses compared to other process loads, with leakage, blowing and cooling consuming almost half of the total plant flow. This answered the question as to why three air compressors were no longer enough to handle the compressed air demand.

Recommended Pressure and Energy Improvements

The compressed air auditor estimated significant savings could be gained if the following measures were implemented:

- Replace the most troublesome air compressors with more efficient new or refurbished lubricant-free rotary screw air compressors, this will give adequate spare capacity and allow reduced maintenance.
- Improve the air compressor control by installing a sequencing controller.
- Remove the offending orifice plate, reduce the average air compressor discharge pressure.
- Repair 100 cfm of leaks.
- Eliminate 250 cfm of inappropriate uses by installing electric enclosure coolers and eliminating or optimizing blowing.
- Switch to refrigerated air dryer from desiccant for instrument air.
- Install 5,000 gallons of surplus storage receiver capacity on the instrument air system to prevent pressure dips during high flow transient demands.
- Install 3,000 gallons surplus storage capacity at transient demand to smooth out the flow.

It is estimated these energy efficiency measures would reduce the compressed air costs by 33%, saving about $79,000 per year in electrical costs and $60,000 in maintenance costs. This project would qualify for a substantial utility incentive if implemented.

The Value of System Measurement

Once again, the value of performing a full measurement of the compressed air system is shown in the unanticipated discoveries made during this assessment. The plant was suffering from reduced pressure due to an unexpected cause; this was located by special testing. Air compressor capacity was lacking due to the addition of more and more inappropriate uses over time, finally reaching the full capacity of the system. The maintenance costs were much higher than normally seen on similar systems do to obsolescence and age. Many of these items were not previously known by plant management.

The plant engineering staff is now working hard to address the deficiencies, with an improvement in pressure, and significant reduction in operating costs on the horizon. BP

For more information about this article, contact Ron Marshall, Marshall Compressed Air Consulting, tel: 204-806-2085, email: ronm@mts.net.

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TECHNOLOGY PICKS

Kaeser Announces New SFC 37 and 45S Variable Frequency Drive

Kaeser Compressors announces the new SFC 37 and SFC 45S. With the advanced SynRM motor-drive combination, these 50 and 60 hp units deliver flows from 54 to 275 cfm at 125 psig with superior part-load efficiency, longer service life, and reduced maintenance costs. The available pressure range is 80-217 psig.

Kaeser SFC 37 and SFC 45S models now with SynRM motors and IES2 classification.

Developed in partnership with Siemens and specifically designed to work with Kaeser's SFC models, the SynRM motor-drive combination achieves top tier IES2 classification. This results in better specific performance, especially in the part-load conditions that call for variable speed compressors.

SynRM motors do not use aluminum, copper, or expensive rare earth metals in the rotors. Instead, they are made of electrical steel and feature a special profile. With this unique rotor design, the motors run cooler – resulting in lower bearing and winding temperatures and increased motor life. Because there are no magnets in the rotor, motor service is safer and easier.

To further enhance overall sustainability, SFC T models with the integrated refrigerated dryers have been upgraded with R-513A, a non-flammable, non-toxic advanced formulation refrigerant. R-513A has 56% lower global warming potential (GWP) compared to the current US standard (R-134a). This, combined with Kaeser's advanced heat exchanger design, reduces refrigerant requirements without compromising dryer performance. With these new additions, Kaeser has improved reliability and energy efficiency across its entire range of variable frequency drive units in the SFC 18-110S (25–150 hp) series.

About Kaeser Compressors, Inc.

Kaeser Compressors is a leader in reliable, energy efficient compressed air equipment and system design. We offer a complete line of superior quality industrial air compressors as well as dryers, filters, SmartPipe™, master controls, and other system accessories. Kaeser also offers blowers, vacuum pumps, and portable gasoline and diesel screw compressors. Our national service network provides installation, rentals, maintenance, repair, and system audits. Kaeser is an ENERGY STAR Partner. For more information, visit www.us.kaeser.com.

Medical Compressed Air Top Priority for BOGE

Coronavirus SARS-CoV-2 has resulted in a state of emergency across most of society. Our collective aim is to ensure that our health care systems do not become overstretched caring for critical cases of COVID-19 despite hospital capacity being increased. BOGE compressed air specialist from Bielefeld, Germany, is directing all its efforts to helping. Clinics need compressed air daily to help provide machine ventilation to patients in intensive care units and to operate different medical devices. BOGE is a major supplier to plant constructors and device manufacturers working in medicine – and is giving top priority to orders in this sector.

Medical compressed air is a medicinal product. This vital gas needs to be supplied uninterruptedly around the clock and always needs to guarantee the highest quality. When providing machine ventilation to patients in intensive care units, the respiratory air must be completely clean, as well as dry and free from all oils and pathogens. BOGE compressors can produce the very highest quality clean compressed air. Additionally, the air in treatment units undergoes drying, cleaning, and processing in seven stages. To ensure availability, compressed air systems in clinics are generally designed with at least triple redundancy. In addition, they are also subject to the strictest of fire and noise control regulations. At a regulatory level, compressed air systems in clinics are already designed to cope with extreme circumstances. One example is the concurrent supply of compressed air to exceptional numbers of patients – something which is to be expected across the globe and which we are already seeing in several regions.

TECHNOLOGY PICKS

"The demand for medical compressed air is expected to skyrocket with the increasing number of COVID-19 patients. We are standing side by side with medical companies and hospitals in this extraordinary situation and are doing everything in our power to intensify the manufacture of our machines and devices," said Michael Rommelmann, Technical Director at BOGE. For decades, the family business from Bielefeld in Germany has been the preferred partner of medical technology product manufacturers such as Dräger in Lübeck. Our competence and experience in plant engineering and our medical expertise guarantee a reliable medical compressed air supply.

In addition, BOGE has also set up a corona crisis committee which is following closely the development of the coronavirus and is implementing all the necessary precautions. With the help of different safety precautions to protect our employees, the drawing up of contingency plans and the roll out of other additional measures, BOGE can continue to maintain its business operations.

About Boge

BOGE America is the United States of America Daughter Company of BOGE International GmbH based in Bielefeld, Germany. BOGE manufactures a comprehensive range of oil lubricated and oil free screw and piston compressors used by all sectors of industry to supply compressed air for a wide range of manufacturing processes. It also supplies a complementary range of filters, dryers, and condensate management equipment. The product is sold and serviced through a dedicated network of over 70 distributors in North and South America. For more information, visit www.boge.com.

BOGE compressor series for medical compressed air.

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Kaishan Expands Range of KRSB Belt Drive Compressors

Kaishan USA has recently expanded its KRSB series belt drive rotary screw air compressors. The product range now extends from 5-50HP in the product portfolio. The 5-30HP products can be sold as base mounted units or easily re-configured to tank mounted machines. Tank mounted machines all have the option to have a refrigerated dryer and coalescing filter mounted and piped on the package. Kaishan has also released several convenient options on the product that can be easily added at its new 65,000 ft2 state of the art manufacturing facility in Loxley, AL or in the field by qualified technicians.

Electronic tank drains, food grade lubricants, 115-175 psig full load pressures, low ambient kits, and rain hoods are all price book options. The standard tank size is a 120-gallon horizontal type with heavy duty foot mounting for ease of installation and attachment to a variety of mounting surfaces. The large tank capacity prevents rapid cycling issues often experienced on smaller 15 and under horsepower machines. All Kaishan KRSB products come standard with an aftercooler and moisture separator trap eliminating the need of an expensive high temperature air dryer which adds to the upfront cost of the system and increases the installation space.

Kaishan KRSB series belt drive rotary screw air compressor.

TECHNOLOGY PICKS

Kaishan has also added an option to mount an "Oversized Dryer" to the package which allows for the machine to be installed in high ambient applications without losing dewpoint stability or causing nuisance shutdowns due to high temperature. In addition to these new options, Kaishan has retained the package features that makes their machines so attractive to many buyers of rotary screw compressors. Among these include, TEFC motors, all stainless steel control tubing and lubricant hoses, independent cooling fan motor and air/lubricant coolers, automatic belt tensioning, digital microprocessor control, current transducers to display volts/amps on HMI, and wye-delta starters down to 10HP. All backed by an industry leading 5-year airend and major component warranty.

About Kaishan Compressor USA, LLC

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. This allows Kaishan to vigorously control the cost and quality of its product to an extremely high level. Kaishan is performing precision machining of rotating and static parts in our ultra-modern machine center cells that provides exact tolerance control to thousands of an inch. Kaishan is also performing complete machine assembly, modification, and testing of rotary screw compressors from 5-500 horsepower in the new factory.

In addition to these highly technical processes, the new facility is home to the global engineering and product development team for 60HZ compressors. The latest in 3D design software and techniques are utilized to model new designs and implement seamlessly into manufacturing systems. Product support in terms of a fully stocked warehouse of over 300 finished units and accompanying aftermarket parts are all housed in Loxley. Monthly sessions for beginner level and advanced service technician training are also a large part of the Kaishan USA total distributor experience. To learn more about Kaishan USA and becoming part of a rapidly expanding company as a team member or distributor, visit www.KaishanUSA.com.

Mac and Jack's Brewing Generates Nitrogen with Atlas Copco

Washington State has a proud history of businesses that got their start in a garage. A case in point is Mac and Jack's Brewing Company. Malcolm Rankin and Jack Schropp established Mac and Jack's in 1993, in Jack's garage. The partners started brewing about 200 kegs a month using a straightforward

Mac and Jack's brewery operation uses an Atlas Copco NGM nitrogen generator.

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approach: make beer that people love and make it the right way instead of the easy way.

It proved a winning formula. They moved their growing business into a converted transmission repair shop in Redmond, WA. Today, Mac and Jack's is the 3rd largest craft brewery in Washington with a tight-knit crew of 20 dedicated beer fanatics and a capacity of 50,000 barrels.

"We're lucky, I believe, to live in a region where craft beer is available everywhere," said Ken Nabors, Brewery Manager for Mac and Jack's Brewing Company. "Here we're making all kinds of ales, from our flagship African Amber to multiple kinds of IPAs, porters and stouts."

Nabors emphasized that Mac and Jack's is constantly evaluating best practices that mesh with their philosophy about making beer. "We don't want to put anything into our beer that doesn't belong there," he said. "So, using an inert gas to push our beer fits into that nicely."

That inert gas is nitrogen. The air we breathe is about 78% nitrogen, but at a higher level of purity, nitrogen has a wide variety of practical applications across many industries, including brewing. Beer moving between various stages of brewing at Mac and Jack's is pushed from one vessel to the next with pressure supplied by nitrogen gas.

Companies like Mac and Jack's that require a reliable supply of nitrogen benefit by generating it in-house. This enhances production flexibility by ensuring that they have the nitrogen they need, at the level of purity they need, when they need it. Because there's no third-party nitrogen supplier, constant order processing, refills and delivery costs are eliminated. Space otherwise needed to store nitrogen bottles (both full and empty) is freed up.

Continuing growth in demand for Mac and Jack's beers has brought with it the need for more nitrogen. "When it came time for us to increase our nitrogen production, Atlas Copco was the logical choice," said Nabors. Mac and Jack's brewery operation uses an

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TECHNOLOGY PICKS

Atlas Copco NGM nitrogen generator to provide a reliable and secure supply of nitrogen at low operating costs. Using advanced membrane air separation technology, the NGM delivers purities from 95% to 99.5%."

"The NGM made sense here because, for purity control, Mac and Jack's was targeting 95% nitrogen," said Evan Stanley, Sales Manager, Atlas Copco Compressors in Seattle. "This system is designed to do that all the time, and we meet or exceed that target. Besides the purity level, the NGM also takes up minimal floor space. It's a plug-and-play kind of a system where you don't have a lot of other components you need to add with it."

"The primary objective in switching to nitrogen was cost savings," said Nabors. "We're using two-thirds less CO_2 than we were using before. An added benefit of nitrogen is that it's dry, and now we can run all our pneumatics on nitrogen. One of the advantages we didn't expect was no loss. We use all of the nitrogen we produce. There's no loss. There's no waste."

Twenty-seven years in, Mac and Jack's Brewing Company is still owned by Mac and Jack. They're still in that converted transmission repair shop in Redmond. Their dedicated crew is still listening to customers and delivering the most compelling beers they can.

As Nabors explains it, "Our mission is simple and fixed: make beer people love, make it the right way not the easy way. And this nitrogen generator from Atlas Copco is now a big part of that."

About 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

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TECHNOLOGY PICKS

SUTO iTEC Rolls Out Leak Management Solution

SUTO recently released a set of seamlessly integrated leak management solutions, which comprises the S531 ultrasonic leak detector and the Leak Management Software (LMS). This solution helps service providers significantly save time spent in finding air leaks, estimating possible losses, and preparing reports for customers.

The ultrasonic leak detector S531 finds leaks in the compressed air or gas system from a distance. Air loss is presented in l/min, m^3/h or cfm and in your local currency. The built-in camera and voice recorder allow the S531 to record leaks in a multimedia way. Integrated noise reduction technology and wireless connection with headset give you a comfortable experience.

LMS is a web-based application that frees service providers from heavy work on leak management. LMS enables service providers to manage customers and site information centrally and wirelessly distribute them to the S531. After receiving leak records from S531, LMS analyses leaks and prepares various reports of saving opportunities, costs for leak repairs, and service time estimates. LMS can generate documents for leak repairs and manage the ordering of spare parts. Flexible installation options enable service providers to choose between a local and a cloud installation while keeping all data secured and absolutely private.

About SUTO iTEC

SUTO iTEC has been a trusted global partner for reliable measurement and monitoring solutions for compressed air and other gases for over 20 years. They offer measurement solutions for parameters of compressed air systems including flow, consumption, dew point, oil vapor and particulate For more information, visit www.suto-itec.com.

S531 and Leak Management Software (LMS).

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