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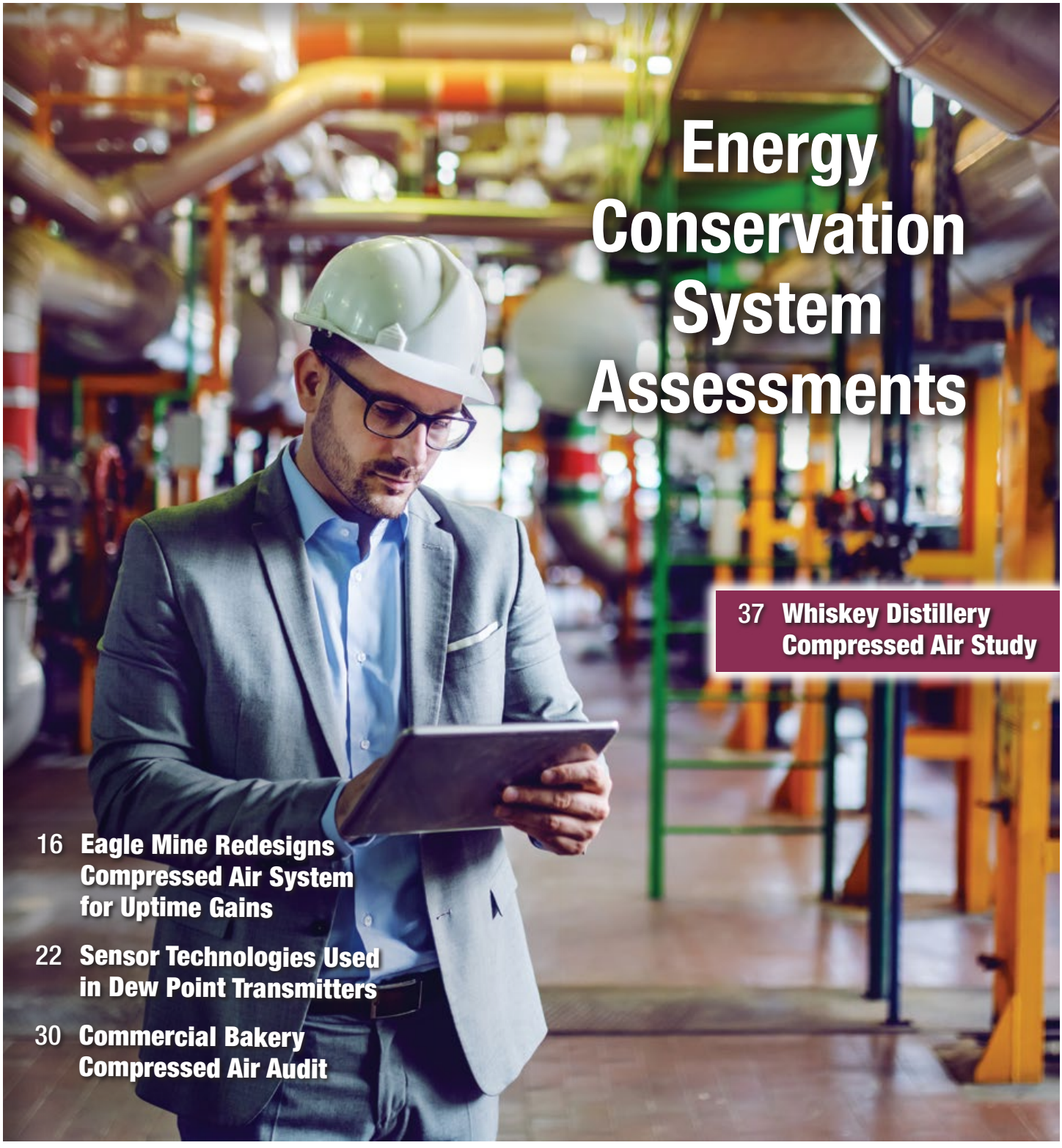

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Compressed Air Best Practices® (USPS# 17130) is published monthly except January-February combined by Smith Onandia Communications LLC, 37 McMurray Rd., Suite 104, Pittsburgh, PA 15241. Periodicals postage paid at Pittsburgh, PA and additional mailing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

FROM THE EDITOR

Our lead article is the result of our subscribers from Eagle Mine contacting us to share their "Best Practice" story detailing how they redesigned an unreliable compressed air system. Our own Mike Grennier enjoyed interviewing Lead Reliability Technician, Ted Lakomowski, to write, "Eagle Mine Redesigns Compressed Air System for Uptime Gains."

While not new, could compressed air quality audits be the next great opportunity? I personally believe dew point should be monitored (with alarms) in every system where compressed air enters into contact with food or food packaging materials. We are therefore pleased to publish this article from Simon Gleissner, from SUTO iTEC, titled, "Sensor Technologies Used in Dew Point Transmitters – Advantages/Disadvantages."

Do you understand how compressed air is used in a commercial bakery? Mike Lenti, from Compressed Air Consultants, provides this information in his article, "Commercial Bakery Compressed Air Audit Optimizes the Constituents of Demand."

How proficient are you at understanding graphs resulting from the data logging done in a compressed air audit? Ron Marshall again provides our readers with an excellent training resource in his article titled, "Whiskey Distillery Compressed Air Study Saves Energy."

Please save the date for the Best Practices 2022 EXPO & Conference being held October 4-6, 2022 at the Cobb Galleria in Atlanta. Visit https://cabpexpo.com for more information!

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

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tel: 412-980-9901
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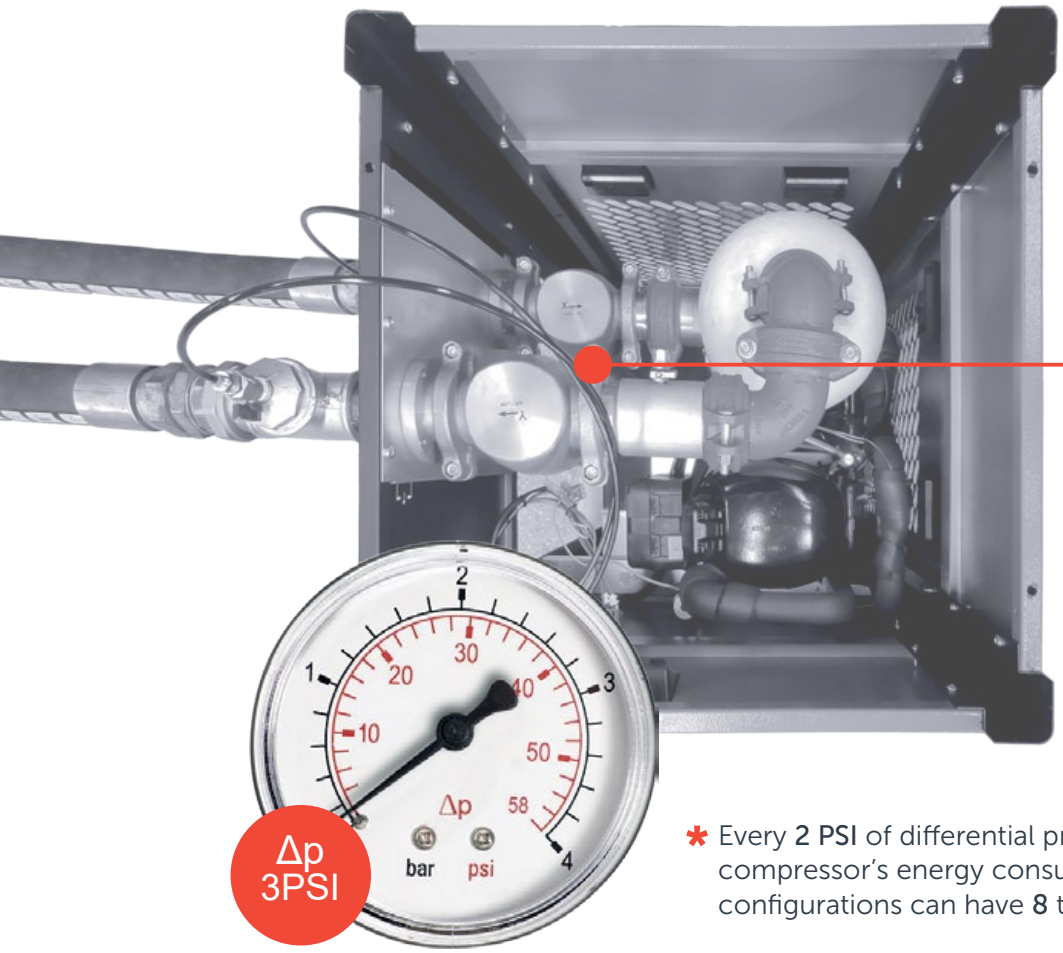

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COMPRESSED AIR INDUSTRY NEWS

Atlas Copco to Acquire Lewa and Geveke

Atlas Copco has agreed to acquire LEWA GmbH and subsidiaries, and Geveke B.V. and subsidiaries for a combined enterprise value of MEUR 670 (BSEK 7.15). LEWA is a leading manufacturer of diaphragm metering pumps, process pumps and complete metering systems. Geveke distributes compressors and engineers advanced and complex process pump installations.

LEWA was founded in 1952 and is based in Germany. The company has around 1200 employees and in 2021 they had revenues of MEUR 233 (BSEK 2.4). LEWA offers industry-specific high-quality pump solutions for a wide range of industries.

"LEWA has a long tradition of supporting customers and developing leading industrial flow technology for efficient, precise and safe handling of fluids", said Andrew Walker, Business Area President Power Technique. "Through this acquisition we are building our presence and technology offering within positive displacement pumps.

Geveke was founded in 1874 and is headquartered in Amsterdam in the Netherlands. The company has 173 employees and in 2021 they had revenues of approximately MEUR 61 (MSEK 648).

"Geveke has strong engineering capability, providing complete industrial pump solutions from concept to commissioning", said Andrew Walker, Business Area President Power Technique.

The acquisition is an all-cash transaction utilizing Atlas Copco's funds and is subject to regulatory approvals. The acquisition is expected to be completed during the second quarter 2022.

The main part of the acquired businesses will have its base in the Power and Flow division

within Atlas Copco's Power Technique Business Area and a smaller part will have its base in the Service division within the Compressor Technique Business Area.

About Atlas Copco Group

Great ideas accelerate innovation. At Atlas Copco we have been turning industrial ideas into business critical benefits since 1873. By listening to our customers and knowing their needs, we deliver value and innovate with the future in mind. In 2021, Atlas Copco had revenues of BSEK111 and at year end about 43 000 employees. For more information, visit www.atlascopcogroup.com.

Sulzer Opens Service Center in Vadodara

Sulzer's new facility widens availability of high-quality services for rotating equipment in India. In a move to provide additional support to one of the industrial centers in India, Sulzer is opening a new state-of-the-art service center in Vadodara, Gujarat, India. The facility will offer repairs, upgrades, retrofits and parts manufacturing for a wide range of rotating equipment including pumps, steam turbines, compressors and expanders.

The new, modern engineering facilities cover 10,500 square feet and have been designed to deliver fast and efficient workflows, incorporating lean principles to ensure an effective service for customers. The new service center has the capability to deliver leading maintenance solutions for a variety of equipment, regardless of the original equipment manufacturer (OEM).

Sulzer has been delivering manufacturing and maintenance services in India for more than 30 years. The company pioneered the introduction of high-energy pumps to the

Compressed Air Industry News

industrial sector and continues to lead the pump market in the oil & gas and power generation sectors. This expertise and experience also provide an excellent foundation for overhauling and repairing these vital assets to improve reliability and performance, while also potentially reducing their carbon footprint with energy savings.

The new team at Vadodara comprises a mixture of local talent and select engineers from the company's national headquarters in Navi Mumbai with over 30 years' experience in delivering maintenance services to customers from around the world. Together, these facilities form an important part of Sulzer's global manufacturing and maintenance network.

As such, the team in Vadodara has access to the global engineering capabilities within the company, including Venlo in the Netherlands and Indonesia, both of which have vast experience and expertise in turbomachinery repairs and upgrades. To complement this, Sulzer has also invested in its parts manufacturing capabilities at Vadodara with cutting-edge equipment, such as an advanced CNC 4-axis turnmill machine, vertical & horizontal balancing machines, as well as the necessary expertise in design and materials engineering.

The management team at Vadodara Service Center welcomes businesses to visit the new facility to see how the performance and availability of their critical assets can be improved by Sulzer. Interested parties are encouraged to contact the service center directly and arrange a tour of the site and pose any questions they may have.

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 production facilities and service centers across the globe. Sulzer has been headquartered in Winterthur, Switzerland, since 1834. In 2020, our 15,000 employees delivered revenues of CHF 3.3 billion. The

Sulzer's new state-of-the-art service center in Vadodara.

Pumps Equipment division specializes in pumping solutions specifically engineered for the processes of our customers. We provide pumps, agitators, compressors, grinders and screens developed through intensive research and development in fluid dynamics and advanced materials. We are a market leader in pumping solutions for water, oil and gas, power, chemicals and most industrial segments. For more information, www.sulzer.com.

Kaishan USA Partners With Gary Sinise Foundation

Kaishan USA, a leading worldwide manufacturer of industrial air compressors, has formalized its partnership with the Gary Sinise Foundation, whose mission is to serve our nation by honoring our defenders, veterans, first responders, their families, and those in need. Specifically, Kaishan USA will support the foundation's R.I.S.E. program, which enables our nation's most severely wounded heroes to receive 100% mortgage-free specially adapted smart homes, and its Relief & Resiliency program, which aims to ensure our defenders and their families stay strong through hardships by offering complete support in times of need.

Kaishan USA has formalized its partnership with the Gary Sinise Foundation.

"Kaishan USA has long been a supporter of our nation's heroes – our defenders at home and abroad, our first responders and their families," said Carl Stokley, marketing manager, of Kaishan USA. "As a proud American company, with military veterans comprising more than 20% of our staff, we couldn't think of a better organization with whom to partner. Thank you, Gary Sinise Foundation, and here's to years of engineering a better, brighter future for all of us."

Chrissy Kreisel, Director of Corporate and Community Relations for the Gary Sinise

Compressed Air Industry News

Foundation, stated, "At the Gary Sinise Foundation, we serve our nation by honoring and supporting our defenders, veterans, first responders, their families and those in need. With the generosity and ongoing support of companies like Kaishan USA, we will continue to provide support for these heroes who have sacrificed so much for our country. We look forward to a mutually rewarding partnership in the years to come."

About the Gary Sinise Foundation

The Gary Sinise Foundation was established under the philanthropic direction of actor Gary Sinise, who has been an advocate of our nation's defenders for nearly 40 years. The Gary Sinise Foundation's mission is to serve our nation by honoring our defenders, veterans, first responders, their families, and those in need. The Foundation's programs – designed to entertain, educate, inspire, strengthen, and build communities – serve America's heroes and their loved ones 365 days a year. To learn more, please visit www.garysinisefoundation.org.

About Kaishan USA

Kaishan USA engineers the highest quality rotary screw air compressors that enable us to build a better, more efficient future. We streamline our operations by taking direct ownership of 85% of our product content. This process enables us to vigorously control the cost and caliber of our equipment while improving its energy efficiency and safe use. Our solutions range from 5-600 horsepower and are used in a variety of industries. Based in Loxley, Alabama, our new 65,000-square-foot, state-of-the-art manufacturing facility fully stocks over 300 finished units and aftermarket parts that serve customers around the world. We are a proud American manufacturer, with military veterans comprising more than 20% of our staff. To learn more, please visit www.kaishanusa.com.

EPA Announces Energy-Efficient Manufacturing Plants of 2021

The U.S. Environmental Protection Agency (EPA) announced that 93 U.S. manufacturing plants earned the agency's ENERGY STAR certification in 2021. ENERGY STAR certified plants are verified to be among the most energy-efficient plants within their industries. Together, they prevented more than 5 million metric tons of greenhouse gas emissions from the industrial sector, which is responsible for nearly a third of U.S. greenhouse gas emissions.

"As these companies demonstrate, improving energy efficiency serves to confront climate change while strengthening our economy," said EPA Administrator Michael S. Regan. "Manufacturing plants that reduce energy consumption as part of the transition to a zero-emissions future save money and create the resiliency needed for the long-term health of their operations, our economy, and our planet."

Thanks to their superior energy performance over a single year, these plants avoided nearly 90 trillion Btus of energy consumption and prevented emissions equal to the annual energy use of nearly 650,000 American homes. Since the first plants were certified

93 U.S. manufacturing plants earned the agency's ENERGY STAR certification in 2021.

in 2006, ENERGY STAR certified plants have cumulatively saved manufacturers more than $7 billion on energy bills when compared to average-performing facilities.

Energy efficiency cuts energy waste and is an essential action for achieving net-zero greenhouse gas emissions by 2050 for both the United States' Long-Term Strategy and the sustainability of the manufacturing sector.

To assess energy performance, plants use EPA's ENERGY STAR energy performance indicators (EPIs), or, in the case of petroleum refineries, the Solomon Associates Energy Intensity Index (Solomon-EII™) scoring system. Plants must score 75 or higher on these 100-point scales – indicating that they are more energy efficient than at least 75% of similar facilities nationwide – to be eligible for ENERGY STAR certification. ENERGY STAR certification is available for 20 manufacturing sectors, from cement and steel to glass and commercial bakeries.

All ENERGY STAR certified manufacturing plants in 2021:

**Represents first-time certification*

Alabama:

Argos USA, Calera (cement manufacturing)
Georgia-Pacific, Brewton Containerboard & Bleached Board (integrated paper mill)*
Honda Development & Manufacturing of America, LLC, Lincoln (automobile assembly)
Honda Development & Manufacturing of America, LLC, Lincoln (automobile engine)
Tuscaloosa Organic Baking Co., LLC (commercial bread and roll baking)

Arizona:

Bimbo Bakeries USA, Inc., Phoenix (commercial bread and roll baking)
CalPortland, Rillito (cement manufacturing)
Drake Cement, LLC, Paulden (cement manufacturing)
Holsum Bakery of Tolleson, LLC (commercial bread and roll baking)
Mesa Organic Baking Co., Inc. (commercial bread and roll baking)
Salt River Materials Group, Clarkdale (cement manufacturing)

Arkansas:

Flowers Baking Co. of Batesville, LLC (commercial bread and roll baking)

California:

Ardagh Glass Inc., Madera (container glass manufacturing)
Bimbo Bakeries USA, Inc., Escondido (commercial bread and roll baking)
Bimbo Bakeries USA, Inc., San Luis Obispo (commercial bread and roll baking)
Bimbo Bakeries USA, Inc., Placentia (commercial bread and roll baking)*
Flowers Baking Co. of Modesto, LLC (commercial bread and roll baking)
J.R. Simplot Company, Helm (nitrogenous fertilizer)

Colorado:

GCC, Pueblo (cement manufacturing)
Mile Hi Companies, Denver (commercial bread and roll baking)
Rocky Mountain Bottle Company, Wheat Ridge (container glass manufacturing)*

Delaware:

AstraZeneca Pharmaceuticals, Newark (pharmaceutical)

Compressed Air Industry News

All ENERGY STAR certified manufacturing plants in 2021:
**Represents first-time certification*

Florida:
CEMEX USA, Miami (cement manufacturing)
Flowers Baking Co. of Bradenton, LLC (commercial bread and roll baking)*
Titan America LLC, Medley (cement manufacturing)

Georgia:
Honda Development & Manufacturing of America, LLC, Tallapoosa (automobile transmission)

Illinois:
Marathon Petroleum Corporation, Robinson (petroleum refining)
TreeHouse Foods, Inc., South Beloit (cookie & cracker baking)

Indiana:
General Motors Company, Roanoke (automobile assembly)
Honda Development & Manufacturing of America, LLC, Greensburg (automobile assembly)
Klosterman Baking Company, Morristown (commercial bread and roll baking)
PepsiCo, Indianapolis Gatorade Hotfill Facility (juice production)
Tate & Lyle, Lafayette (corn refining)

Iowa:
Bimbo Bakeries USA, Inc., Dubuque (commercial bread and roll baking)
Koch Fertilizer Ft. Dodge, LLC (nitrogenous fertilizer)*

Kentucky:
Bimbo Bakeries USA, Inc., London (commercial bread and roll baking)
TreeHouse Foods, Inc., Princeton (cookie & cracker baking)

Louisiana:
ExxonMobil Fuels & Lubricants, Baton Rouge (petroleum refining)
Flowers Baking Co. of New Orleans, LLC (commercial bread and roll baking)
Marathon Petroleum Corporation, Garyville (petroleum refining)

Maine:
Lepage Bakeries Park Street, LLC, Lewiston (commercial bread and roll baking)*

All ENERGY STAR certified manufacturing plants in 2021:

**Represents first-time certification*

Michigan:

AbbVie, Wyandotte (pharmaceutical)

General Motors Company, Flint (automobile assembly)*

Minnesota:

Bimbo Bakeries USA, Inc., Fergus Falls (commercial bread and roll baking)

Flint Hills Resources, Pine Bend (petroleum refining)

Lamb Weston/RDO Frozen, Park Rapids (frozen fried potato processing)

Marathon Petroleum Corporation, Saint Paul Park (petroleum refining)

Mississippi:

Georgia-Pacific, New Augusta (pulp mill)

North Carolina:

Bimbo Bakeries USA, Inc., Gastonia (commercial bread and roll baking)

Nebraska:

Koch Fertilizer Beatrice, LLC (nitrogenous fertilizer)

New Jersey:

AbbVie, Branchburg (pharmaceutical)

Ardagh Glass Inc., Bridgeton (container glass manufacturing)

Nevada:

Flowers Baking Co. of Henderson, LLC (commercial bread and roll baking)

New York:

Bimbo Bakeries USA, Inc., Olean (commercial bread and roll baking)

Bimbo Bakeries USA, Inc., Auburn (commercial bread and roll baking)

TreeHouse Foods, Inc., Tonawanda (cookie & cracker baking)

Ohio:

Bimbo QSR Ohio, LLC. – Airport, Zanesville (commercial bread and roll baking)*

Bimbo QSR Ohio, LLC. – Eastpointe, Zanesville (commercial bread and roll baking)

Honda Development & Manufacturing of America, LLC, Anna (automobile engine)

Honda Development & Manufacturing of America, LLC, East Liberty (automobile assembly)

Honda Development & Manufacturing of America, LLC, Marysville (automobile assembly)

Honda Development & Manufacturing of America, LLC, Russells Point (automobile transmission)

Klosterman Baking Company, Cincinnati (commercial bread and roll baking)

Klosterman Baking Company, Springboro (commercial bread and roll baking)

Marathon Petroleum Corporation, Canton (petroleum refining)

Oklahoma:

Koch Fertilizer Enid, LLC (nitrogenous fertilizer)

Oregon:

Dave's Killer Bread, Inc., Milwaukie (commercial bread and roll baking)

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**Represents first-time certification*

Pennsylvania:
Bimbo Bakeries USA, Inc., Reading (commercial bread and roll baking)
O-I, Brockway (container glass manufacturing)*

Puerto Rico:
Merck & Co., Inc., Las Piedras (pharmaceutical)

South Carolina:
Argos USA, Harleyville (cement manufacturing)

South Dakota:
GCC, Rapid City (cement manufacturing)

Tennessee:
Beiersdorf North America, Cleveland (pharmaceutical)
Buzzi Unicem USA, Chattanooga (cement manufacturing)
Crown Bakeries, Dickson (commercial bread and roll baking)
Crown Bakeries, Nashville (commercial bread and roll baking)
Nissan North America, Decherd (automobile engine)
Nissan North America, Smyrna (automobile assembly)
Tate & Lyle, Loudon (corn refining)

Texas:
AbbVie, Waco (pharmaceutical)
ExxonMobil Fuel & Lubricants, Beaumont (petroleum refining)*
Flowers Foods, Inc., El Paso (commercial bread and roll baking)
Flowers Baking Co. of Houston, LLC (commercial bread and roll baking)
Flowers Baking Co. of Tyler, LLC (commercial bread and roll baking)

Utah:
Bimbo Bakeries USA, Inc., Salt Lake City (commercial bread and roll baking)
TreeHouse Foods, Inc., Odgen (cookie & cracker baking)

Virginia:
Flowers Baking Co. of Norfolk, LLC (commercial bread and roll baking)
Titan America LLC, Troutville (cement manufacturing)

Washington:
Bimbo Bakeries USA, Inc., Kent (commercial bread and roll baking)*
Marathon Petroleum Corporation, Anacortes (petroleum refining)

Wisconsin:
Bimbo Bakeries USA, Inc., Milwaukee (commercial bread and roll baking)
Bimbo Bakeries USA, Inc., La Crosse (commercial bread and roll baking)

Wyoming:
J.R. Simplot Company, Rock Springs (nitrogenous fertilizer)*

About the ENERGY STAR Industrial Program

Since 2006, the ENERGY STAR Industrial Program has annually certified manufacturing plants for performing within the top 25% of energy performance in their industries nationwide. More than 230 plants have achieved this distinction since 2006. For more information, see: ENERGY STAR plant certification. For more information, visit www.energystar.gov.

Eagle Mine Redesigns Compressed Air System for Uptime Gains

By Mike Grennier, Compressed Air Best Practices® Magazine

Eagle Mine, located in the Upper Peninsula of Michigan, is expected to produce 440 million pounds of nickel and 429 million pounds of copper, as well as trace amounts of other minerals over its estimated life.

When the design capabilities of an installed compressed air system didn't align with real-world production needs at its ore processing mill in northern Michigan, Eagle Mine decided to move beyond theoretical compressed air concepts and deal in reality.

After thorough analyses of its compressed air challenges and implementing a variety of solutions, the team at the mill bolstered the operation's ability to efficiently mill approximately 2,200 metric tons of ore per day.

Changes to the original compressed air system were nothing short of essential, said Ted Lakomowski, Lead Reliability Technician at Eagle Mine (www.eaglemine.com).

"If we have a hiccup with compressed air, it disrupts our entire process," said Lakomowski, noting how "hiccups" had threatened production to the tune of tens to hundreds of thousands of dollars in losses per incident, driving the need for change. "Everything was based on modeling and theory. We knew we had to improve the compressed air system to match actual needs."

Making Compressed Air a Focus

Eagle Mine, owned and operated by Lundin Mining based in Canada, is located in Powell township, Michigan. Situated in Michigan's Upper Peninsula, the underground high-grade nickel and copper mine is expected to produce 440 million pounds of nickel and 429 million pounds of copper, as well as other trace amounts of minerals over its estimated life.

Approximately sixty miles away by truck from the mine is Eagle Mine's processing mill where crushing, grinding and flotation methods are used to produce nickel and copper concentrates. Lundin Mining had purchased the existing mill from a former owner, and in 2012, it began preparing it for production in 2014. The company ultimately invested $275 million in construction and equipment upgrades at the mill, which operates 24 hours per day, seven days a week.

While the design for the compressed air system at the mill looked good on paper during the planning phase, the team encountered problems by 2015 when the realities of actual compressed air needs set in. Issues ranged from insufficient air for powering critical processes to all-out air compressor failures.

"We were doing a lot of firefighting," Lakomowski said. "Compressed air became a huge priority."

Dedicated Air Compressors

The original compressed air system design at the mill consisted of three separate sets of air compressors and related equipment, with each dedicated to specific equipment and/or processes used in milling ore concentrates.

The main set of air compressors included three, 100-horsepower (hp) fixed-speed rotary screw air compressors, along with one desiccant dryer rated at -100°F (-73°C) pressure dew point and several 103-gallon receiver tanks. Combined, the three air compressors delivered up to 1,350 scfm of air at 125 psi each.

Housed in a poorly vented air compressor room, the main units were designed to deliver air to spargers, which are devices that aerate water during the flotation process used in separating nickel and copper concentrates. Sparging makes up roughly 70% of the mill's compressed air consumption. The main set of air compressors also supply instrument air to pneumatic valves that control the flotation process. Additionally, the main air compressors provide air for a variety of utility purposes, such as mill cleanup.

A second set of air compressors located in the mill included two, 7.5-hp reciprocating air compressors rated to produce a combined 60 scfm of air at 175 psi each. The design also included two 88-gallon air tanks. The two small air compressors were dedicated to two ball mills. The cylindrical mills are grinding devices used to reduce ore from less than half an inch to 120 microns.

The original configuration also featured two air compressors for powering two filter presses used to remove excess water in the milling process.

Eagle Mine Redesigns Compressed Air System for Uptime Gains

Eagle Mine's processing mill uses crushing, grinding and flotation methods to produce nickel and copper concentrates.

Located in the Concentrate and Loadout Out (CLO) area of the mill, one 175-hp rotary screw air compressor rated to produce up to 790 scfm of air at 150 psi was dedicated to the nickel press. Another 150-hp rotary screw air compressor rated to deliver 535 scfm at 150 psi powered the copper press.

Original Design Falls Short

The theory of having a compressed air system design with units unique to each critical piece of equipment and/or process created a number of challenges that hindered the plant's ability to operate efficiently at all times.

A major problem was insufficient air and pressure drop that occurred randomly throughout various areas of production, including the flotation process.

"Early on, we noticed the spargers would begin to pull air meant for instrument air when a high percentage of copper came through the system that we didn't know about, which would threaten to disrupt the whole process," Lakomowski said, noting how the lack of readily available data for the compressed air system exacerbated the situation.

"If we had low pressure and the pneumatic valves weren't responding properly someone would have to run to the air compressor room to understand what was happening," he said, as an example. "You wouldn't have known otherwise if an air compressor was down."

The team also determined the air compressors powering the nickel and copper presses were short cycling, resulting in an extraordinarily high number of starts and stops. Another serious problem occurred when the air compressors in the CLO area of the plant eventually failed.

"When a reciprocating air compressor runs non-stop, it'll have a very short life," Lakomowski said. The failed air compressors were the final straw, he said. "That's when we decided to tie everything together and get some intelligence going on with all of the air compressors."

System Reconfiguration the Best Option

Based on an assessment of air use and an evaluation of the original compressed air system design, the team at the mill determined its best option was to reconfigure the system in order to remedy issues and deliver a balanced supply of air to the entire mill.

The overarching solution hinged on the realization the air compressors powering the filter presses were large enough to meet the bulk of the plant's needs. As such, the team discontinued using the reciprocating air compressors dedicated to the ball mills. It also added flow meters throughout the system to regularly measure airflow rate – and opted to tie all five remaining air compressors into the mill's Digital Control System (DCS) to allow the system to operate automatically based on established setpoints.

The team also reconfigured the piping throughout the mill and installed regulators and valving to allow the networked compressed air system to deliver air at the right volume and pressure to equipment and processes. It included a backflow regulator to ensure air delivered at 100 psi to mill processes is protected from air supplied intermittently to the filter presses at 150 psi. The team also added a 439-gallon receiver tank to the CLO to smooth out spikes in the operation. In the mill, the team installed a desiccant dryer rated at -100°F (-73°C) to ensure the delivery of dry instrument air at all times. Additionally, it implemented a leak detection and repair program.

Eagle Mine Redesigns Compressed Air System for Uptime Gains

Ball mills at the processing mill reduce ore from less than half an inch to 120 microns.

With the automated and networked system in place, the two air compressors in the CLO area effectively serve as base units and regularly satisfy the entire mill's load. The three air compressors in the mill serve as trim units and operate when needed to meet additional demand for air. Additionally, the new configuration allows the three trim air compressors to satisfy the entire operation's need for compressed air if problems are encountered with the units in the CLO area.

Improving Reliability and Saving Costs

The Eagle Mine team implemented changes to the compressed air system step by step since

Shown is one of two air compressors located in the mill's CLO area.

2015, which steadily improved the reliability of the system and its performance – while also allowing the operation to maintain production as the project progressed.

Today, the compressed air system operates flawlessly, allowing the mill to focus on processing ore. Cost savings are also expected to be realized given improved uptime, as well as cost savings tied to air compressors and their operation.

Lakomowski said every phase of the system overhaul has delivered value, noting how he especially appreciates the capabilities of having an automated and networked system in place.

"If anything happens, the system is able to alert people to problems and essentially manage itself," he said. "As long as we continue to stay up with routine maintenance, the system is bullet proof. We've checked all the boxes and we feel very comfortable with the system." BP

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Sensor Technologies Used in Dew Point Transmitters – Advantages/Disadvantages

By Simon Gleissner, SUTO iTEC

➤ Foreword

Have you ever had a failing dryer in your compressed air system, ruining your production output, but it was not noticed until it was already too late? Dry compressed air is one of the most important quality parameters when it comes to process safety. When ambient air is compressed, the ratio of the humidity to the air volume will rise drastically. Therefore the higher concentration of humidity in the compressed air leads to a higher dew point temperature and the humidity is more likely to condensate at higher temperatures.

What can be worse than having water droplets in the compressed air piping, which can lead to machinery breakdown, contaminating your process or even cause blockages?

Using an instrument to measure dew point, a so-called dew point analyzer or dew point meter, will help users to operate a safe and reliable compressed air system, notifying them early in case of alarms. This article is a short overview of available dew point transmitter technologies, with a review of their advantages and disadvantages when used in measurement equipment.

Introduction

The dew point describes the temperature when water vapor in the air starts to condense. Typically, the dew point temperature (Td) in

ambient pressure and temperature conditions is around 54–57°F (12–14 °C) Td. Everyone has encountered this phenomenon in their daily lives. Take a cold beverage out of the refrigerator on a warm summer day and within seconds water droplets will start to build up on the can or bottle surface. The reason is the cold drink has cooled the surrounding air causing it to condense its water vapor onto the surface of the container as the dew point temperature was reached.

It is most common to name the above-described temperature the dew point, pressure dew point or dew point temperature. But when temperatures are below 32°F (0°C) Td, the correct term would be frost point instead of dew point. In the past twenty years, the term dew point and dew point meter has been used and accepted, where frost point sensor or frost point meter would be the strictly correct term, but not commonly used in the industry.

Sensor Technologies for Measuring Water Vapor (Humidity / Dew Point Temperature) in Compressed Air

There are various technologies used to measure the amount of water vapor in compressed air or gases. Many of them are compact and reliable solutions, where others come with cost intense installation requirements and the tendency to lose accuracy over time. Chilled mirrors are setting the benchmark in measuring humidity with a very high degree of accuracy, but these chilled mirrors are relatively expensive and not easy to use, especially in field and portable applications. Chilled mirrors are therefore most likely to be used as reference meters in calibration laboratories or similar facilities, where a very high precision is needed.

The most common sensor types to be used in dew point sensors are electrical sensors which change their electrical characteristics in a certain ratio to the presence of water vapor and offer typical accuracies of +/- 2°C Td. The most well known are Polymer sensors, Quartz-Crystal Microbalance sensors and Metal-Oxide sensors.

In this document, only these three sensor types will be shortly discussed to highlight their advantages and disadvantages.

Metal-Oxide Sensors

There are many variations on the design of this sensor type, but the most common is the Aluminum-Oxide sensor, which basically consists of two layers, or sometimes three layers. The first layer is commonly an aluminum surface forming the base layer on which the second layer, in the form of Aluminum-Oxide, is applied through chemical processes. Some sensors offer a third layer, which acts as a protective layer in the form of high-grade porous metals.

The simplified working principle can be described as that water molecules travel into the Al-Oxide layer and stay there as a water vapor molecules. The water molecule will now change the overall capacitance of the sensor element. As the Al-Oxide gaps are acting as a multiple capacitor array, the electrical capacitance changes when water molecules enter the space between the single gaps. This change can be measured and used to calculate the corresponding humidity present.

Sensor Technologies Used in Dew Point Transmitters – Advantages/Disadvantages

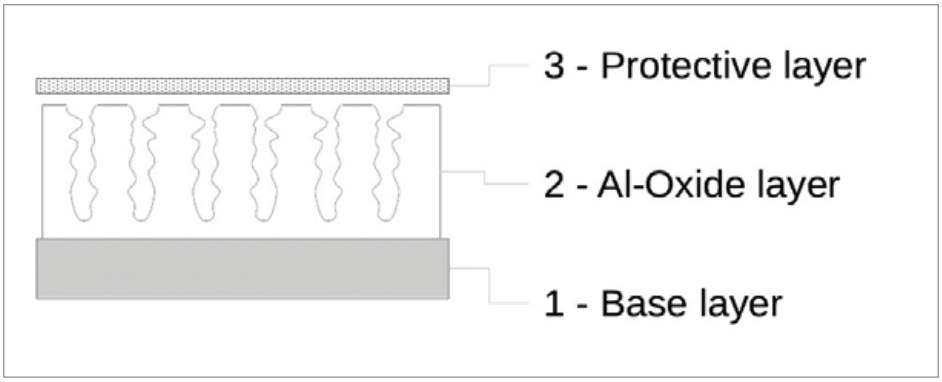

Figure1. Simplified structure of an Aluminium-Oxide Humidity Sensor

TABLE 1 – ADVANTAGES AND DISADVANTAGES OF ALUMINIUM-OXIDE SENSORS

Advantages	Disadvantages
Cheap to manufacture	Slow response time wet-to-dry due to the structural roughness
Fast dry-to-wet response time	Drift over time
Small size	Massive sensitivity to contamination
Wide range of pressure	High calibration frequency

The biggest advantage of this sensor type is they are relatively cheap to manufacture and can be developed in a small size sensor element and can be used over a wide pressure range.

The downside of these sensors is their slow response time and relatively high drift over time. The major problem is the structure of the Al-Oxide surface, which is likely to trap dust or other particles as well as getting progressively clogged over time.

These sensor types are known to offer a good accuracy when deployed, but due to the above described, the accuracy will drift over time, especially if used in conditions where slight contamination exists.

Where these sensors are showing a good response time for dry-to-wet measurements, the response time wet-to-dry is significantly slower. The microscopic rough surface of the Al-Oxide does not release water molecules easily, making them a poor option for fast-changing systems, especially in portable use. Due to the drift, which is around 2°C Td per year, these sensors need to be maintained and calibrated much more often than other technologies.

Polymer Sensors

Polymer sensors are very similar to the principle used in Aluminium-Oxide sensors, but have a determining difference in terms of the sensor structure. Polymer sensors are built in three layers; the base structure acting as an insulated substrate, the second layer of Polyimide measuring the humidity and finally a protection layer on top.

To describe the simplified working principle it can be said the protective layer is made of a porous material acting as a filter. This only lets water molecules pass, but bigger sized impurities are not able to enter the Polymer layer. The water molecules are then changing the electrical capacitance of the sensor element, similar to the described principle for the Aluminum-oxide sensor. The change of the capacitance is electrically measured and is proportional to the presence of the humidity within the sensor element and therefore the surrounding air.

The major advantage of the Polymer sensor comes from the physical structure of the Polymer layer. The even surface makes it easy for water molecules to enter as well as to be released and molecules are not easily trapped. This results in a very fast response time in either or both directions, from dry-to-wet as well as wet-to-dry measurements.

Another advantage is the sensors are highly resistant to contamination and there is almost no drift caused, as the Polymer is unlikely to age or change its structure, even if exposed to high humidity.

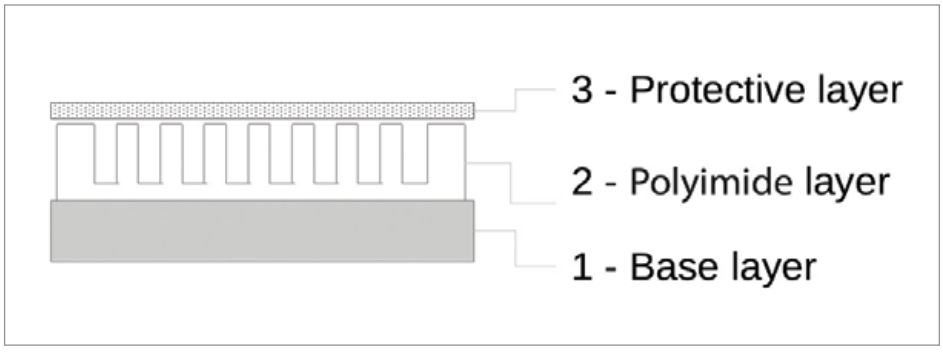

Figure 2. Simplified structure of an Polymer Humidity Sensor

TABLE 2 – ADVANTAGES AND DISADVANTAGES OF POLYMER SENSORS

Advantages	Disadvantages
Structure enhanced resistance to contamination	Not suited for low moisture applications
Fast dry-to-wet & wet-to-dry response times	Inaccurate below -76°F (-60°C) Td
Almost no ageing and/or drift	—
Wide range of pressure	—

Sensor Technologies Used in Dew Point Transmitters – Advantages/Disadvantages

The drawback of these sensors is their sensitivity loss in low moisture applications. Most commonly Polymer sensors are used to measure pressure dew points down to -76°F (-60°C) Td. Below this point the sensitivity decreases massively and results in inaccurate readings.

Quartz-Crystal Microbalance (QCM) Sensors

Quartz-Crystal Microbalance sensors are built with a quartz substrate as a base and covered with a thin film of active moisture adsorption layer. Their measurement principle is based on the mass-change of the oscillating quartz due to the additional mass of water molecules, which will directly alter the oscillating frequency.

At an applied voltage, the quartz will start to oscillate at a resonance frequency. If the sensor is now exposed, to compressed air or gases containing humidity, the water molecules are adsorbed by the thin layer of coating on the sensor surface. By adsorbing the water molecules, the sensors mass will change, and simplified, as it gets heavier by adding up the mass of the water molecules to the total mass, the resulting oscillating frequency will be different from the one when there is no molecule present at all. Based on this, in theory, a QCM sensor is able to detect a single water molecule present on the sensors adsorption layer. Of course heavily depending on the electrical circuit used to apply the oscillating voltage and the evaluation of the frequency shift.

The major advantage of these sensors is the high accuracy in very low moisture applications, where other sensor principles are having drawbacks in terms of sensitivity.

At the same time, QCM sensors have moderately fast response times in wet-to-dry applications, thanks to the highly water adsorbing polymer layer.

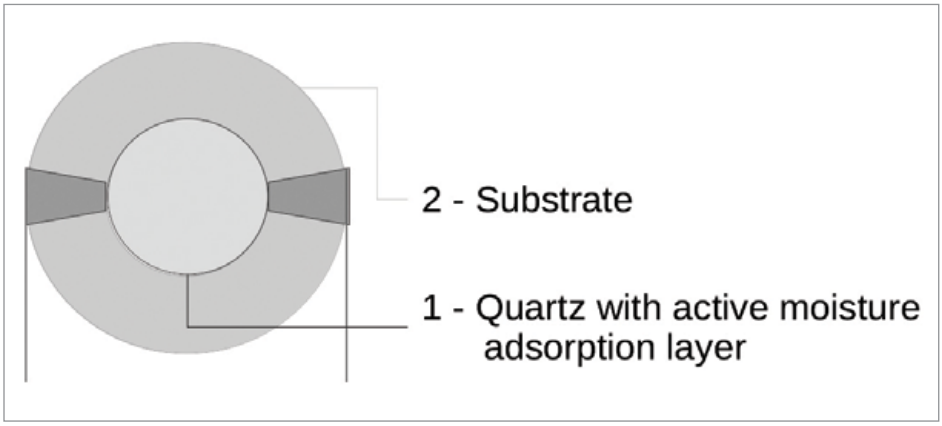

Figure 3. QCM Sensor Element

TABLE 2 – ADVANTAGES AND DISADVANTAGES OF POLYMER SENSORS

Advantages	Disadvantages
Ability to measure in very low dew point applications	Not suitable for high moisture applications at -4°F (-20°C) Td or higher dew points
Fast response time in dry-to-wet applications	Not suitable for high pressure applications

Figure 4. Dew point meter combining QCM and Polymer sensor technologies into a single measurement device.

The disadvantages of QCM sensors are their limitation to be not used in moisture applications where full range dew points shall be measured from -148 to 122°F (-100 to 50°C) Td. The microbalance is typically designed to have a stable frequency in relation to the thickness of the moisture-adsorbing layer. To design a sensor with a high sensitivity in low moisture environments, the thickness of the layer must be thin to get a stable frequency and a noticeable mass change. But this layer thickness limits the capabilities to adsorb more water molecules and therefore limits the capabilities to measure higher dew points. As the adsorption layer becomes saturated at higher moisture levels there is a physical limit to measure higher moisture concentrations.

If the thickness of the adsorption layer was increased, the low range dew point measurements would not have a significant mass change anymore. Therefore in the design of QCM sensors a compromise must be taken, either having a thin layer to measure low moisture or a thicker layer to measure higher moistures but lose accuracy in the lower end. Typically a QCM sensor is designed to measure in low moisture applications.

Another limitation is their use in high-pressure applications. QCM sensors lose accuracy when used in high pressure applications above 1.6 MPa(g) or more, since the compressed gas dampens the ability of the quartz to oscillate.

Sensor Technologies Used in Dew Point Transmitters – Advantages/Disadvantages

Conclusion

The described technologies of Aluminium-Oxide sensors and the Polymer sensors are the most commonly used sensors in dew point meters available on the market and they are well suited for standard moisture measurement applications.

QCM sensors are much more seldom used, as they are to be used in high tech applications, where accurate low moisture measurements are needed.

Aluminium-Oxide sensors are having their major drawback in the sensitivity to contaminations and their physical structure is likely to age and therefore drift over time.

Polymer sensors are the more robust sensors, offering high accuracy and long-term stability, but at the same time, not being suited for low moisture applications.

Sensor Technology used in SUTO iTEC Dew Point Meters

For standard applications, SUTO iTEC relies on the Polymer sensor technology in their dew point meters. Offering a fast response time and a good accuracy in applications where dew points between -76 and 122°F (-60 to +50°C) Td are present, making them optimal to monitor refrigerated and desiccant compressed air dryers.

For high-tech applications, the firm combines two sensor technologies into a single dew point meter. Their unique sensor solutions combines the QCM sensor together with the Polymer sensor into a single measurement unit, offering the advantages of both sensors to be combined and eliminating the disadvantages of each of the both sensor technologies against each others. The sensor automatically switches the sensor element on which it is reading, based on the actual conditions and range. For this purpose SUTO has developed a reliable switching algorithm, which accurately switches to the better-suited sensor element when needed.

With this unique design, the firm is able to offer a Dew Point sensor capable to accurately and reliably measure the full range of dew point temperatures, down to -148°F (-100°C) Td.

In addition, the dew point sensors feature an integrated pressure sensor. By adding a pressure sensor to the measurement device, users are first of all enabled to measure the system pressure, which is a key indicator of any compressed air system, but this also enables them to convert the measurement output to other humidity units on the fly, for example to measure ppm(v), absolute humidity and many others units which are depending on the pressure. This makes this dew point sensor one of the most versatile sensors on the market. BP

About the Author

Simon Gleissner has 8 years experience in measurement technology for compressed air and gases. He is the Product Manager for in-house software developments, as well as Product Manager for Air Quality and Purity Measurement tools. He is also responsible for the German operations of SUTO iTEC, acting as Managing Director since 2019.

About SUTO iTEC

SUTO iTEC is one of the market leaders in measurement technology for compressed air and gases. With more than 20 years of experience in dew point meters, their Research & Development Teams are creating outstanding products, used by companies all over the world. Innovations, like developing their own QCM sensor element and combing it with a Polymer sensor into a single measurement device are making the difference. Their motivation is to create new products to solve common problems and to satisfy their customer needs. For more information please visit www.suto-itec.com

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Commercial Bakery Compressed Air Audit Optimizes the Constituents of Demand

By Mike Lenti, Compressed Air Consultants

➤ Introduction

Compressed Air Consultants performed a compressed air system audit at a commercial bakery. The primary objective of the audit was to determine the constituents of demand that have contributed to the increase in demand over the last couple of years. Presently the plant must operate all three available air compressors in order to support the full production needs of the plant. Therefore, there is insufficient backup to support full production in the event of a primary compressor failure.

The secondary objective of the audit is to determine what opportunities exist to reduce compressed air demand further so that less than two fully loaded compressors are able to support the needs of the plant during all shifts. The supply arrangement was analyzed to determine the integrity of the equipment with the intention to improve compressed air efficiency and quality. The header network was monitored in several locations to determine if any flow restrictions exist.

The current cost to operate the compressed air system is $139,100 annually, and the proposed measures will reduce it by $50,700 annually. The proposed cost to complete the measures is $47,600 providing a simple payback of 11 months. The cost included in the Action Plan includes engineering, project assistance, services to maintain the gains, and a 10% contingency.

Brief Description of the Supply-Side

During full production, the plant is supported by three (3) available rotary screw air compressors located outdoors under the cover of a roof. The flow of compressed air from the compressors feeds a wet receiver tank located beside the compressors and then through 185 feet of 4" pipe to the compressed air dryer room located inside the main facility on a Mezzanine. The 4" wet header feeds a single 1,500 Scfm

depth-of-bed mist eliminator and then to a 140-gallon wet receiver tank located on the mezzanine above the Fermentation Room.

Downstream of the tank is a single 1,250 Scfm cycling type refrigerated air dryer. A pressure control station is installed downstream of the dryer which regulates the air to a lower pressure before being delivered to the distribution header. A dry receiver tank is teed into the line upstream of the pressure control station to extend the cycling time of the air compressors and improve the pressure control of the station.

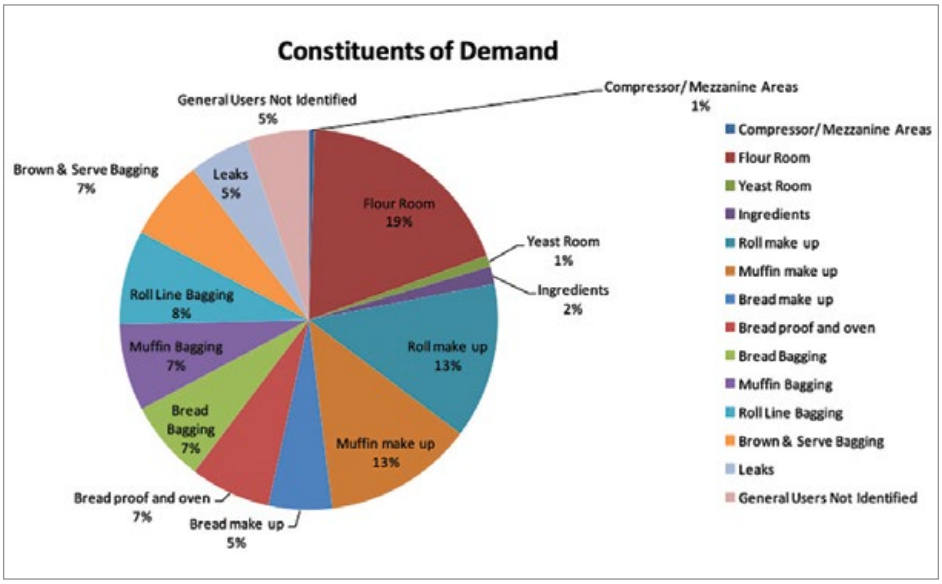
An oil water separator is located in the Main compressor room outside but such equipment is not present in the Mezzanine area where the dryer, small tank, and mist eliminator are located. The system is equipped with compressor automation coordinating the sequencing of the air compressors based on the prevailing system demand.

The compressed air audit was a full supply and demand-side system assessment. Due to article length limitations, this article will share the results of only the demand-side audit.

Constituents of Demand in the Bakery

The plant demand during full production (Bread, Roll, and Muffin Lines operating) when all lines were in operation is 974 Scfm (1st profile), and reduces to 816 Scfm when the Muffin line is shut down (2nd profile). The demand drops to 746 Scfm during the four hour cleaning cycle (3rd profile) which occurs every day.

Since the last compressed air audit, conducted over ten years ago, the Roll make-up area has been upgraded with new equipment that has changed the demand profile of the facility. There are other users that have been added to the system but which had not been identified before this audit.



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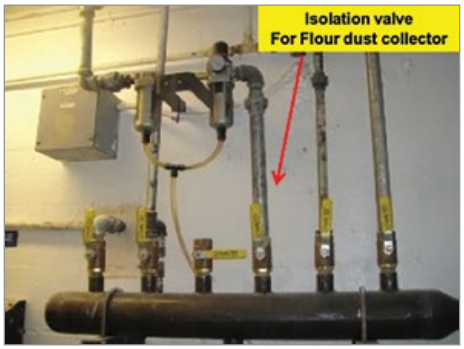
Below is the distribution makeup of the compressed air usage for the facility. Note the largest area consumer of air in the plant resides in the Flour Room area. This anomaly is due to a malfunctioning dust collector that is discussed later in the report. The plant maintenance and engineering team has done a great job of maintaining high levels of production with minimal waste. An example is there are very few leaks representing less than 5% of the entire load (50 Scfm).

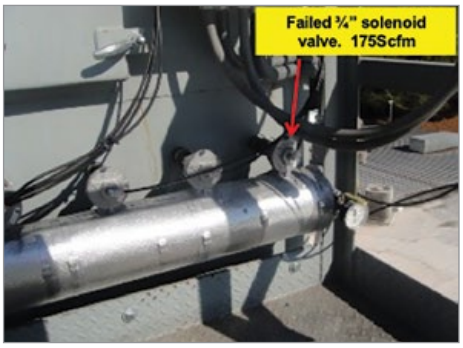
Demand Side Projects to Enable Air Compressor Redundancy

The audit has identified over 300 Scfm of demand side reductions that will restore the system back to a point where the plant can operate on two air compressors during full production. Please note it is important that all measures are completed as it will enable the facility to withstand the loss of its largest compressor, a 125 HP unit, during the summer months without impacting production.

1. Flour Room: Flour Dust Collector on Roof

The pilot valve assembly on a ¾" solenoid valve on the Flour dust collector located on the roof has come disconnected allowing 175 Scfm of air to continuously blow. The supply of air and primary isolation valve for the Flour





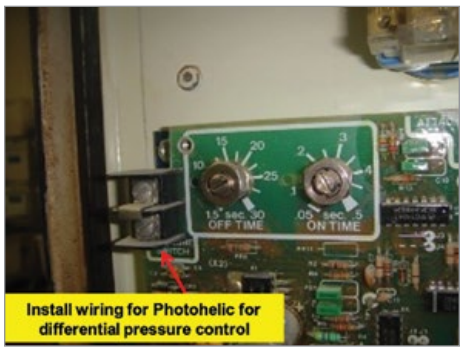
dust collector is located in the Flour Room. The malfunctioning pilot assembly valve is consuming 175 Scfm and represents 16% of the entire system demand. The malfunctioning solenoid valve is the primary reason the plant can no longer support full production with two (2) air compressors. During the study we shut off the supply of compressed air to the Flour dust collector during full production and noted that the reduction in demand enabled the third on line compressor to unload, time out, and shut off. This test confirmed the plant can in fact operate on two air compressors if the pilot solenoid valve on this dust collector is restored.

The primary cause of the failure is the connection fitting on the pilot air solenoid valve, which needs to be upgraded to a compression type fitting so that it does not occur in the future. The dust collector can also be retrofitted to operate on differential pressure instead of timer based to reduce the demand from 10 Scfm to 3 Scfm.

2. Bread Line Minor Ingredients Station

The Ingredients Station is equipped with a pulse regeneration dust collector. The dust collector cleans the filter bags that catch the airborne flour from the mixing process at the station. The dust collector is equipped with a controller that is set for a fixed regenerating pulse interval of three (3) seconds set for a pulse duration of 0.22 seconds. When the dust collector is in operation (in automatic mode), the dust collector consumes an average of 26 Scfm and can represent as much as 3% of the entire compressed air demand. We project that the station is in use about 50% of the time. Often the station is left idle for extended periods of time while the machine is not manually stopped causing the dust collector to continue to consume air for regeneration even though it is not needed. The existing controller on the dust collector can be retrofitted to accommodate a Photohelic for differential pressure control.

We propose installing a photohelic differential pressure control to the existing controller as shown in the picture. We project the plant can eliminate about 50% of the average demand or 6.5 Scfm by completing this measure. In the future, if the operator leaves the machine on and leaves the station, the dust collector will only pulse when the differential across its tube sheet reaches a certain level.



3. Air Knife on Pan Cleaner for Bread Line

On the bread line an air knife is used cleaning the empty bread pans before being returned to the beginning of the line. During the study an inline flow meter was installed on this application and it was measured to consume

37 Scfm Continuously. Install Solenoid valve activated by existing proximity switch.

an average of 37 Scfm. The supply of compressed air to the air knife is configured without a solenoid valve or a proximity switch for automatic operation and therefore consumes air continuously even if a pan is not present.

There are opportunities during production, where there is an interruption to the flow of bread pans returning to the Pan cleaner, where the supply of compressed air can be automatically turned off. There is an existing proximity switch upstream of the pan cleaner that can be utilized to detect the presence of a pan and in turn determine whether compressed air is required at the Pan Cleaner air knife. We project that air is not required 30% of the operating time for the Pan cleaner and will reduce the average compressed air demand by 12 Scfm. Install a solenoid valve on the supply of compressed air that is controlled using the existing proximity switch located upstream of the pan cleaner station.

4. Secondary Pan Cleaner on the Bread Line

There is a secondary pan cleaner on the Bread line used intermittently for additional cleaning. The secondary pan cleaner is typically used when the small bread pans are used with toppings, which often leave product hard to dislodge. The air consumption of the secondary Bread Pan cleaner is 50 Scfm based on a measurement using a flow meter. The secondary pan cleaner uses a homemade air-knife consisting of twenty-six (26) small holes.

Using an engineered air knife in place of home-made drilled holes will help reduce the compressed air consumption. The difference in compressed air consumption is over 2:1 at the same inlet pressures. We project the air consumption of the secondary Bread pan cleaner will be 25 Scfm when in operation. The primary motive for implementing this action is to ensure that the backup compressor is not turned on to support this intermittent event. A solenoid valve should also be installed that shuts off the supply of compressed air when a pan in not present. A new proximity switch may be required in order to detect the pan upstream of the secondary pan cleaner

50 Scfm air consumption on homemade air knife used for small bread pans with toppings.

5. Open Blowing – Bag Tails

Open blowing is used for orienting the bag tails at the end of each line before being fed through the wrapper. By blowing air at high velocity between the pan and the bread, it frees the product from sticking. On all three lines, it is used to blow against the bag tail

Commercial Bakery Compressed Air Audit Optimizes the Constituents of Demand

prior to adding the tie wrap. We observed that the compressed air usage in this area is not consistent as the consumption of each line for bag tails were 3, 6, and 8 Scfm for a total consumption of 17 Scfm.

A low-pressure blower can be used in this application but has not been received well when tested. If compressed air is continued to be used for this application, then a small flow meter should be installed on each application so that a standard can be established. We believe this application can be adequately served using 3 Scfm each. Establishing a standard for this application will reduce the average air consumption by 8 Scfm.

6. Open Blowing on Roll Line Flour Exhaust Hoods

Each of the two (2) roll lines is equipped with an exhaust hood for removing Flour from the Roll Pans using a vacuum system. The efficiency of the vacuum system is improved by the use of an air knife that tangentially deflects the flour off of the pan towards the exhaust hood. During the study an air flow meter was installed on the unit and it was determined that the average compressed air consumption per line is 27 Scfm for a collective usage of 54 Scfm for the two lines. The supply of compressed air to the exhaust hoods is continuous and cannot be shut off unless an operator manually shuts it off.

Each of the compressed air supply lines feeding the exhaust hoods should be retrofitted to automatically shut off if a Roll pan is not present on the line. A proximity switch will have to be installed upstream of the exhaust hood so that it can ensure air is being supplied to the exhaust hood as the pan cross under it. We project that 50% of the air for this application can be eliminated due to the running schedule. There is an opportunity to shut off the supply of air when there is an interruption to the product flow or when the line is down.

7. Farr Dust Collector for Roll Pan Cleaner

The Farr dust collector supporting the Roll Pan Cleaner operates on a continuous cleaning cycle. The pressure drop across the tube sheet of the dust collector is over 6" WC even when cleaning in a continuous mode. The interval between pulses for the dust collector is 15 seconds with a pulse duration of 0.15 milliseconds. The dust collector consumes an average of 5 Scfm. The filters in the dust collector need to be replaced and the unit switched to differential pressure control so that it only regenerates when the differential reaches a certain level. We project that there is a 3 Scfm savings by completing this measure.

8. Muffin Line Air Vibrators

The facility uses a large amount of air vibrators to ensure the movement of the bread making ingredients. These devices perform their duties admirably; however, when considering the volume of air consumed which ranges from 7 to 30 Scfm each, do not out perform their electric counterparts. Understandably, the environment in which they are applied may force the facility to stay with the air vibrator due to the inability to run electricity to the vibrator or perhaps if the vibrator were in an explosive condition. Production has indicated

that it is more difficult for the dough to freely travel down the line since corn meal is being used in lieu of flour.

There are nine (9) air vibrators located downstream of the Muffin line dividers at the drop lines. The air vibrators are located on the Corn Meal feed chute, the sifter, on the drop section, and the Corn Meal reclaim system. During the study an in line flow meter was installed to measure the largest five (5) Vibco air vibrators. The five largest air vibrators consume 85 Scfm. Collectively, the nine (9) air vibrators on the Muffin Line consume 109 Scfm and represent close to 11% of the entire system demand. The plant has indicated that it is difficult to keep the product flowing in this area since corn meal is used in lieu of flour and the resistance or friction against the conveyor is much greater. They believe that the air vibrators do a satisfactory job keeping the Muffin dough flowing down the line.

On occasion we observed that the air vibrators continue to consume air even if the Muffin line is out of production unnecessarily taxing the


Air consumption of five largest air vibrators Zig Zag on Muffin Line

compressor supply. The supply of compressed air is controlled using a manual isolation valve and therefore requires operator intervention in order to shut off the supply of compressed air during the appropriate times.

We propose installing an interlocked solenoid valve that shuts off the supply of compressed air when the line is out of operation. In addition, if the upstream conveyor to the line is idle, the air vibrators do not need to operate and can be automatically shut off with the new solenoid valve. We project that the Muffin line operates 50% of the operating hours during the week and the supply of compressed air is left on the air vibrators half of the time. Therefore, the consumption of compressed air for this application can be reduced by 25% by installing the interlocked solenoid valve. We project the average air consumption to be reduced by 22 Scfm (25% of 89 Scfm).

One of the air vibrators in this area is a large Vibco VS510 vibrator, located on the Corn Meal reclaim system cover directly below the drop area, consuming 20 scfm continuously. We propose replacing it with an electric vibrator which we believe will work satisfactorily for this specific application.

9. Vacuum Generators

There are five (5) engineered compressed air generated vacuum generators located at the Roll dough mixer, the Bread dough divider, muffin dough divider, and the Muffin and Brown & Serve box makers. These devices use compressed air to flow through the engineered passages within the device to create a vacuum for suction, and the compressed air is exhausted to atmosphere. The vacuum generators are consuming 10% (95 scfm) of the compressed air for the system.

With the exception of the box makers, the other four units were placed on the line to supplement an existing system that was not working properly. These devices work incredibly well, and their initial cost is inexpensive; however, the cost to generate the compressed air for these makes them a poor long-term solution. Based upon the cost to generate compressed air at this commercial bakery, using compressed air to generate vacuum versus a dedicated vacuum pump is four times less efficient. A dedicated vacuum system, however, for these operations would be difficult to justify due to the initial capital cost of the equipment, and the extensive piping network that would be required.

During the audit, the compressed air supplied to the vacuum generators on the bread dough

divider and the roll mix would only energize when required, and would shut off when not in use. The air supply to the muffin divider, muffin box maker and Brown & Serve box maker are left on continuously, essentially acting as a leak. If the air supply were to be turned off to these vacuums when not in use, the plant demand would easily be reduced by 15 scfm assuming a reduction of usage by 50%. We propose installing similar controls be placed on the air supply for the Muffin and Brown & Serve vacuums as is used on the roll and bread units.

10. Empty Box Reject Station

There is an empty box reject station using compressed air to eject empty boxes that were not filled with brown and serve rolls. The open blowing application is a nozzle consuming 8 Scfm continuously. This application should be controlled using a solenoid valve where compressed air is only activated when the line is active. We project this measure can reduce the average air consumption of this application by 5 Scfm. BP

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Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – *Sponsored by BEKO Technologies*
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APR 28
Air Compressor Cooling, Water- or Air-Cooled?
Presenter Tom Taranto, Owner, Data Power Services – *Sponsored by Kaeser Compressors*
Thursday, April 28, 2022 – 2:00PM EST

MAY 12
IIot Solutions for Multiple and Multi-brand Compressors Remote Monitoring
Presenter Tim Dugan, P.E., President and Principal Engineer, Compression Engineering Corporation – *Sponsored by Kaishan*
Thursday, May 12, 2022 – 2:00PM EST

MAY 19
ASME PTC 13 Wire-to-Air Performance Test Code for Blower Systems Part 1
Presenters Julie Gass, Lead Mechanical Process Engineer, Black & Veatch, Fred Constantino, S&C Project Engineering Advisor, ASME and Andrew Balberg, President, Lone Star Blower and Compressor – *Sponsored by Lone Star Blower & Compressor*
Thursday, May 19, 2022 – 2:00PM EST

JUN 09
Sizing and Maintaining Compressed Air Systems
Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – *Sponsored by Kaishan*
Thursday, June 9, 2022 – 2:00PM EST

JUN 23
Compressed Air System Design for Lowest kW/100scfm
Presenter Tom Taranto, Owner, Data Power Services – *Sponsored by VPInstruments and BEKO Technologies*
Thursday, June 23, 2022 – 2:00PM EST

JUL 21
Applications for Adiabatic Cooling Technology
Presenter Bert J. Wesley, Sr. Principal Industrial Plant Engineering Practice Leader, Woodard & Curran – *Sponsored by Evapco*
Thursday, July 21, 2022 – 2:00PM EST

JUL 28
ASME PTC 13 Wire-to-Air Performance Test Code for Blower Systems Part 2
Presenters Hiran de Mel, Senior Project Manager and Principal Technologist, Jacobs and Lloyd Slezak, Consulting Engineer (ret), Brown and Caldwell – *Sponsored by Howden*
Thursday, July 28, 2022 – 2:00PM EST

AUG 18
Liquid Ring Vacuum Pump Sizing Fundamentals & Best Practices
Presenter Chris Halbach, Senior Applications Engineer, Wintek Corporation
Thursday, August 18, 2022 – 2:00PM EST

AUG 25
Avoiding Production Downtime: Realtime Compressed Air Quality Monitoring and Audits
Presenter: Francisco Lara, Manager, Airtec Global LLC – *Sponsored by SUTO-iTEC*
Thursday, August 25, 2022 – 2:00PM EST

OCT 20
How to Determine the Ideal Physical Location of a Cooling Tower
Presenter Nick McCall, P.E., Technical Manager, Woodard & Curran – *Sponsored by SPX Cooling Technologies, Inc.*
Thursday, October 20, 2022 – 2:00PM EST

OCT 27
Compressed Air: What You Don't Know Can Hurt You
Presenter Ron Marshall, Chief Auditor, Marshall Compressed Air Consulting – *Sponsored by VPInstruments and Kaeser Compressors*
Thursday, October 27, 2022 – 2:00PM EST

NOV 10
ASME PTC 13 Wire-to-Air Performance Test Code for Blower Systems Part 3
Presenters John Conover, Consultant, Mark Addison, Senior Engineer, Artesian Water Company, and Fred Constantino, S&C Project Engineering Advisor, ASME – *Sponsored by APG-Neuros*
Thursday, November 10, 2022 – 2:00PM EST

DEC 08
Compressed Air: Reliable Source for Nitrogen Generation
Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – *Sponsored by Rogers Machinery and Parker*
Thursday, December 8, 2022 – 2:00PM EST

Bert J. Wesley
Sr. Principal Industrial Plant Engineering Practice Leader, Woodard & Curran

Antonio Mayne, P.E.
Utilities Optimization Engineer, Molson Coors Beverage Company

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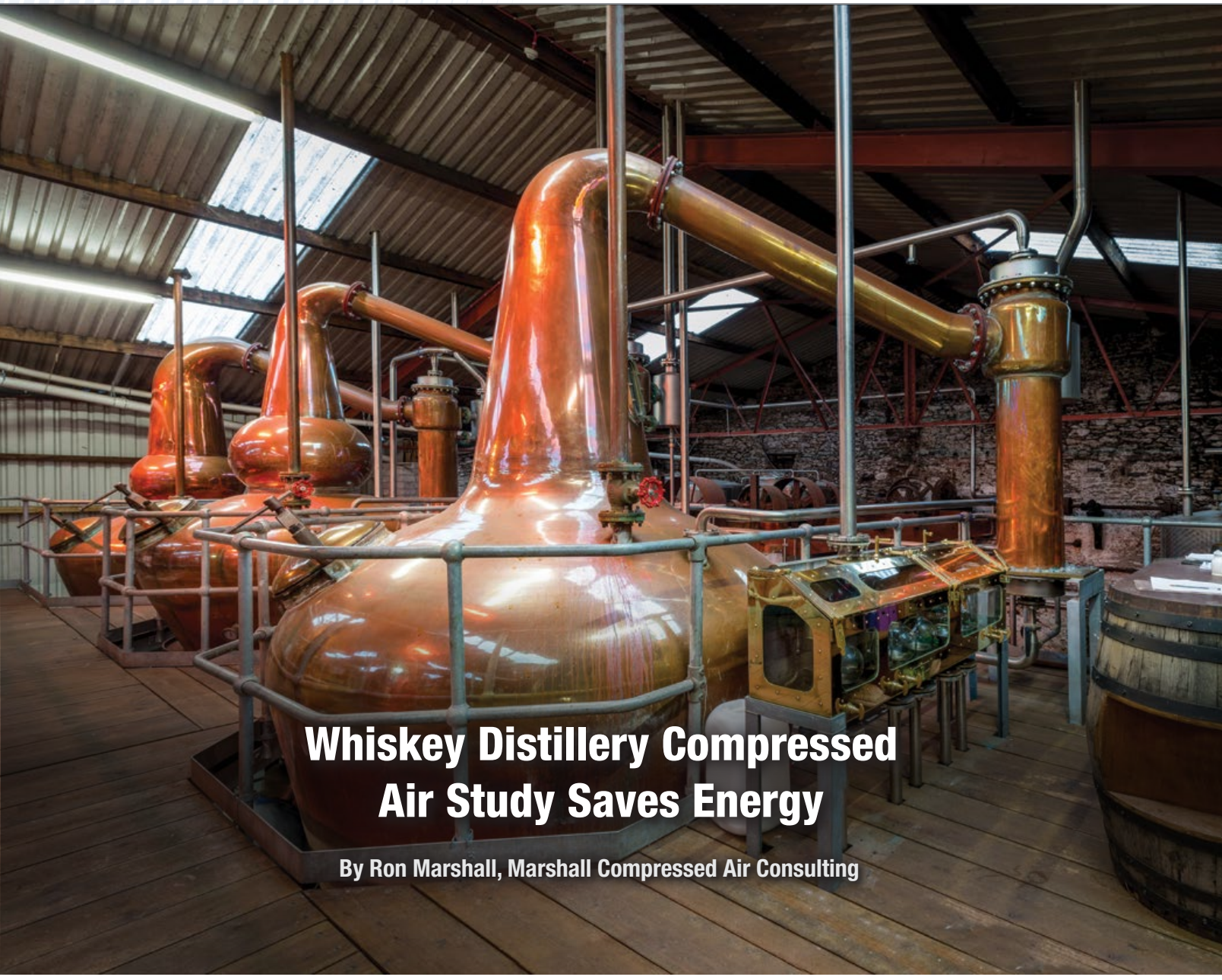

Whiskey Distillery Compressed Air Study Saves Energy

By Ron Marshall, Marshall Compressed Air Consulting

A premium whiskey distillery was seeking to renew their compressed air system and meet their corporate mandate in making their production facility more efficient. The first step on the road to improvement was having their compressed air system assessed. This article discusses some of the findings of the system study, which saved significant energy, improved system reliability, and captured a significant utility incentive to help with the study costs and the cost of a new compressor.

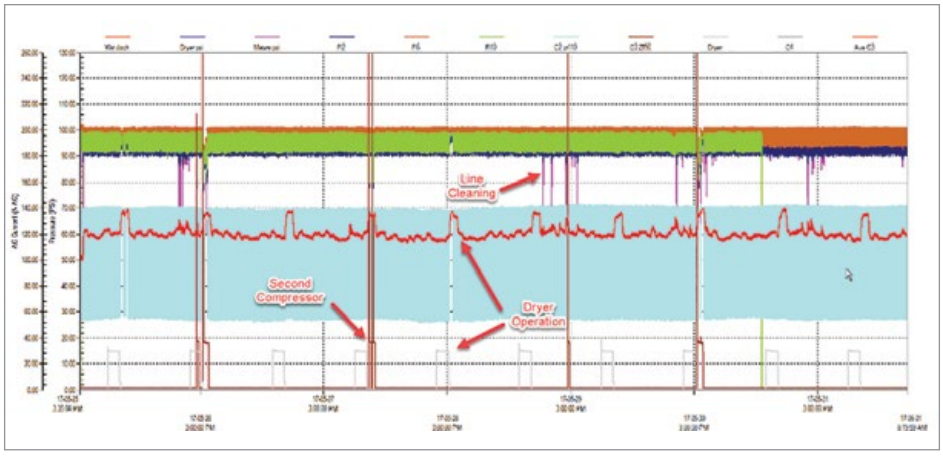

Figure 1. Pressure and amp profiles showed no significant pressure loss, other than the pressure differential caused by orifice plates deliberately placed on storage receivers. The amp profiles showed that higher than desired flow caused by air dryer cooling purge caused a second compressor to be required to hold pressure.

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Background

The facility had installed compressed air capacity consisting of three non-lubricated screw compressors sized 110 kW, 90 kW (air cooled) and 160 kW (older spare). These compressors were independently controlled with only one normally operating to feed plant requirements. Occasionally a second compressor was required to feed peak flows. The system has a heated blower desiccant dryer with dew point control to condition the air, with associated filters.

The compressed air is directed throughout the plant through a radial feed of steel piping. One medium sized 500-gallon storage receiver is located in the compressor room area as dry control storage.

Installed data loggers showed minimal pressure loss across the piping system. Most of the pressure loss was across the drying and filtering system and/or across restrictor plates deliberately designed into the system to reduce high transient flows caused by some high flow end uses.

The amp logging showed that the compressors were running in load/unload mode and some had significant unloaded run time, reducing system efficiency. The captured data also showed when the air dryer cooling purge operated a second compressor was required.

A survey of the demand side of the system was done including leakage. A total of 49 leakage points were found, estimated at 50 cfm. Various compressed air uses that could be classed as potentially inappropriate uses were found including star seal blowing, bin vibrators, poorly adjusted dust collectors, compressed air vacuum, air horn ventilators, and fume blowing.

The shape of the compressed air flow demand curve during production (approximated by the red line Figure 1) captured over a one-week period at the end of the data logging can be seen. The pressure profile shows good pressure regulation when only one compressor is required. Dips in pressure can be seen on occasion when two compressors are required. The profile shows a somewhat flat pattern during production activities with higher peak flows just after the air dryer heating cycle. These peaks are caused by the dryer cooling cycle. Heated blower style dryers don't use compressed air for purging the desiccant, however, after the heated regenerating cycle an amount of dried compressed air is expanded to atmosphere as it passes through the hot desiccant bed. The typical flow for this cooling cycle is about 8 percent of the nameplate rating of the dryer. The actual purge for this dryer was found to be much higher.

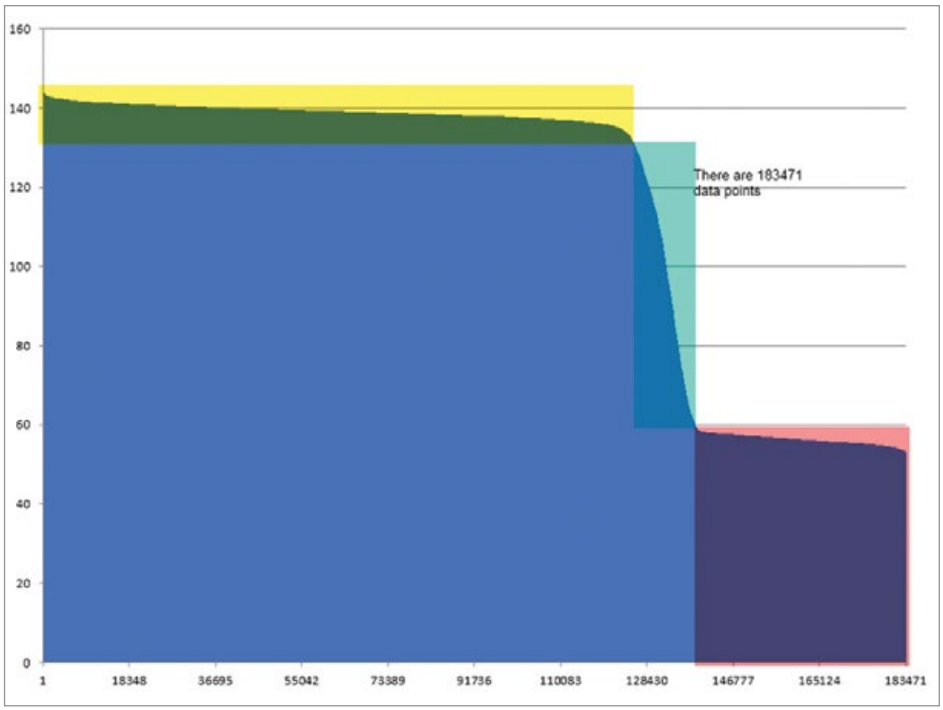

Figure 2. Amp data shorted highest to lowest to form a histogram showed two areas of inefficiency, when the compressor was switching states (light blue regions) and when the compressor was running unloaded (light red region)

Additional peak flows are somewhat random, associated with clearing of liquid product lines after transfer from production areas to storage vessels. The dryer associated peaks, with coincident line cleaning, required two compressors, on occasion, to support plant pressure, although the second unit barely loads In this way line clearing and the dryer heater contribute to the plant peak electrical demand.

This profile showed that the air dryer was consuming higher than normal cooling purge, if something could be done about this, the requirement for two compressors running would be minimal, saving on peak demand. Savings could also be gained if leakage and inappropriate use could be reduced.

The existing compressors were running in load/unload mode with coordinated cascaded pressure bands. With this type of operation there are periods of time where a compressor is running, consuming power, but producing no compressed air. The area of inefficiency, where the compressor runs unloaded, is identified in light red highlight in Figure 2, this is a "load duration" profile of C3 compressor amp data points sorted highest to lowest to form a histogram. This area of inefficiency can be addressed by choosing a compressor with a control mode that doesn't have unloaded run time (VSD operation).

It should be noted, further to this, due to compressor cycling, there is a period of time where the compressor is in transition between loaded and unloaded, or reverse indicated with the green highlight. This can also be addressed by eliminating compressor cycles using VSD mode.

And, in addition, there is extra power consumed by the compressor if it runs at higher pressure than required by the plant, this is indicated with the yellow highlight. This can be addressed by reducing the compressor discharge pressure by adjustment.

			Annual
Baseline	**Units**	**Average**	**kWh**
Discharge ave	psi	98.5	
Dryer Out ave	psi	98.3	
Pure Link EOL ave	psi	95.5	
ZR110	kW	106	928,560
ZT90	kW	1	8,760
Dryer	kW	3.6	31,536
Total	kW	110.6	968,856
Peak	kW	177	
Specific Power	kW/100 cfm	21.7	
Flow	cfm	492	
Peak Flow	cfm	760	
Operating	hours	8760	
Cost			$66,420

Figure 3. Baseline readings showed the system running at fair efficiency.

VSD compressors typically run at a fixed target setpoint, rather than a "sawtooth" pattern, resulting in lower average discharge pressure if the target is set to the previous "load" setpoint of the original compressor. This chart, and similar ones for the other compressors can be used to determine projected savings.

Assessment Results

The analysis of the data collected showed the baseline shown in Figure 3.

The readings and observations during the measurement period showed the compressed air system was producing air at fair efficiency (21.7 kW/100 cfm). Problems with the air

End Uses	Hours	cfm	duty	peak kW	annual kWh	peak cost	kWh cost	Total cost	Duty Saved	Saved kWh	Saved $	Available Incentive
Boiler View Port	8760	5	100%	1.1	9,945	$ 102	$ 372	$ 474	100%	9,945	$ 474	$ 1,492
Magnetic Detector Chute	100	30	2%	6.4	14	$ 613	$ 1	$ 614	50%	7	$ 307	$ 1
L16 chute blowing (G4)	7896	40	20%	1.7	14,342	$ 164	$ 536	$ 700	50%	7,171	$ 350	$ 1,076
L16 chute vibrator (G4)	7896	10	20%	0.4	3,585	$ 41	$ 134	$ 175	90%	3,227	$ 157	$ 484
F8 dust collector	8760	10	100%	2.1	19,889	$ 204	$ 744	$ 948	50%	9,945	$ 474	$ 1,492
Cooker 1 blowing	7896	30	20%	6.4	10,756	$ 613	$ 402	$ 1,016	50%	5,378	$ 508	$ 807
Slurry Blowing	7896	40	100%	8.6	71,710	$ 818	$2,682	$ 3,500	50%	35,855	$ 1,750	$ 5,378
Air Vacuum	100	30	2%	6.4	14	$ 613	$ 1	$ 614	90%	12	$ 553	$ 2
G4 Bin Vibrator	7896	10	30%	0.6	5,378	$ 61	$ 201	$ 262	90%	4,840	$ 236	$ 726
Dryer Purge	8760	150	12%	32.1	35,800	$ 3,067	$1,339	$ 4,406	36%	12,888	$ 1,586	$ 1,933
Failed dc valve	100	185	1%	39.6	42	$ 315	$ 2	$ 317	100%	42	$ 317	$ 6
					171,475	n/a	$6,413	$ 13,027		89,268	$ 6,396	$ 13,390

Figure 4. Various potentially inappropriate uses were found in the plant and some priorities (highlighted) identified

Whiskey Distillery Compressed Air Study Saves Energy

dryer cooling purge flow, higher than needed discharge pressure, some small leakage and drainage issues, and some inappropriate end uses were causing higher than desired operating costs and occasional pressure issues.

Figure 5. Compressed air vacuums like this can cause high peak demand which trigger an additional compressor to start.

Demand side

A thorough look at the demand side turned up various potentially inappropriate uses, these were assessed and costed out in Figure 4. Figure 5 shows a typical compressed air powered vacuum that has low duty cycle but can contribute to starting a second compressor. A typical dust collector manifold arrangement is shown in Figure 6 with a significant leak identified. Various random blast valve failures, one caught during verification logging,

Figure 6. Six reverse pulse dust collectors exist in the facility. The failure of one blast valve caused low pressure in the plant during a final measurement period.

occasionally cause low pressure events in the plant (shown in Figure 8).

Some end uses associated with the handling of grain in the facility cooker area were identified, continuous blowing was being used for cleaning of star seals and to promote the flow of grain within chutes. One blowing application (Figure 7) was found to be consuming a surprising 15% of the total plant compressed air flow.

Verified Savings

Conservative estimates done during the compressed air assessment showed a possible projected reduction in operating costs of 29% could be gained if a new compressor was installed and end uses were addressed. Various improvement projects were initiated, with a five-figure incentive from the local utility offered to help with the costs:

- Replacement of 90 kW load/unload compressor with a 132 kW VSD compressor

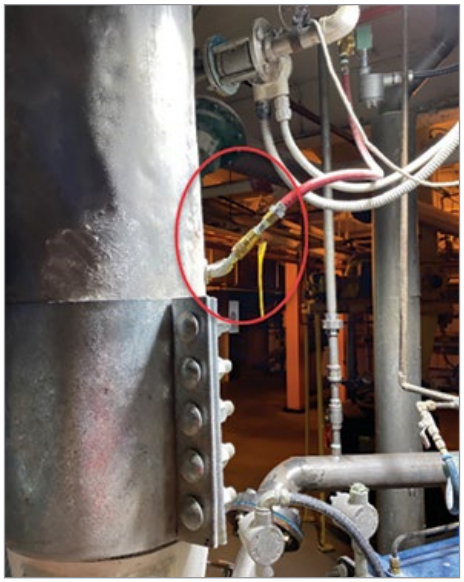

Figure 7. Plant personnel had made modifications to product chutes to prevent clogging, the continuous flow of this blowing represented 15% of the total plant cfm demand.

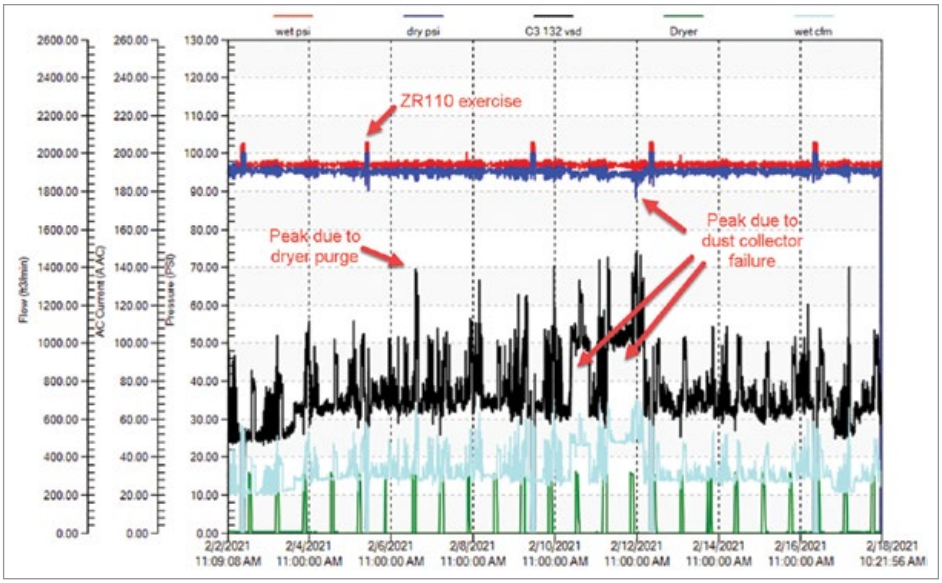

Figure 8. An older 90 kW compressor was replaced with a 132 kW VSD unit. The new compressor and reduced flow due to end use optimization.

- Adjustment of the air dryer cooling purge
- Leakage repair
- Elimination of various blowing or reductions in blowing pressure using regulators
- Adjustment and repair of various dust collectors, installing local storage
- Replacement of air vibrators with electric

Final verification of this project showed that the end use and leakage repair had resulted in the reduction of the average air demand by175 cfm. With the new compressor installed the system operating costs fell by $28,000 saving 43%, much higher than the projected amount.

Conclusion

This project shows the value of having a thorough assessment done before any compressor replacement. The audit found various unanticipated savings areas that increased the available savings and increased the available utility incentive that could be granted. As a result of the improvement efforts, the plant is now running more efficiently, and more reliably. Plant management have also ensured annual assessments are done to ensure the savings can be sustained. BP

For more information about this article, contact Ron Marshall at Marshall Compressed Air Consulting, tel: 204-806-2085.

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

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COMPRESSED AIR TECHNOLOGY NEWS

Kaeser's New M30PE 100 cfm Portable Compressor

Kaeser's new M30PE Mobilair™ portable compressor offers heavy-duty performance in a lightweight package. This compact unit delivers up to 100 cfm at 100 psig and has been optimized for low noise and emission levels. The tough, dependable M30PE features a non-scratch, dent and temperature-resistant, molded polymer shell and is perfectly suited for construction, demolition, and other heavy-duty uses.

Standard features include the power saving Sigma Profile airend and a reliable, fuel efficient Kubota diesel engine meeting Final Tier 4 specifications. The one piece canopy allows quick access to all service points. Torsion bar suspension system, oversized tires, and a lightweight, compact design provide superior road handling and onsite maneuverability. The M30PE also features Kaeser's anti-frost control to protect and extend the life of pneumatic tools in cold weather. Mobilair™ compressors are available in a wide range of sizes.

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 us at us.kaeser.com/mobilair or call us at (877) 417-3527.

The M30PE delivers 100 cfm at 100 psi with a compact, low emission design.

Teledyne FLIR Introduces Thermal Studio Software

Teledyne FLIR has announced the addition of FLIR Thermal Studio Software Suite to the entire family of FLIR Si124 Industrial Acoustic Imaging Cameras: the Si124, the Si124-LD, and the Si124-PD. The software integration offers Si124 users additional, advanced troubleshooting and processing features for predictive maintenance on critical components including high-voltage electrical or compressed air systems, providing increased productivity and streamlined analysis.

FLIR Thermal Studio Software Suite empowers operators to quickly build professional inspection reports, including with more than 100 images within fully customizable templates, overlays, and formulas. Advanced features include batch processing and Magic Wand accelerate post-processing tasks for streamlined thermal analysis, with the added ability to enhance thermal video by analyzing, recording, segmenting, and editing footage in the software. The added value of offline reporting provides a complete detection and analysis package for the easy-to-use and high-performance family of acoustic imaging cameras.

For operators already leveraging Thermal Studio Suite on other thermal imaging devices, they can now create a single report using imagery from multiple devices, including any of the Si124 family of cameras. They also enjoy the ability to customize templates and combine sound imaging and thermal imaging assets into one. Users can preview, open, and process

Compressed Air Technology News

images, then adjust them in the report while still conducting inspections.

"The recent FLIR Si124 camera family expansion provides tailored solutions specific for compressed air leak detection or particle discharge detection to end-users ranging from utility infrastructure to plant environments, at a fraction of a cost," said Rob Milner, global business development manager, condition monitoring, Teledyne FLIR. "Now, with the integration of FLIR Thermal Studio Software Suite, users can enjoy advanced processing features and unchallenged reporting capabilities like leak quantification, partial discharge severity assessment, and reporting options in both thermal and acoustic images to create a swift classification and quantification process."

FLIR Si124

The flagship FLIR Si124 locates pressurized leaks in compressed air systems and detects partial discharge or corona from high-voltage electrical systems, offering the widest range of capabilities in one package. The lightweight, one-handed solution with 124 microphones can identify issues from up to 130 meters (430 feet) and 10 times faster than traditional detection methods via a precise acoustic image that visually displays ultrasonic information upon a visible image. The camera empowers inspectors to pinpoint a sound source, even in loud industrial or bright outdoor environments. For more, visit https://www.flir.com/products/si124/.

Si124-PD for Partial Discharge Detection

The FLIR Si124-PD is specifically designed for electrical and utility inspection, featuring automatic electrical fault classification for partial discharge issues, including surface discharge, floating discharge, and discharge into air. With the PD Severity Assessment software feature, users can also input the kind of component, the equipment voltage, and the distance from the component to get a severity assessment specific to those parameters. This feature is included within the FLIR Acoustic Camera Viewer cloud software included with the camera. For more, visit https://www.flir.com/products/si124-pd/.

Si124-LD for Compressed Air Leak Detection

The Si124-LD features real-time, on-device leak sizing and cost analytics, allowing users

FLIR Si124 Industrial Acoustic Imaging Cameras include FLIR Thermal Studio Software Suite.

to instantly view the leak rate onscreen as it occurs, either in liters per minute (l/min) or cubic feet per minute (CFM), and to quantify leak size. This feature provides a quick assessment of how much air is being lost and estimated cost savings from fixing the issue. As part of a regular maintenance program, organizations can extend the life and efficiency of existing compressors while reducing the need to install new units all while lowering electricity costs. For more, visit https://www.flir.com/products/si124-ld/.

The FLIR Si124-PD, Si124-LD, and original Si124 Industrial Acoustic Imaging Camera models with FLIR Thermal Studio Software Suite are available for purchase globally from Teledyne FLIR and its authorized dealers. To learn more or to purchase, visit https://www.flir.com/products/si124.

Eisele New 2-in-1 Connector for Air & Vacuum Tubing

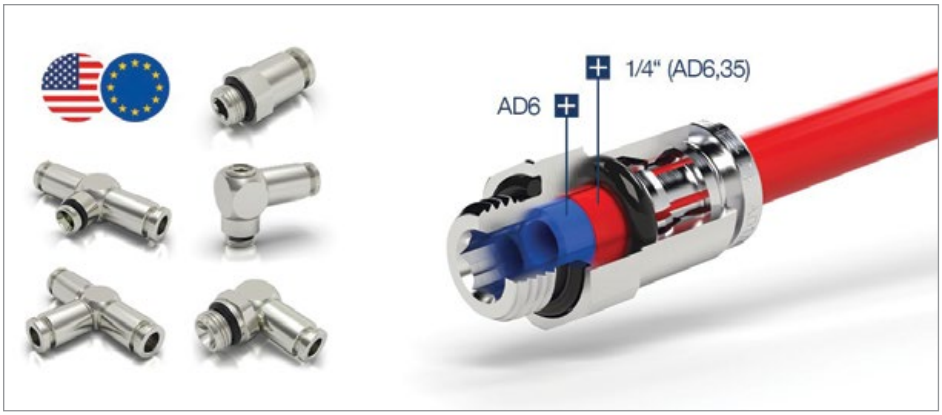
Eisele introduces the 2-in-1 Connector – one connector, two diameters. The simple push-in fittings of the Eisele BASICLINE have already proven themselves millions of times in industry and technology for the fast, tool-free assembly and disassembly of tubing for the supply of compressed air and vacuum. Now Eisele is reducing the variety of parts in stock with the new 2-in-1 connector for two tube sizes in one – ideal for international use.

The classics among the Eisele compressed air connectors are made of nickel-plated brass, are leak-free and fail-safe even under difficult environmental conditions. The push-in fittings for compressed air with the easy-to-handle release ring are suitable for pressures from -14 to 217 psi and ambient temperatures from -4 to +176°F. Thanks to a design change, two different tube diameters can now be mounted with the same push-in fitting using the new 2-in-1 Connector: Whether it is a metric tube with OD 6mm (0.236 in) or inch tube with 1/4" (OD 6.35mm), the installed connector is the same. The same connector can be used for applications in Europe and in the USA.

The 2-in-1 Connectors are very economical and compatible with all common connection systems. This connector offers full tube passage without diameter constrictions. Tube damage during the assembly of the 2-in-1 Connectors is not possible, due to the defined penetration depth. Thanks to the optimized collet, the tube can be easily released from the connector without tools. The lightweight and compact push-in connectors are available in many designs, for example straight, angled or as a T-connector, and are supplemented by a comprehensive range of accessories. They are available with all common thread sizes (M5, M7, G1/2, G3/4) as well as internal and external hexagon for application-specific assembly.

This combination results in greater process reliability, as it is impossible to mix up the connectors for country versions with other dimensional units. This optimizes the assembly process while reducing parts diversity and storage costs. In addition, there is a higher diameter tolerance when compensating for oval deformed tubing. For the customer, there is less administrative work due to fewer storage locations and less part numbers and CAD data. The plug-in connection version with hexagon socket can be mounted using a cordless screwdriver, thus speeding up assembly.

For more information, visit www.eisele-connectors.com.



With the new 2-in-1 Connector from Eisele, two different tube diameters can now be mounted with the same push-in connector.

Compressed Air Technology News

Siemens Announces SIMOTICS SD200 in Frame Size 440

Siemens announced the immediate availability of the SIMOTICS SD200 severe-duty motor in frame size 440 as its latest offering in the low-voltage SIMOTICS motor family.

Providing high productivity and energy-efficient operation in all torque ranges, these new cast-iron NEMA motors are built to power pumps, fans, compressors, hoists, winders and similar equipment in harsh environments. With a three-year warranty, the SD200 motors offer 75-800 hp output and feature 444-5013 cast-iron frames for operation in 460V and 575V ranges. They meet or exceed NEMA Premium® MG1 Table 12-12 efficiencies. A wide selection of options is offered, including IP56 ingress protection, encoders, brakes, and blowers plus others to suit the applications presented.

On these motors, the frame, end-shields, fan guard and easy-access, diagonally split, oversized terminal box are all cast-iron. Complementing this construction are zinc-plated hardware, epoxy paint and stainless-steel nameplates for long life and easy identification in the field. A unique offset rotor bar provides improved efficiency, while larger bars and end rings reduce resistance. Each die-cast aluminum rotor assembly is dynamically balanced for extended bearing life and includes a high-strength C1045 carbon steel shaft for maximum performance. Premium C5-grade steel laminations and copper magnet wire are standard.

Siemens SIMOTICS SD200 frame size 440 low-voltage, severe-duty AC motors are designed for use in the harsh environments.

For insulation, the Class-H non-hygroscopic system with NEMA Class B temperature rise provides an extra margin of thermal life. The insulation system meets or exceeds NEMA MG1 2014 Part 31, making these motors suitable for variable speed drives in constant torque (4:1) and variable torque (20:1). All windings are tested for Corona Inception Voltage (CIV).

The Siemens Product Manager for Low-Voltage NEMA Motors, Oscar Palafox, said, "One of the features of the SD200 is its flexibility in the field, as the motor can be switched from F1 to F2 and F3 orientation with ease. Plus, the safety features on this new line are unmatched by competition. Full H-Class conformity provides winding protection, while the swivel hooks are a significant improvement over eyehooks for handling of these heavy units. In addition, the unique Siemens composite insulation on the SD200 is a cost-saver over the ceramic bearing alternative with ten times the resistance of other solutions in the market. Finally, the NEMA Premium® efficiency is a guarantee of long performance life with very tight deviation of losses. Shaft current remains more consistent for better uptime." Palafox further notes this new line affords users Division II, Class 1 (gas) and Class 2 (dust) protection.

About Siemens Corporation

Siemens Corporation is a U.S. subsidiary of Siemens AG, a global powerhouse focusing on the areas of power generation and distribution, intelligent infrastructure for buildings and distributed energy systems, and automation and digitalization in the process and manufacturing industries. Through the separately managed company Siemens Mobility, a leading supplier of smart mobility solutions for rail and road transport, Siemens is shaping the world market for passenger and freight services. Due to its majority stakes in the publicly listed companies Siemens Healthineers AG and Siemens Gamesa Renewable Energy, Siemens is also a world-leading supplier of medical technology and digital healthcare services as well as environmentally friendly solutions for onshore and offshore wind power generation. For more than 160 years, the company has innovated and invented technologies to support American industry spanning manufacturing, energy, healthcare and infrastructure. In fiscal 2018, Siemens USA reported revenue of $23.7 billion, including $5.0 billion in exports, and employs approximately 50,000 people throughout all 50 states and Puerto Rico. For more, please visit http://usa.siemens.com.

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The Magazine for Safety, Quality & Reliability in Energy-Efficient Compressed Air Systems

Compressed Air Best Practices® is part of a family of magazines dedicated to **Safe, Quality and Reliable Systems Powering Automation.** The U.S. Department of Energy estimates compressed air represents 30% of industrial energy use. Each issue features expert articles on how to conduct **Best Practice System Assessments** to reduce energy consumption while enhancing **Quality, Safety and Reliability.**

"Some of our plants have created Air Strike Teams to focus on compressed air, particularly compressed air leaks. The teams have purchased ultrasonic leak detectors, and we expect these will help us with our Energy Treasure Hunts."

— Michael Jones, Director of Corporate Energy, Intertape Polymer Group

"We have had supply-side compressed air audits performed, within the last three years at around forty percent of our plants. Generally, we are looking for a ten to fifteen percent energy savings from most of the projects we identify and execute."

— Daniel K. Pemberton, Corporate Project Engineer, Berry Global

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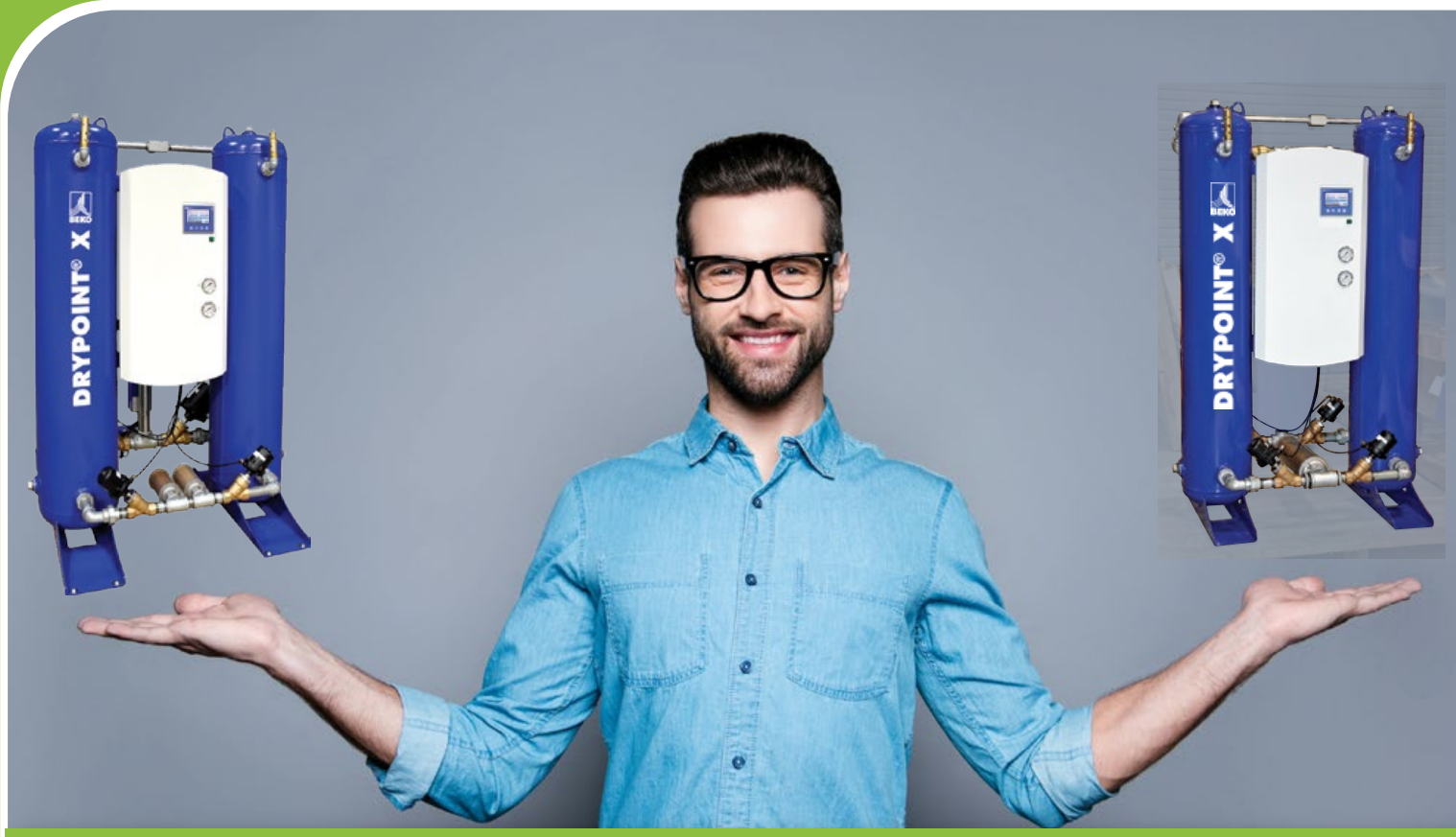

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