The Magazine for ENERGY EFFICIENCY in Compressed Air Systems

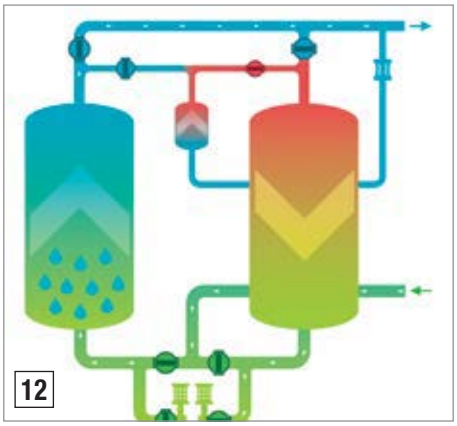
COMPRESSED AIR BEST PRACTICES

airbestpractices.com

November 2017

Compressed Air Purification

SUSTAINABLE MANUFACTURING FEATURES



COLUMNS

FROM THE EDITOR | Compressed Air Purification

The ANSI/ISA-7.0.0-1996 Instrument Air Standard is often used as a reference in production facilities. Pressure dew point, particle size, lubricant content and contaminants are the four elements identified in the standard in its effort to define instrument air quality for use in pneumatic instruments. Deepak Vetal, from Atlas Copco, provides us with a succinct summary of the Standard followed by a review of adsorption compressed air drying technologies.

Air Capital Equipment has represented Sullair in Kansas since 1978 and now represents them also in Oklahoma and parts of Missouri. Their longtime customer, Wichita-based seeding equipment manufacturer Great Plains, has grown over the years and had Sullair compressors running in five separate buildings. Nicholas De Deken, from EnergAir, provides us with an interesting audit story detailing how using a master compressor control helped Great Plains consolidate and optimize their compressed air system.

Air compressors are actually responsible for removing most of the moisture in a compressed air system. Tim Dugan, from Compression Engineering Corporation, provides us with a solid review of the air compressor intake, oil-temperature control, after-cooler cleanliness and maintenance, moisture separator design and drain maintenance. All these factors impact performance.

Ron Marshall has provided us with an article about an audit done at a meat processor where the energy costs associated with compressed air were $153,000 per year. The audit discovers these costs can be lowered by almost fifty percent. Chief culprits were 71 compressed air leaks and air compressors running in very inefficient modulating modes of operation.

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

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INDUSTRY NEWS

Gardner Denver Acquires LeROI Compressors

Gardner Denver Holdings Inc. (NYSE: GDI), a leading global provider of mission-critical flow control and compression equipment, announced it has acquired LeROI Compressors ("LeROI") for a purchase price of approximately $20 million funded by cash on hand. Based in Sidney, Ohio, LeROI is a leading North American manufacturer of gas compression equipment and solutions for vapor recovery, biogas and other process and industrial applications. LeROI will be part of Gardner Denver's Industrials Segment.

"LeROI is a market-leading business with strong talent and excellent long-standing customer relationships," said Vicente Reynal, Gardner Denver's CEO. "This transaction is aligned with our strategy of leveraging core technologies and know-how to drive organic growth and build additional value at acquired companies. LeROI will provide mission-critical gas compression technologies and enable expansion of our product offering into new and attractive markets. We are thrilled to welcome the LeROI team to the Gardner Denver family," added Reynal.

"This marks an exciting time for the LeROI business," said Richard Wall, LeROI's president. "As part of Gardner Denver, LeROI will be better positioned than ever to continue to deliver service excellence to our customers and expand into new markets."

About Gardner Denver

Gardner Denver (NYSE: GDI) is a leading global provider of mission-critical flow control and compression equipment and associated aftermarket parts, consumables and services, selling across multiple attractive end-markets within the industrial, energy and medical industries. Its broad and complete range of compressor, pump, vacuum and blower products and services, along with its application expertise and over 155 years of engineering heritage, allows Gardner Denver to provide differentiated product and service offerings for its customers' specific uses. Gardner Denver supports its customers through its global geographic footprint of 37 key manufacturing facilities, more than 30

complementary service and repair centers across six continents, and approximately 6,100 employees world-wide. For more news and information on Gardner Denver, please visit www.gardnerdenver.com.

California Compression Appointed Sullair Distributor

Sullair, an industry leader in innovative compressed air solutions since 1965, is pleased to announce California Compression, LLC has been appointed an authorized distributor for Sullair Commercial and Industrial Products for Northern California. As an authorized distributor, California Compression will provide full customer sales and support for Sullair equipment, parts, service, and warranty support.

"Sullair is very excited to have a distributor offering such a highly trained and experienced compressor team to customers in Northern California," according to Tim Sohnlein, Sullair director of sales, commercial and industrial products. "We are excited about the end-to-end capabilities California Compression brings to the market. Their expert audit capabilities will be a tremendous asset in ensuring customers receive the compressed air solution best suiting their application."

California Compression carries the full line of Sullair oil flooded compressors from 5 hp to 600 hp, plus the complete line of oil-free and centrifugal compressors up to 30,000 hp. Additionally, they offer the complete Sullair air treatment system, including compressed air dryers/filters/drains, industrial vacuum systems, flow controllers and Genuine Sullair Replacement Parts.

"Our team at California Compression is very excited to represent the Sullair line in the Northern California area," says Jim Morgan, California Compression's president. "We truly believe that Sullair products are the best in the industry, and their commitment to the oil-free and Centrifugal product lines, combined with our expertise in auditing and utility incentive programs, provide tremendous growth opportunities for both companies well into the future."

Located in Livermore, CA, California Compression offers guaranteed performance

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system installations, turnkey projects and air system audits as part of their full-service approach to servicing industrial air compressor customers.

About Sullair

Since 1965, Sullair has developed and manufactured air compressors with proven reliability and wear-free durability. Sullair is globally recognized as a leading manufacturer of portable air compressors, contractors' air tools, stationary air compressors, compressed air treatment equipment and vacuum systems. Additionally, Sullair provides customers with a full line of aftermarket parts, fluids and services. Sullair has manufacturing capabilities in Michigan City, Indiana; Shenzhen and Suzhou, China; Mahindra World City, India; as well as a JV (IHI-Sullair) based in Suzhou. For more information, visit www.sullair.com.

SMC Opens a New Sales Office in Knoxville, Tennessee

SMC Corporation of America, a leading global pneumatics and industrial automation components manufacturer, expands its local support by opening a new sales office at 1703 Schaeffer Road, Knoxville, TN 37932. This office will provide local support to East Tennessee and is located just minutes east of Oak Ridge National Laboratory in the Hardin Valley.

The new 3,500 sq. ft. office features a training room with a 24-person capacity, a product show room fully equipped with a wide range of pneumatic and electrical product displays and will be home to the local sales and support team.

The SMC Knoxville office will continue its commitment to personal service and face-to-face interaction with customers in all industries, especially automotive, heavy vehicles, machine tool, life sciences, food and packaging as well as renewable energy. The East Tennessee team consists of six locally based, direct account managers and specialists partnering with an extensive network of authorized SMC distributors.

About SMC Corporation of America

SMC Corporation of America is headquartered at 10100 SMC Boulevard, Noblesville, Indiana 46060, and is a subsidiary of SMC Corporation in Japan. SMC Corporation is the world's largest pneumatics company dedicated to factory automation with technical

"We are excited about the end-to-end capabilities California Compression brings to the market. Their expert audit capabilities will be a tremendous asset in ensuring customers receive the compressed air solution best suiting their application."

— Tim Sohnlein, Sullair

development centers in Japan, the U.S., Europe and China. There are 26 sales offices in the United States and 4 sales offices in Canada supported by domestic engineering, manufacturing and inventory located in Noblesville, Indiana. For more information, visit http://www.smcusa.com/.

MCAA Newsletters Reinforce Economic Growth

Two economic newsletters published by the Measurement, Control & Automation Association (MCAA) reinforce the widespread news of continued US economic growth through 2017 and 2018, barring any interference from other geopolitical or black swan events. The recent impacts of Hurricanes Harvey and Irma are yet to be measured in this calculus.

Measuring Markets is a quarterly economic newsletter published by the Association. This quarter indicates the 2.6% GDP bounce back in the second quarter of this year is attributable to solid consumer spending, an uptick in government spending and still solid business investment spending and exports. Capital spending during the second quarter increased at a seasonally adjusted annualized rate of 5.2%. This is very encouraging against the historical backdrop of a weak 2.3% growth over the course of 2015, and an actual decline of 0.6% in 2016. Additionally, business spending in the equipment category expanded at an 8.2% annualized rate during the quarter, almost double the 4.4% rate in 1Q17, and the strongest quarterly increase recorded during the past two years.

In a special Economic Report prepared exclusively for MCAA members by ITR Economics, five manufacturing categories were reviewed in depth, these were, chemical and chemical products, food, paper and paper products, mining, and electric power. ITR projects chemical production will grow during 2018, and paper production will expand for a slight period. Food and mining production will both grow in 2018, although at slowing rates during the first half of next year. ITR noted accelerating growth in the manufacturing

INDUSTRY NEWS

sector (up 0.7% year-over-year), and recovery in the mining sector (virtually even with the year-ago level), are contributing to the accelerating growth in U.S. industrial production (up 0.5%). However, U.S. electric and gas utilities production is slowing, up 0.7% year-over-year and is expected to contract mildly during the next two quarters. U.S. electric power generation, transmission and distribution is expected to transition to a rise by early 2018.

In addition to these periodic economic outlooks, MCAA collects data (confidentially) from member companies and publishes to the participants monthly and quarterly bookings reports. These provide far more granular information about specific product categories and end-user industries. Aggregated data from those reports is provided to the editors of the economic newsletters to analyze and compare with broader economic data available from a variety of sources.

About MCAA

MCAA is the voice of the measurement, control and automation industry. The Association provides the best community and resources for manufacturers and distributors of instrumentation and systems, used by industry around the world. MCAA members run and grow their businesses by utilizing unsurpassed market and business insights, unique networking opportunities, effective employee development programs and unbiased, affordable market data. For information, visit www.mcaa.org.

Festo Opens New Customer Solutions Center in Ohio

Festo, a leading manufacturer of pneumatic and electromechanical systems, components, and controls for process and industrial automation, will close its Appleton, WI, center and move custom assembly and kitting services to a larger facility in Mason, Ohio. The move places custom services within a few miles of the parts and logistics resources of the Festo North American Regional Service Center. The new Customer Solutions Center will provide customized products to the company's North American customers.

The new 15,000-square-foot Customer Solutions facility will be located at 4028 Binion Way in Mason, about five miles from the parts and distribution resources of the Regional Service Center at 7777 Columbia

> "The Mason Customer Solutions Center will be the newest of the company's five North American custom solutions locations and will support customers with customized multi-axis systems and components, assembly and kitting services and pre-assembled control cabinets."
>
> — Festo Corporation

Road also in Mason. The new facility will consist of present employees and new hires and is expected to open in September. The Mason Customer Solutions Center will be the newest of the company's five North American custom solutions locations and will support customers with customized multi-axis systems and components, assembly and kitting services and pre-assembled control cabinets. Fast turnaround and delivery of customized products, one of the company's competitive advantages, will be augmented by proximity to the regional distribution center.

In 2016, Festo moved its distribution and assembly operations from Hauppauge, New York, to a new 230,000-square-foot Regional Service Center in Mason, Ohio, to create a more centrally located distribution hub. The regional center serves customers in the United States, Canada and Mexico and is comprised of logistics, production, purchasing and engineering. Festo employs to date almost 180 employees in Mason and targets 250 employees by end of 2018.

About Festo

Festo is a leading manufacturer of pneumatic and electromechanical systems, components and controls for process and industrial automation. For more than 40 years, Festo Corporation has continuously elevated the state of manufacturing with innovations and optimized motion control solutions delivering higher performing, more profitable automated manufacturing and processing equipment. For more information, contact us at www.festo.us or by calling 800-993-3786.

The ANSI/ISA Instrument Air Standard and ADSORPTION TYPE DRYERS

By Deepak Vetal, Product Marketing Manager – U.S. Oil Free Division, Atlas Copco Compressors

ANSI /ISA–7.0.0–1996 is the globally-recognized quality standard for instrument air as defined by the Instrument Society of America. Below, we'll go through the Standard's four elements of instrument air quality for use in pneumatic instruments.

1. Pressure Dew Point

According to the ISA standard, the pressure dew point, when measured at the dryer outlet, should be at least 18 ˚F below the minimum temperature where any part of the instrument air system is exposed. The pressure dew point should not exceed 39 ˚F at line pressure.

2. Particle Size

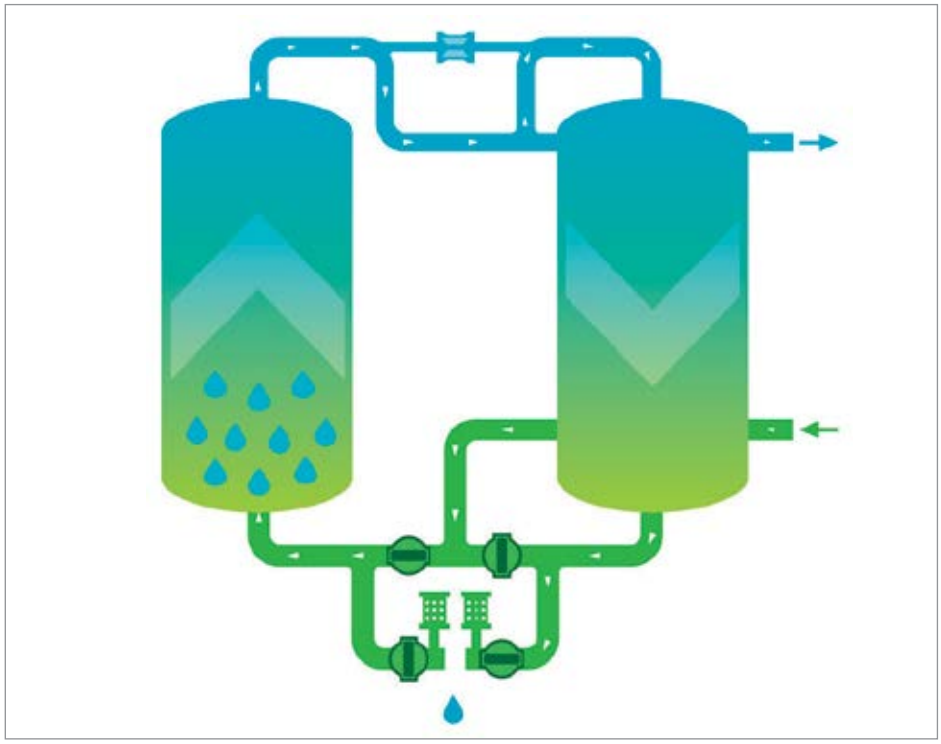
A maximum particle size of 40-micrometer in the instrument air system is acceptable for most pneumatic devices. Additional filtration should be added for pneumatic devices requiring instrument air with less than 40-micrometer particle sizes. After any maintenance or modification to the air system, the maximum particle size in the instrument air system should be verified to be less than 40-micrometers.

3. Lubricant Content

Oil content should be as close to zero as possible, and under no circumstances should lubricant content exceed 1 ppm w/w or v/v. Any lubricant in the compressed air system should be evaluated for compatibility with end-use pneumatic devices.

4. Contaminants

Instrument air should be free of contaminants and hazardous gases. If contamination exists in the compressor intake areas, the intake should be moved to a different elevation or location where it is free from contaminants. Sources of contamination may include painting, chemical cleaning and/or engine exhaust.



How a heatless dryer with two towers of desiccant functions.

A Review of Adsorption Compressed Air Drying Technologies

Compressed air quality is an important element when it comes to meeting instrument air requirements, since any amount of particulates, vapors or aerosols can cause damage to the equipment. Operators often install filters to remove particulates and aerosols, as well as dryers to remove any excess moisture, but sometimes operators can take these measures too far. Greatly surpassing necessary limits and increasing energy consumption.

Let's take a look at different adsorption drying technologies available for instrument air applications, and how choosing the right technology can save energy and reduce carbon emissions.

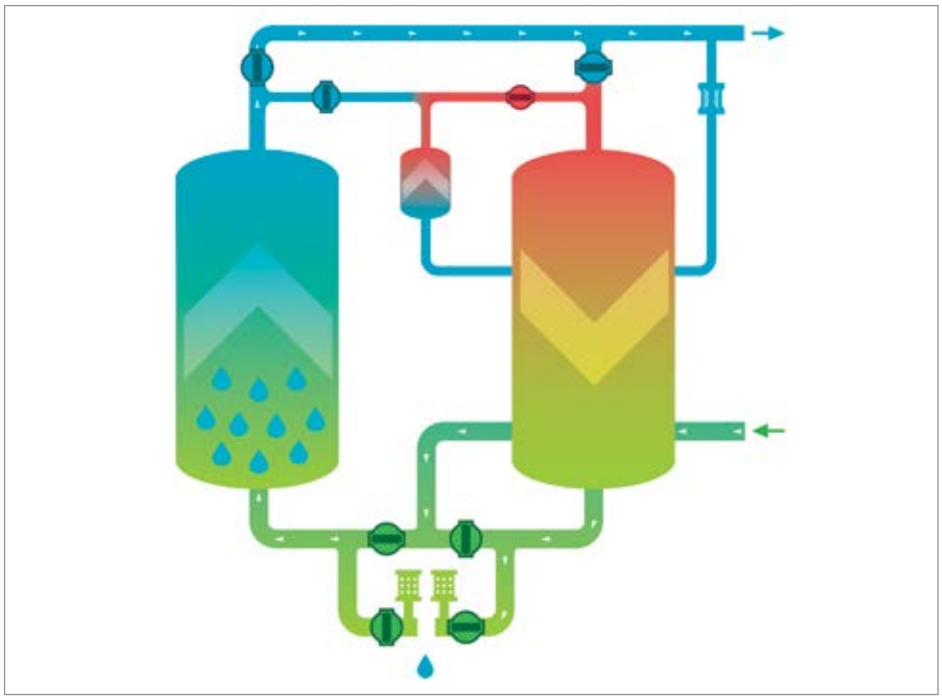
Heatless Dryer

In a heatless dryer, water molecules are transported through the pores of desiccant beads in a process called diffusion. The molecules accumulate on the pores' surface via physical binding, chemical binding and capillary condensation.

A heatless dryer consists of two towers of desiccant. Air enters the dryer through a series of filters, helping to prevent desiccant contamination and deterioration to the dryer's performance.

The dryer's valve system directs air into the first tower vessel and switches the towers over when the regeneration process is complete. Meanwhile, wet compressed air enters the first tower from the bottom. The desiccant removes moisture from the air as it travels upwards, and once the air reaches the required dew point of, say -40 °F, the dry air leaves the dryer and enters a filter removing any residual desiccant dust. Once this process is complete, the air is ready for use in sensitive applications.

THE ANSI/ISA INSTRUMENT AIR STANDARD AND ADSORPTION TYPE DRYERS



Example of externally heated drying.

When the first tower becomes saturated with air, the remaining air begins to enter through the second tower. The drying cycle is repeated when the first tower needs to be regenerated, followed by the second tower, where 15% to 20% of dry compressed air enters from the top of the regenerating tower.

As the air travels downwards, it removes water from the desiccant and exits the tower through a silencer. A heatless dryer can offer lower dew points, but may result in loss of compressed air and wasted energy.

Externally Heated Dryer

In an externally heated dryer, the process begins when wet air enters from the bottom through the valve system as one tower dries the air, and the other tower regenerates it.

Approximately 7% of dry air is used for regeneration, passing through the heating vessel and into the wet tower. The hot, dry air pulls moisture off the desiccant bed, then is ejected through the silencer and into the atmosphere. After a few hours, the heaters switch off, and dry air is passed over the bed to cool the desiccant and remove any remaining water. The purge valve then closes and the tower re-pressurizes. When the towers are ready to switch, the same cycle repeats in another vessel.

Externally heated dryers normally experience a 7% purge loss of compressed air, while also requiring heating power for regeneration.

Blower Reactivated Dryer

A blower reactivated dryer also consists of two desiccant towers. In one tower, the desiccant adsorbs the air's moisture, while the saturated desiccant is reactivated in the other tower. After half of a cycle is complete, the tower functions are reversed.

During its adsorption phase, wet air enters the bottom of the drying tower through the lower main valve. The air flows upwards through the desiccant, adsorbing the moisture, and dry air leaves the tower through the upper main valve.

When the desiccant is saturated in the reactivation phase, the dryer's fan blows ambient air through the internal heater. The heated air forces the adsorbed moisture out of the desiccant, as the hot, wet, ambient air leaves the tower through the bottom valve until the heater is switched off by its thermostat. The reactivation phase is further improved by cooling the desiccant bed with dry, expanded compressed air. Regeneration efficiency is greatly enhanced by use of this dry air from the drying tower.

After regenerating, the tower is pressurized to equal the system's pressure by closing the bottom valve. The dryer is now ready to shift over to the other tower.

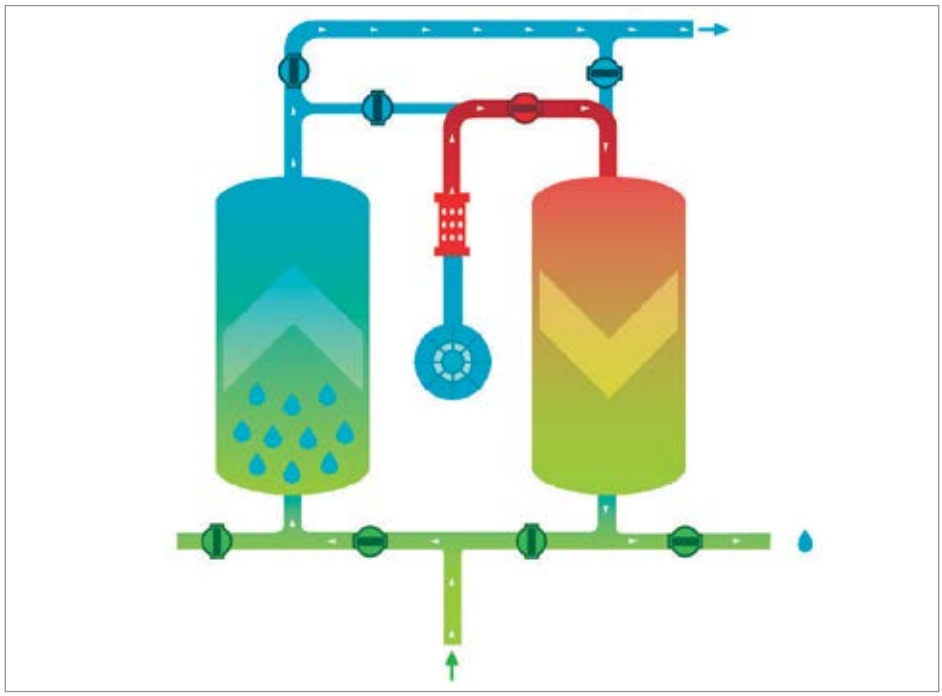
Heat of Compression Dryer

In a normal drying process, electrical heaters, or dry compressed air, are used for the regeneration of desiccant. Heat of compression dryers use the heat generated in the compression stage to fulfill the desiccant regeneration.

During the first phase of flow regeneration, hot compressed air enters, without an after cooler, from the top of the tower vessel and exits from the bottom, where it removes all moisture from the desiccant. The air then travels through the cooler and a water separator before entering the drying tower.

After this heating step is complete, the desiccant is cooled so it does not exceed 302 ˚F, a temperature where the desiccant could lose its hygroscopic capacity and prevent it from capturing moisture. The cooled desiccant helps

THE ANSI/ISA INSTRUMENT AIR STANDARD AND ADSORPTION TYPE DRYERS



Example of blower reactivated drying.

in avoiding spikes in dew point after shifting towers.

In the zero-purge cooled variant, there is an extra cooler in the dryer. The hot air from the compressor is sent through the cooler and a water separator before entering the hot tower. The process is then repeated, helping the air reach its required dew point without wasting energy and the compressor's heat of compression.

Although we've explored different ways of reaching the necessary requirements for dry instrument air, obtaining a -40 ˚F PDP is often overkill. This is because it requires much more energy than what's required to achieve the minimum level of acceptable PDP, which is 18 ˚F below the minimum ambient temperature. By adjusting this factor, operators can save energy, reduce their carbon footprint and decrease operating costs.

Let's take a look at an example using two drying technologies with different PDP requirements: a heatless desiccant dryer at -40 ˚F and a heat of compression dryer at -3 ˚F with these site conditions and process requirements:

- Oil-free compressor
- Minimum ambient temperature = 15 ˚F
- Flow = 1,000 cfm
- Pressure = 100 psig
- Ambient temperature = 80 ˚F
- Relative humidity = 60%
- Ambient pressure = 14.5 psia

Heatless Desiccant Dryer with -40 ˚F PDP

With a heatless desiccant dryer, there is always purge loss. Coupled with the low PDP of -40 ˚F, this amounts to a total annual energy consumption of 387,000 kWh and an annual CO_2 production of 166,000 kg. At the price of

$0.07/kWh, the annual electricity cost is $27,000 for the compressor and dryer alone. Not only does this scenario harm the environment, it can also seriously impact the bottom line.

Heat of Compression Dryer with -3 ˚F PDP

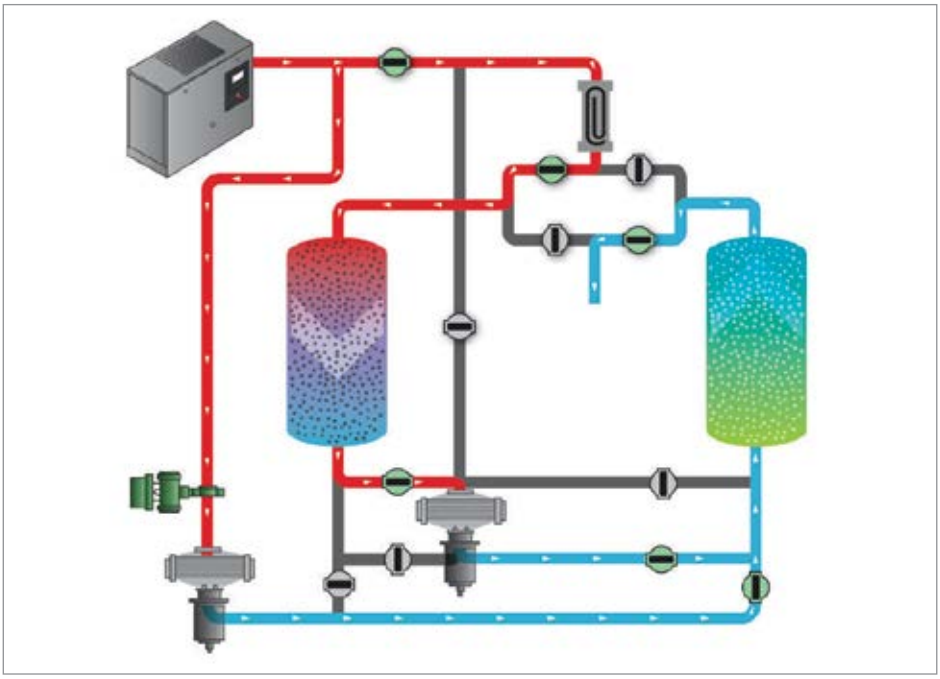
Now, let's change the required PDP to -3 ˚F. As mentioned before, the minimum level of acceptable PDP is 18 ˚F below the minimum ambient temperature, and in this case, it's 15 ˚F - 18 ˚F = -3 ˚F. When using a heat of compression dryer, the total annual energy consumption is 5,610 kWh with an annual CO_2 production of 2,410 kg. At the price of $0.07/kWh, the annual electricity cost is considerably lower at $392.

By making two small changes in technology and PDP, facilities can save approximately $26,708 annually, and reduce their carbon footprint to a fraction of its original size. Similar calculations can be done based on site conditions to see what technology is best suited for your instrument air requirement.

You may be asking yourself why we compared two different drying technologies. This is because at a higher PDP, you don't need the same type of dryer. You can typically find better solutions with different drying technologies, this is why it's important to check with compressed air experts and manufacturers before making a decision. Experts can help you with PDP requirements, calculations and offer recommendations on the best drying technologies for your needs. BP

For more information, contact Deepak Vetal, email: Deepak.vetal@us.atlascopco.com, or visit www.atlascopco.com/en-us/compressors

To read more about ***Compressed Air Standards*** please visit, airbestpractices.com/standards



Example of heat of compression drying with zero purge.

Great Plains and Air Capital Equipment MONITOR GREAT SAVINGS

By Nicolas De Deken, EnergAir

Based in Salina, Kansas, Great Plains has carved a global reputation for producing world-class seeding equipment since it first opened its doors in 1976. Great Plains manufactures a range of products from grain drills and planters, to compact drills and tillage equipment. They have established an international business built on expertise, knowledge and a commitment to producing products meeting the rigorous demands of the agricultural sector.

Great Plains utilizes compressed air in their production lines with pneumatics, cylinders and actuators. They take raw steel materials, and weld and fabricate frames for the plows and other equipment, and then assemble them. Great Plains also uses compressed air for shot peening in their facility.

Air Capital Equipment, one of EnergAir's key distributors in the Mid-West, conducted a comprehensive audit for Great Plains. As a result, Great Plains identified inefficiencies between its five air compressor rooms serving the welding units, blast booths and air tools division, incurring significant cost and generating unnecessary carbon emissions. Energair was called in to determine how

"Air Capital Equipment, one of EnergAir's key distributors in the Mid-West, conducted a comprehensive audit for Great Plains. As a result, Great Plains identified inefficiencies between its five air compressor rooms."

— Nicolas De Deken, EnergAir

Great Plains manufactures a range of products from grain drills and planters, to compact drills and tillage equipment.

Great Plains could optimize its performance, save money and increase its sustainability credentials.

A 360° Approach at Great Plains

Great Plains started as a smaller facility with smaller air compressors, and they added compressors as they expanded tying the whole system together as they went on. Their facility consists of five buildings on a campus about a quarter of a mile in size. Each of the buildings houses one of the five Sullair compressors. All of these compressors also had a refrigerated dryer, except for the 150 hp paint line compressor, which had a heated desiccant dryer. Before the audit, the compressor in the paint line ran 24/7, whether they were painting or not, and the machine they needed to run as the dedicated trim was at the new building by itself in the opposite direction of the main plant.

The piping in the facility, before the audit, connected four of the buildings to one another with a 2" pipe. This piping system

GREAT PLAINS AND AIR CAPITAL EQUIPMENT MONITOR GREAT SAVINGS

Each of the five buildings at Great Plains housed a Sullair compressor.

only connected about halfway into four of the buildings. The areas of the facility where air is most in demand are in the main plant, this includes the paint line and forklift shop.

Below is a brief summary of the five Sullair air compressors running prior to Energair System and piping modifications at Great Plains as observed over a typical production day:

- V250S-250H: 15% to 20% loaded without shot peen in operation. 50% to 60% loaded when shot peen was in operation. Plant was isolated.
- LS25S-250H: Modulating near minimum with spiral valve, occasionally loading and unloading. Open to main plant.
- LS20-100H: Modulating near minimum with inlet valve, occasionally loading and unloading while paint was off, only light assembly. Modulating 80% to 100% when the paint system was running: Plant was isolated.
- LS16-75H: Running fully loaded, never saw it unload.
- LS200S-150H: Modulating near minimum with spiral valve, occasionally loading and unloading while paint was off. Modulating 70% to 90% when paint system was running. Isolated to the main paint line.

The audit conducted by Air Capital Equipment, revealed the following inefficiencies:

- Most of the time the compressed air system was operating at an unnecessarily high pressure, at 120 psig to 130 psig, causing artificial demand resulting in increased running costs and pressure swings up to 25 psi were observed.
- The five compressors were simultaneously loading and unloading, and during periods of low demand most compressors kept running unloaded.

- Setting up a cascade arrangement of compressor pressure setpoints to synchronize the compressors failed to work due to inadequate piping, as well as continuously changing pressure differentials in between the compressors located in five compressor rooms. This resulted in poor system efficiency.

The audit identified huge saving potential by introducing a smart centralized system control, allowing synchronized compressor use and narrow pressure band control (allows reduction in actual system pressure).

Initially, on request of the customer, the pressure band of the master controller had been set up between 107 and 117 psi. However, after the commissioning, Great Plains was advised to keep lowering the pressure through the web pages of the TX communication module, or directly on the master controller HMI. Keeping in mind, every 1 psi pressure drop results in an additional 0.5% energy/cost savings. After two months, the company reduced its pressure band to 96 psi delivering an additional energy reduction of 5.5%.

Great Plains always knew their piping was inadequate, but learned the extent of it when they began monitoring the pressure readings in their plant on the TX Cyber Console web pages. They noticed the Sullair V250S-250H was frequently running at a pressure higher than 120 psi to maintain 101 psi target pressure near the Paint area in Building S1. Considering running a compressor at higher pressure than required is a waste of energy (0.5% per 1 PSI),

After the commissioning of the Metacentre XC, the pressure band was maintained within 10 psi (vs. 25 psi before).

we recommended the customer to improve their piping. Initially, piping was from Building S1 to S7 then to S2 and S5.

In November/December of 2015, a 4" pipe was installed between Building S1 and S5 to close the loop as we advised. This new 4" pipe

GREAT PLAINS AND AIR CAPITAL EQUIPMENT MONITOR GREAT SAVINGS

The Metacentre™ XC has the capability to monitor up to two remote pressures from compatible compressor controllers.

runs directly to the main plant near the main usage point from the newest facility, 600 ft. underneath the building. As a result of this improved piping, the Sullair V250S-250H is now running at 104 psi to maintain 101 psi target pressure in the system. This 20 psi operating pressure reduction on the Sullair V250S-250H provides an additional energy reduction of 10% (on this variable speed compressor only), estimated to be 134,000 kWh savings or $4,022 savings per year. Cost to install the additional pipe was $8,000, so return on investment is two years.

"We knew Great Plains was often running more compressors than needed, and had potential piping issues. Initially, we advised them to manually shutdown compressors during low air demand periods while we worked towards a complete systems control and piping modifications solution," said Marc McGee, Air Capital Equipment's vice president. "Once the Metacentre control system was implemented, it was easy to see the energy savings realized and the potential for further savings by implementing the piping modifications recommended through the visualization package. There is no doubt that the installation of Metacentre has led to the system running significantly more efficient."

Efficient Solutions, Optimum Performance

Energair's Metacentre XC product, the renowned compressor and vacuum system range of parent company CMC, was identified as an ideal solution. It was installed in a cost-effective way, using the customer's existing Ethernet network (instead of having to pull cables in between all compressor rooms) to establish communication between the master controller and compressors.

In order to meet minimum pressure requirements in all areas of the plant, it was decided to install multiple pressure sensors where pressure was critical. This being in the forklift shop, paint line and at the end of the piping near the VFD compressor. After the commissioning of the Metacentre XC, the pressure band was maintained within 10 psi (vs. 25 psi before). The master controller also intelligently and efficiently controls the compressors in the five rooms by continuously matching output to air demand. The XC master controller utilizes the trim capability of the Sullair VFD (V250S-250H) to maintain a target system pressure, while running the fixed speed compressors in tandem fully loaded. As a result, non-productive energy (energy consumption while running unloaded) has been reduced to a minimum and compressors are only running when needed.

The Metacentre TX communication module was installed to remotely visualize and analyze the compressed air system over TCP/IP. It then sends the customer, and Air Capital Equipment service personnel, alert messages in case of system and compressor issues.

Metacentre is the vacuum and compressed air system product range of CMC. Metacentre products are used to fully integrate vacuum or compressor equipment, optimize vacuum or compressed air generation, reduce energy consumption, cost and CO_2. It is also able to manage key aspects of the equipment and system with intuitive visual software.

Compressors can be assigned one of three "zones." The Metacentre™ XC will always attempt to balance utilization across the zones to maintain, as near possible, an equal number of utilized compressors in each zone. This function is intended for installations

GREAT PLAINS AND AIR CAPITAL EQUIPMENT MONITOR GREAT SAVINGS

Air Capital Equipment

Air Capital Equipment was first chartered as a Corporation on October 1, 1978. Air Capital Equipment became a distributor for Sullair Compressors at this time, and began with only two employees/owners. Since then, the company has grown, with the help of good and dedicated employees, to a total of 40 employees, and four locations in three states. The main office, and original location, is in Wichita, KS with branches in Springfield, MO, Tulsa, OK and Oklahoma City, OK. The company now serves most of Kansas, one third of Missouri and all of Oklahoma. The Missouri location was founded in 1990 and the Oklahoma territory was taken over in the last five years.

Air Capital Equipment is headquartered in Wichita, KS and has branches in Springfield, MO (pictured), Tulsa and Oklahoma City, OK.

The cost of power has led industry to focus more on conserving energy and lowering operating costs. Air Capital Equipment has obtained equipment and training to do compressed air audits to help customers select the most efficient equipment, with the latest controllers to operate machines at maximum efficiency. Air Capital has partnered with Energair in an effort to provide the latest technology for controlling compressed air systems with multiple machines for maximum efficiency.

Air Capital also fabricates compressed air systems for starting air for natural gas pipeline compressor stations, control air systems and systems for explosion proof classified areas. Some of the systems are housed in metal buildings with lighting, heaters, ventilation duct work, electrical all wired and all mounted on a fab steel base. Systems for outdoor installation are also being fabricated per the customer's specifications.

The objective at Air Capital Equipment is to provide the customer with quality equipment meeting their needs and to provide excellent service. This along with fairness and honesty has led to many good and loyal customers. Visit www.aircapitalequipment.com

with multiple compressor locations. In some instances, large pressure differentials can exist in remote areas of an air distribution network if generation is concentrated in one area. The aim of the 'zone' function is to facilitate a balanced pressure across a site air network by ensuring air generation is distributed.

Metacentre™ XC has the capability to monitor up to two remote pressures from compatible compressor controllers, Metacentre™ compressor integration products or other compatible Metacentre™ product. The remote pressure(s) can be integrated with the primary local pressure to generate a new control pressure value. This function can be used to 'balance' pressure control across a system with multiple compressor locations and/or where a pressure differential across locations exists.

"Initially, we just wanted a system to monitor air demand flow, pressure and compressor status, however we quickly realized that the Metacentre master controller does way more than that," said Steve Boling, Great Plains Manufacturing's maintenance manager at AG Division.

A Leaner Operation: Great Plain's New System

Room	Equipment
1 (Forklift Shop) Main Plant	Sullair L525S-250H (250 HP fixed speed)
2 (Paint Line) Main Plant	Sullair VCC200S-150H (150 HP fixed speed), Heated Blower Purge
3 (Shot Peen) Newest Facility	Sullair V250S-250H (250 HP variable speed)
4	Sullair 16BS-75H (75 HP fixed speed)
5 Isolated	Sullair 20-100H (100 HP fixed speed)

Since the installation of Metacentre XC, Great Plains has:

- Reduced its annual energy bill from $107,257 to $60,576, an annual saving of $46,681
- Decreased its annual energy consumption from 3,575,233 kWh to 2,019,200 kWh following the installation of Metacentre XC, creating a yearly saving of 1,556,033 kWh
- Reduced non-productive energy to a minimum
- Ensured compressors run only when required
- Been able to monitor and evaluate its compressed air operations via TCP/IP

Boling also said, "Since we had Metacentre installed we don't have to intervene at all. Through the remote visualization web pages, we simply monitor the system a couple of times a week to ensure that all compressors are still available and that we're still running at optimum efficiency."

Since the installation, Great Plains has been working on repairing air leaks, minimizing inappropriate uses, such as floor sweeping, while continuing to lower the plant pressure. Through the visualization package they can instantly see KW reductions, and graphically trend these reductions over time. They are currently operating the majority of the time with the one V250S-250H unit and base loading occasionally with the LS16-75H or LS200S-150H during higher demand periods. BP

For more information contact Marc McGee, Air Capital Equipment, tel: 316-522-1111, email: mmcgee@aircapitalequipment.com or visit www.aircapitalequipment.com. Or contact Nicolas De Deken, EnergAir, tel: 855-289-9317, email: Nicolas.de.deken@energair.com or visit www.energair.com

To read more about ***Compressed Air System Assessments*** please visit www.airbestpractices.com/system-assessments.

Compressed Air Purification Fundamentals – THE COMPRESSOR'S JOB

Tim Dugan, P.E. President, Compression Engineering Corporation

➤ Introduction

The air we breathe and the air compressors ingest is a mixture of gases, aerosols, biological material, and particulates. It's a real mess! Humans have their own preference and tolerance for parts of this mixture, and not others, as well as limited internal filters to screen some of it out. Particulate, for instance, is very harmful to humans, because lungs are complex oxygen separators, not filters. They tend to load up with particulate, this is harmful over time. There isn't a sufficient "pre-filter" to prevent all harmful particulate from entering the lungs. However, humans prefer water in the air, gas, aerosol, and to a certain level, liquid form. A de-humidifier would not typically be a healthy addition to our built environments.

Compressed air system components after the dryer are like lungs, except they love dry air. Like lungs, compressed air end-use devices are designed to do one thing very well, like move a product from A to B, or increase the oxygenation of a process from X to Y. However, the addition of particulate and water vapor is usually counter to the component's effectiveness. The product compressed air

"Compressor intake, oil-temperature control, after-cooler maintenance and cleanliness, moisture separator design, and drain maintenance all impact a compressor's ability to provide outlet moisture load to the dryer within its design constraints."

— Tim Dugan, Compression Engineering Corporation

comes in contact with is like our tissue and blood. Water damages products like food, circuit boards, etc. It can cause electrical shorts, rust and bacteria growth, amongst other problems. Particulate plugs small openings like membranes, or orifices, and contaminates product.

Compressed air systems have a uniquely difficult challenge that humans don't. Like goats, compressors eat whatever you feed them. They take the same messy air, typically worse than what most of us breathe in a built environment, concentrate it by compression, and deliver it to the system, concentrated. The system sees up to eight times the concentration of particulate and moisture per volumetric cubic foot of air. The air stream is effectively much "dirtier" after compression, than before.

This article will discuss fundamentals of water concentration and removal in an air compressor package impacting the dryer. How much water is in the intake air? What happens to the water in air when it is compressed, and how can it be removed? What are the implications if the compressor package is not doing its job of removing moisture before the dryer?

Basic Theory

Before I launch into some practical system and component issue, probably more pressing to the audience, let me cover some basic theory. How much water is in the air coming into the compressor inlet? To answer this, I need to define four terms, and show how they interact. These terms also will help understand moisture content throughout the system.

Partial Pressure, Pv.

Water is a gas most of the time in the air. It's floating out there, evenly mixed with the other gases in air. Dalton's Law tells us in a mixture of non-reactive gases, the total pressure of the gas mixture is the sum of each individual gas' "partial pressure."

Molar Mass

Heavier gases have a higher molecular weight than light gases, and contribute to partial pressure proportionately. Chemists have come up with a strange unit called a "mole," consisting of $6.022141x10^{23}$ atoms of a gas. The "molar mass" of a gas is the weight of one mole, in g/mol, or lb/lbmol. It so happens the molar mass is simply the gas' atomic number. For instance, oxygen (O_2) has a molar mass of 32.00, water vapor (H_2O) has a molar mass of 18.02 and Nitrogen (N_2) has a molar mass of 28.01. The molar mass of the mixed gas, air, is 28.97.

Saturation Pressure, Pg.

This is the partial pressure where a gas condenses. This is solely affected by the temperature. The entire gas mixture is at the same temperature, but as you cool the mixture down or raise the total pressure, one gas eventually condenses. In air, the gas is H2O. The partial pressure can't get higher than the saturation pressure. For example, the saturation pressure of water vapor is exponential with temperature as it increases, by about 35% for every 10 ˚F. It is about 0.95 psia at 100 ˚F and about 1.28 psia at 110 ˚F, an exponential relationship. See Table 1, the first two columns.

Relative Humidity, RH.

This is a ratio of "how close" the water vapor is to condensing. It is the ratio of the partial

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pressure of the water vapor to the saturation pressure, at a given temperature. For instance, if the relative humidity is at 50% at 100° F, the partial pressure of water vapor in the air is 0.5 x 0.95 psia = 0.47 psia.

Impact of Molar Mass Ratio on Vapor Pressure and Total Water in Air

In a gas mixture, like air, including nitrogen, oxygen and water vapor, the lower relative molar mass of the water vapor weight mass ratio is 62.2%. Compare this to its volume ratio, 18.02/28.97. In the above example at 50% RH, the mass ratio of water vapor in the air at atmospheric pressure (14.7 psia) would be, 0.622 x 0.47 / 14.7 = 2.0%. One pound of air would have .021 lb of water, about 1/3 of an ounce, or about a teaspoon. This might not seem like a lot, but consider a typical compressor with 1,000 cubic feet of air coming in every minute. The compressor would take in 1.5 lb/min of water, over a ton a day! See Table 1, assuming a 1,000 scfm compressor and 50% relative humidity intake condition.

TABLE 1. WATER VAPOR PRESSURE AND MASS ENTERING AN AIR COMPRESSOR

Compressor Flow		1000 scfm	
Compressor Discharge Pressure		100 psig	
Ambient Relative Humidity		50%	
COMPRESSOR INLET & AMBIENT TEMP, DEG F	**SATURATION VAPOR PRESSURE, PSIA**	**COMPRESSOR INLET % WATER VAPOR (BY MASS)**	**WATER IN AIR, LB/MIN**
40	0.122	0.26%	0.2
50	0.178	0.38%	0.3
60	0.256	0.54%	0.4
70	0.363	0.77%	0.6
80	0.507	1.07%	0.8
90	0.698	1.48%	1.1
100	0.949	2.01%	1.5
110	1.281	2.71%	2.0
120	1.706	3.61%	2.7
130	2.235	4.73%	3.6

Practical Implications

This paper will now move from theory to practice, and talk about compressor package issues impacting how much water goes to the dryer. The next article will discuss dryer types and how they remove moisture.

Compressor Package Issues

Refer to Figure 1 for a typical air-cooled lubricated screw compressor diagram. This one is from an Atlas Copco GA compressor,

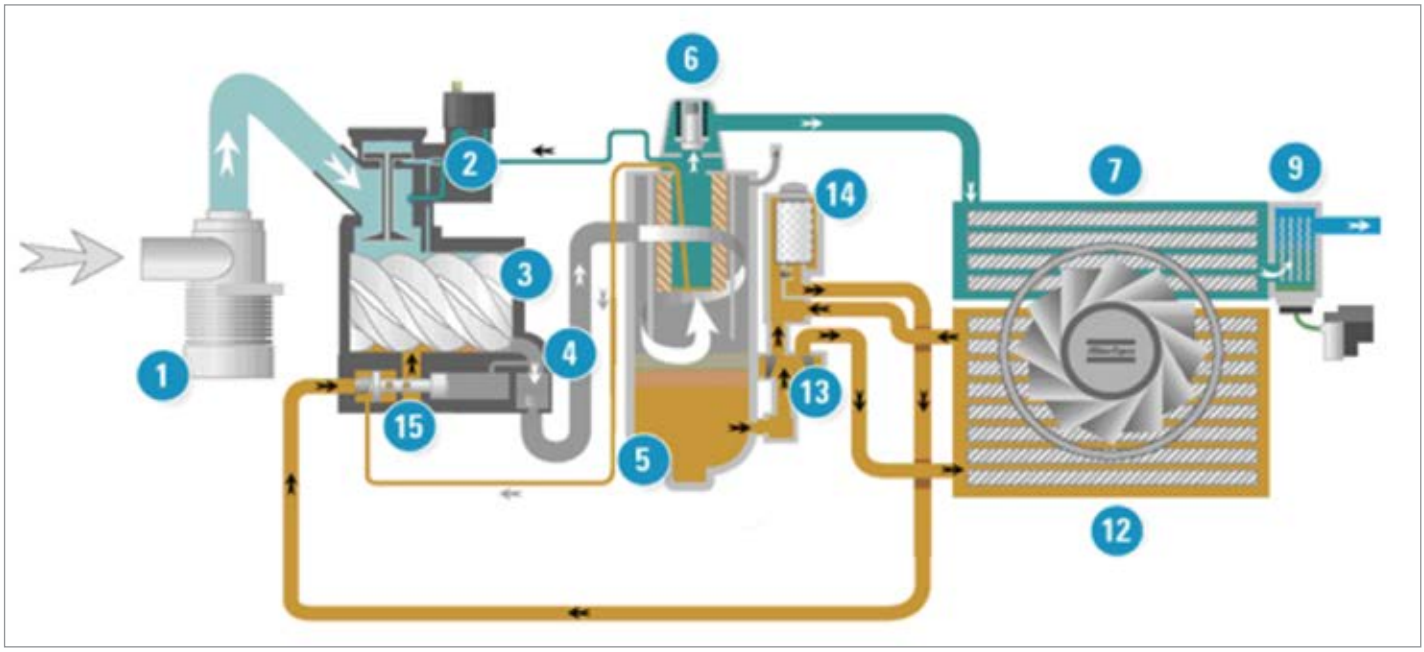

Figure 1. Typical Air-cooled Lubricated Screw Compressor Diagram

but most are similar. Without going into details about dryers, the reader should know a typical dryer inlet design condition is 100 psig, 100 ˚F, and 100% RH. Keep in mind the 35% moisture increase per 10 ˚F rise in temperature.

Air system

inlet filter (1), air intake valve (2), screw compression element (3), non-return valve (4)*, oil separator element (5), minimum-pressure valve (6)*, air-cooled after cooler (7), moisture separator and condensate drain (9)

Oil system

oil receiver (5), thermostatic bypass valve (13), air-cooled oil cooler (12), oil filter (14), oil stop valve (15)*.

*some packages don't have these items.

Intake Location

From a moisture perspective, the water mass flow at the compressor air inlet is the "load" on the system. However, the ambient moisture content is not necessarily the same as the compressor inlet's. I have seen the following situations dramatically affecting how much water vapor is in the compressor intake air:

1. Compressor intake near a pond (or lake) in a hot environment: One site I audited was right on the shore of Salt Lake. In the summer, the hot, dry air evaporates large amounts of water from the lake, and depending on the prevailing wind, delivers humid (and caustic) air to the compressors. In other plants, I have seen venting steam close to the compressor intakes.

TABLE 2. WATER CONDENSATION IN OIL, OVERSIZED OIL COOLER, 140 ˚F INJECTION TEMP, HUMID DAY

Compressor Flow	1000 scfm
Compressor Discharge Pressure	100 psig
Oil Cooler Delta T	30 F
Oil Cooler Entering Temperature Difference	80 F
Oil Cooler Mixing Valve Temperature	**140 F**
Oil Injection Pressure	90 psig
Ambient Relative Humidity	80%

COMPRESSOR INLET & AMBIENT TEMP, DEG F	SATURATION VAPOR PRESSURE, PSIA	COMPRESSOR INLET % WATER VAPOR (BY MASS)	WATER IN AIR, LB/ MIN	OIL INJECTION TEMPERATURE, DEG F	OIL INJECTION SATURATION PRESSURE, PSIA	MAX OIL INJECTION % WATER VAPOR	WATER CONDENSED IN OIL, LB/ MIN
40	0.122	0.41%	0.3	140	2.881	1.71%	0.0
50	0.178	0.60%	0.5	140	2.881	1.71%	0.0
60	0.256	0.87%	0.7	140	2.881	1.71%	0.0
70	0.363	1.23%	0.9	140	2.881	1.71%	0.0
80	0.507	1.72%	1.3	140	2.881	1.71%	0.0
90	0.698	2.36%	1.8	140	2.881	1.71%	**0.5**
100	0.949	3.21%	2.4	150	3.656	2.17%	**0.8**
110	1.281	4.34%	3.3	160	4.574	2.72%	**1.2**
120	1.706	5.78%	4.3	170	5.648	3.36%	**1.8**
130	2.235	7.57%	5.7	180	6.890	4.09%	**2.6**

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TABLE 3. WATER CONDENSATION IN OIL, OVERSIZED OIL COOLER, 170 ˚F INJECTION TEMP, HUMID DAY							
Compressor Flow			1000 scfm				
Compressor Discharge Pressure			100 psig				
Oil Cooler Delta T			30 F				
Oil Cooler Entering Temperature Difference			80 F				
Oil Cooler Mixing Valve Temperature			**170 F**				
Oil Injection Pressure			90 psig				
Ambient Relative Humidity			80%				
COMPRESSOR INLET & AMBIENT TEMP, DEG F	**SATURATION VAPOR PRESSURE, PSIA**	**COMPRESSOR INLET % WATER VAPOR (BY MASS)**	**WATER IN AIR, LB/ MIN**	**OIL INJECTION TEMPERATURE, DEG F**	**OIL INJECTION SATURATION PRESSURE, PSIA**	**MAX OIL INJECTION % WATER VAPOR**	**WATER CONDENSED IN OIL, LB/ MIN**
40	0.122	0.41%	0.3	170	5.648	3.36%	0.0
50	0.178	0.60%	0.5	170	5.648	3.36%	0.0
60	0.256	0.87%	0.7	170	5.648	3.36%	0.0
70	0.363	1.23%	0.9	170	5.648	3.36%	0.0
80	0.507	1.72%	1.3	170	5.648	3.36%	0.0
90	0.698	2.36%	1.8	170	5.648	3.36%	0.0
100	0.949	3.21%	2.4	170	5.648	3.36%	0.0
110	1.281	4.34%	3.3	170	5.648	3.36%	**0.7**
120	1.706	5.78%	4.3	170	5.648	3.36%	**1.8**
130	2.235	7.57%	5.7	180	6.890	4.09%	**2.6**

2. Air conditioning of intake air: This is not always intentional. Some compressors are located in conditioned spaces due to logistics and space. In those situations, the inlet relative humidity is higher than outside in the summer. However, the total water in air might be less, as some condensation occurs in the HVAC system.

NOTE: Cooling of intake air has a small impact on efficiency of a positive displacement screw compressor, not enough to justify a dedicated cooling system in my view. See my July 2015 Compressed Air Best Practices article on the subject.

Oil Cooler Outlet Temperature

This oil-cooler discussion is only for oil-injected screw compressors and somewhat a sidebar to the dryer discussion. However, it is related to the moisture discussion, so I will discuss it briefly. Oil cooler performance

TABLE 4. MOISTURE REMOVAL AND DRYER LOAD, 15 ˚F AFTER-COOLER APPROACH TEMPERATURE								
Compressor Flow					1000 scfm			
Compressor Discharge Pressure					100 psig			
Compressor Aftercooler Approach Temp					**15 F**			
Ambient Relative Humidity					80%			
COMPRESSOR INLET & AMBIENT TEMP, DEG F	**SATURATION VAPOR PRESSURE, PSIA**	**COMPRESSOR INLET % WATER VAPOR (BY MASS)**	**WATER IN AIR, LB/MIN**	**COMPRESSOR OUTLET / DRYER INLET TEMPERATURE, DEG F**	**COMPRESSOR OUTLET SATURATION PRESSURE, PSIA**	**COMPRESSOR OUTLET % WATER VAPOR**	**CONDENSATE DRAIN WATER REMOVED, LB/MIN**	**% OF INLET MOISTURE NOT REMOVED - LOAD ON DRYER**
40	0.122	0.41%	0.3	55	0.221	0.12%	0.2	**29%**
50	0.178	0.60%	0.5	65	0.306	0.17%	0.3	**28%**
60	0.256	0.87%	0.7	75	0.424	0.23%	0.5	**27%**
70	0.363	1.23%	0.9	85	0.588	0.32%	0.7	**26%**
80	0.507	1.72%	1.3	95	0.810	0.44%	1.0	**26%**
90	0.698	2.36%	1.8	105	1.103	0.60%	1.3	**25%**
100	0.949	3.21%	2.4	115	1.481	0.80%	1.8	**25%**
110	1.281	4.34%	3.3	125	1.957	1.06%	2.5	**24%**
120	1.706	5.78%	4.3	135	2.543	1.38%	3.3	**24%**
130	2.235	7.57%	5.7	145	3.252	1.76%	4.4	**23%**

obviously doesn't affect the amount of water in the air intake. However, it does impact condensation inside the compressor. It is not good for bearings or lubricant to have condensation internally to the compressor. The oil coming out of the compressor is mixed with air, and the entrained air bubbles have water vapor in them. If the oil cooler does too good of a job, and the temperature of the air/oil mixture being injected to the compressor is too low it causes the water to condense, and the bearings will be destroyed in short order. See Table 2 for a typical 140 ˚F control setting. The highlighted cells show when condensation would occur. The point of showing the impact of the oversized cooler is not to say it should be undersized! It is to see the impact of the injection temperature mixing valve. If the cooler is adequately sized and the oil is synthetic, I recommend a 170 ˚F injection temperature control for warm, humid areas. See Table 3. The 110 ˚F 80% condition is extremely rare in the U.S., so it is a safe setting.

After-Cooler Outlet Temperature

Air-cooled after-coolers are the most common, and are almost always mounted and plumbed by the compressor OEM. The performance of this component can be one of the biggest issues affecting dry air in the plant, because the majority of water condenses at the outlet of the compressor after-cooler.

Poor cooler core maintenance results in clogging, especially in the lower velocity sections of the cooler. These design issues can result in poor approach temperatures, routinely over 30 ˚F. This means the air outlet temperature would be 130 ˚F on a 100 ˚F summer day. This would load the dryer up to over 150% of its design point! See Tables 4 and 5 for the amount of moisture removed with a 15 ˚F approach and 30 ˚F approach (dirty) aftercooler. The dryer has to remove most of the remaining water, so the load on the dryer goes up by over 50% with a dirty after-cooler.

Moisture Separator Effectiveness

After the after-cooler, there is a mechanical liquid-air separator. Some are better than others. All condensed liquid droplets below a particular size are supposed to drop out. If the separator is not high efficiency, condensed water droplets are flying downstream to the dryer, loading it up.

Automatic Drain Effectiveness

Now we arrive at the smallest item causing the most problems, the little auto drain on the compressor moisture separator. If this valve does not open to discharge condensate reliably, it passes on all the water we are trying to condense and remove, right to the dryer. The coalescing filter gets loaded up with water, blinding it off and creating a high-pressure differential, thus ruining its ability to remove oil mist. The water-laden air slugs the dryer, overloading the evaporator and killing its effectiveness. Oil getting past the overwhelmed coalescing filter coats the inside of the evaporator tubes. A perfect after-cooler and moisture separator can't overcome a bad drain. On the other hand, leaving a drain wide open to avoid condensate loading the dryer isn't efficient either! If the drain is not working at all, the load on the dryer is over triple its design. Obviously, it won't dry the air at all.

Conclusions

Compressor intake, oil-temperature control, after-cooler design and cleanliness, moisture

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TABLE 5. MOISTURE REMOVAL AND DRYER LOAD, 30 ˚F AFTER-COOLER APPROACH TEMPERATURE

Compressor Flow	1000 scfm
Compressor Discharge Pressure	100 psig
Compressor Aftercooler Approach Temp	**30 F**
Ambient Relative Humidity	80%

COMPRESSOR INLET & AMBIENT TEMP, DEG F	SATURATION VAPOR PRESSURE, PSIA	COMPRESSOR INLET % WATER VAPOR (BY MASS)	WATER IN AIR, LB/MIN	COMPRESSOR OUTLET / DRYER INLET TEMPERATURE, DEG F	COMPRESSOR OUTLET SATURATION PRESSURE, PSIA	COMPRESSOR OUTLET % WATER VAPOR	CONDENSATE DRAIN WATER REMOVED, LB/MIN	% OF INLET MOISTURE NOT REMOVED - LOAD ON DRYER
40	0.122	0.41%	0.3	70	0.360	0.20%	0.2	**47%**
50	0.178	0.60%	0.5	80	0.499	0.27%	0.2	**45%**
60	0.256	0.87%	0.7	90	0.690	0.37%	0.4	**43%**
70	0.363	1.23%	0.9	100	0.947	0.51%	0.5	**42%**
80	0.507	1.72%	1.3	110	1.281	0.69%	0.8	**40%**
90	0.698	2.36%	1.8	120	1.706	0.93%	1.1	**39%**
100	0.949	3.21%	2.4	130	2.235	1.21%	1.5	**38%**
110	1.281	4.34%	3.3	140	2.881	1.56%	2.1	**36%**
120	1.706	5.78%	4.3	150	3.656	1.98%	2.9	**34%**
130	2.235	7.57%	5.7	160	4.574	2.48%	3.8	**33%**

separator design, and drain maintenance all impact a compressor's ability to provide outlet moisture load to the dryer within its design constraints. Care to their design, installation and maintenance is recommended, as follows:

Recommendations

1. Use the cleanest and driest intake air possible.
2. Clean the compressor after-cooler regularly, and check its approach temperature when clean. If it is not less than 15 ˚F (outlet temperature minus ambient temperature), install a second after-cooler.
3. Verify the aftercooler air is not being warmed up by recirculating air from other heat in the room. Get the coolest and cleanest possible air available to the cooler core.
4. Verify the compressor auto drain is working properly, and replace it if not. I recommend an over-sized no air-loss type. There are multiple options. Plumb the drain in a way so it can be inspected easily, using a sight glass (if you need pressure to push condensate), or a visible floor drain. Don't hard-plumb it in an opaque pipe all the way to its destination.
5. Set the oil recirculation valve at the proper level, given the performance of the oil cooler and the worst-case ambient conditions. BP

For more information, contact Tim Dugan, tel: (503) 520-0700, email: Tim.Dugan@cmop-eng.com, or visit www.compression-engineering.com

To read similar ***Air Compressor Technology*** articles visit https://airbestpractices.com/technology/air-compressors.

"A perfect after-cooler and moisture separator can't overcome a bad drain. On the other hand, leaving a drain wide open to avoid condensate loading the dryer isn't efficient either!"

— Tim Dugan, Compression Engineering Corporation

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Compressed Air Assessment Finds PROBLEMS AT A MEAT PROCESSOR

By Ron Marshall, Marshall Compressed Air Consulting

➤ A meat processor, located in Canada, hired a consultant to assess their compressed air system as part of a company-wide energy conservation effort. The assessment and analysis showed, despite having a modern compressed air system using a VSD air compressor and pressure/flow control, the system was running inefficiently and had significant levels of leakage and inappropriate use.

Initial Findings

The facility has an installed a compressed air system consisting of three air cooled lubricated screw compressors, one being a 200 hp variable speed drive compressor (VSD). The fixed speed units are 150 hp and 100 hp. These compressors are locally controlled in each compressor. The system has a mist eliminator filter installed before the air dryer. A single heated blower type desiccant dryer with dew point control (EMS), with coalescing filtration on the inlet and particulate filter on the outlet, has been installed to produce dry compressed air for plant operations. The compressed air is directed throughout the plant by a system of galvanized steel piping. Two large storage receivers are located in the compressor room area as system control storage, and two are in the plant at the end of the pipeline for pressure stability. An electronic flow control valve has been installed to regulate the plant pressure, however, it was out of service due to failure.

The compressed air is delivered to the multiple production areas through a main 3-inch galvanized piping header, where various branches are tapped to supply each production area. The piping is arranged in a loop for the main production areas. Installed data loggers showed minimal pressure loss across the piping system. Most of the system pressure loss is across the drying and filtering system.

Compressed Air System Baseline

The compressed air system electrical consumption was monitored using amp loggers. Kilowatt readings were done for both the active compressors to calibrate amps to power. System flow was recorded by placing loggers on a newly installed main flow meter at the output of the compressor room main receiver. Pressure loggers were located at the compressor discharge, after the mist eliminator and the dryer in the compressor room. Mainline pressure loggers were place at the end of line in various areas. See the baseline in Table 1 that was determined over a two-week period.

Part of the measurement period was done during a one-week shutdown, providing a good indication of non-productive flow and power consumption. A full eight days of production were captured and have been used to create the load profile as seen in Table 2.

Based on a blended rate of $0.115 per kWh this would make the annual electrical cost of compressed air about $153,000 plus taxes.

The readings and observations during the measurement period showed the compressed air system was producing air at lower efficiency (23.2 Kw/100 cfm), compared to similar optimized systems (optimum is under 19 Kw/100 cfm). There is significant waste due to poor compressor control, higher pressure than needed, inappropriate uses, as well as leakage and drainage. The study found significant improvements are possible. As can be seen in the previous table, the poor compressor control strategy is causing very inefficient operation during non-production hours.

Demand Side Profile

A survey of the demand side of the system was done including leakage. A total of 71 leakage points were found (some drains and inappropriate uses included). A number of end uses potentially classed as inappropriate uses were found including air motors, cabinet venting, compressed air cooling, compressed air blowing nozzles and manual drains.

TABLE 1. BASELINE

BASELINE	UNITS	AVERAGE	ANNUAL KWH
Discharge ave	psi	120.8	
Dryer In ave	psi	119.5	
Dryer Out ave	psi	114.2	
EOL ave	psi	113.1	
EOL 2 ave	psi	113	
200 hp VSD	kW	15	131,400
150 hp	kW	123	1,077,480
Dryer	kW	14	122,640
Total	**kW**	**152**	**1,331,520**
Peak	kW	234	
Specific Power	kW/100 cfm	23.2	
Flow	cfm	595	
Operating	hours	8760	
Cost			**$153,125**

TABLE 2. SHIFT PROFILE

	HOURS	CFM	KW	KW/100
Weekday	3840	830	167	20.1
Saturday	208	774	160	20.7
Sanitation	2024	449	124	27.6
Weekend	1992	368	107	29.1
Shutdown	696	327	99	30.2
Total	**8760**			

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COMPRESSED AIR ASSESSMENT FINDS PROBLEMS AT A MEAT PROCESSOR

The shape of the compressed air flow demand curve can be seen on the profile shown in the Figure 1. The profile shows the typical cyclical pattern of a shift oriented production process. The highest peaks are mid-morning weekdays with low flows on weekends and during shutdown periods. The pressure profile mirrors the flow demand, with lowest plant pressures occurring at the highest peak flows. These pressures fall below the lowest acceptable pressure of 100 psi identified by plant personnel.

Potential Opportunities

Analysis of the information collected shows some potential opportunities existing that could result in improvements in the operation of the compressed air system. Further, they could result in potential savings in compressed air related electrical and maintenance costs, estimated at 52% of the current costs. These savings could be worth about $79,700 per year in annual electrical savings. There are possible additional heat recovery savings of up to about $5,000 if the compressor heat of compression can be used to pre-heat hot water. Some specific potential opportunities are as follows:

Compressor Operating Mode

One of the existing compressors was operating in load/unload mode with upper range modulation. This modulation must happen with this unit to protect the compressor motor from overload, because the compressor has been set to operate higher than its maximum full load pressure rating of 115 psi. The large VSD was operating at minimum speed, starting and stopping as required, but only during production shifts.

Modulating mode of operation is the least efficient mode for screw compressors. In modulation, a typical screw compressor will consume from 65% to 100% of its rated power through an output range of 0% to 100% of rated compressed air output. Fortunately, this unit appeared to be modulating only at the top end of its pressure settings range, the remainder of its operation was in load/unload mode. This mode is less efficient than VSD mode, especially at light loading during sanitation shift, weekends, and shut down periods.

The 200 hp VSD compressor was operating only during production shift where it runs at the bottom end of its range. This type of duty is typically not recommended, because the unit is less efficient at minimum speed, and also because it generates less heat. The reduced heat makes it difficult for the unit to drive off the moisture forming in the lubricant during the compression process. Long term operation like this can allow water build-up corroding internals, and causing lubrication failure potentially ruining the main screw element bearings.

COMPRESSED AIR ASSESSMENT FINDS PROBLEMS AT A MEAT PROCESSOR

Operating a fixed speed compressor as the lead unit and a VSD as the lag compressor is a non-standard and inefficient control strategy. This is one of the reasons the production of compressed air is so inefficient in this system. Two experiments were done to show the difference in compressor electrical consumption under two different conditions. The first is shown in Figure 3. The fixed speed unit was unloaded during a shutdown to see the effect on input amps. It can be seen under the same flow conditions the input dropped by 90 amps (the unit did not turn off because it doesn't have auto shutdown activated, this was corrected). This equated to a reduction of about 47 kW, or almost 50%, just by better coordinating the compressor control settings.

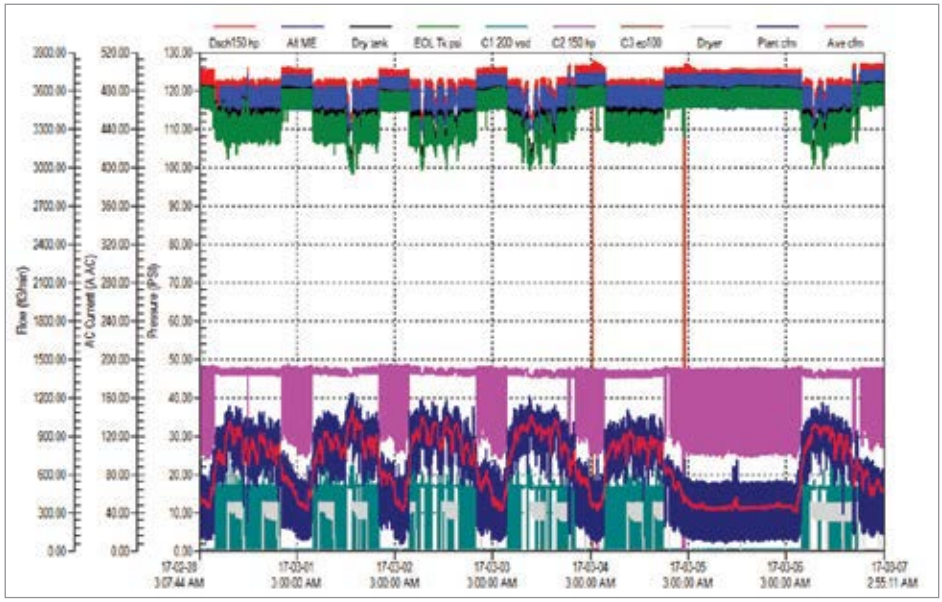

Figure 1: Compressed air profile during baseline week.

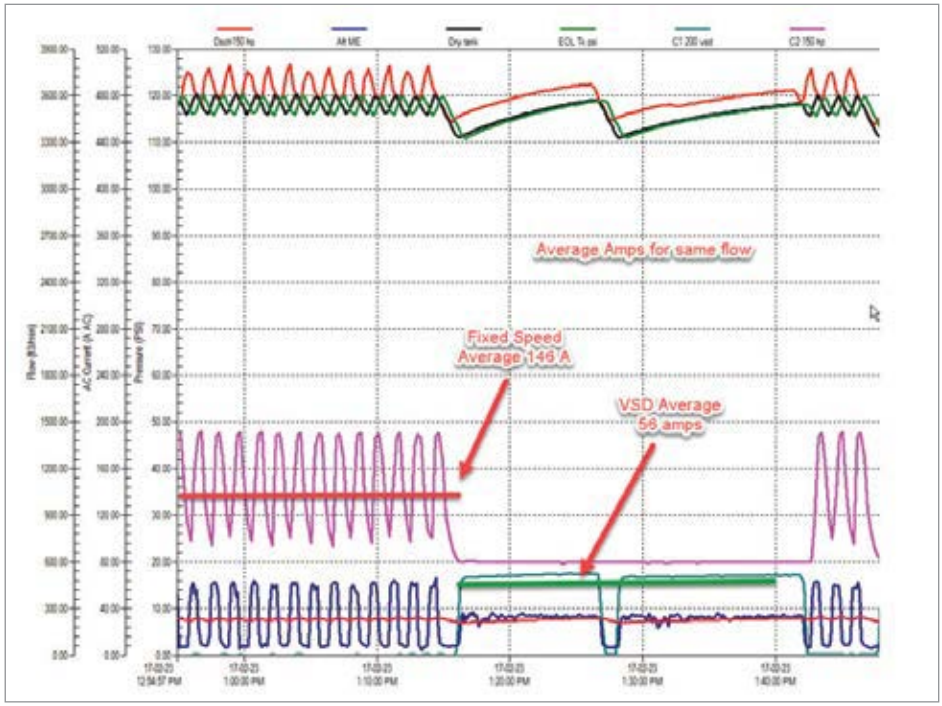

Figure 2: Control Experiment 1.

The second experimental run is shown in Figure 4, where the compressor settings were temporarily altered allowing the VSD to run during the sanitation shift (as it should in a correctly controlled system). Again, under similar conditions, the amp consumption is much lower. In fact, the VSD made it all the way to mid-morning without needing any help from the fixed speed compressor (when the test was discontinued).

Pressure drops can be seen on the pressure profile at peak flows. This was caused by the pressure loss across the air dryer and filters. The VSD keeps its output pressure nice and constant, yet the plant pressure droops. This dip in pressure can be corrected by implementing remote pressure sensing. With remote sensing installed on the downstream of the air dryer, the VSD compressor will hold the plant pressure at its set point, rather than allowing the discharge pressure to raise in order to compensate for the sagging pressure.

This strategy causes lower discharge pressure operation in normal and low load conditions. This saves power and adjusts the discharge pressure higher only during peaks, occurring a small percentage of the time. This strategy must be implemented carefully to ensure the fixed speed compressor does not inadvertently overpressure. A low-cost solution would be to purchase a remote sensing kit for each compressor from your service provider. However, a better way might be to purchase a compressor sequencer to automatically control all the compressors. An advantage of the sequencer would be the capability of remotely monitoring the compressor efficiency by remote web interface.

Estimated savings in energy consumption for correcting the compressor control is 334,200 kWh (6 kW peak), worth $38,000 in electrical cost reductions.

Flow Control Valve

A pressure/flow control valve (PFC) had been previously installed to limit the line pressure fluctuations and to lower plant pressures. The lower system pressure maintained by a flow control valve will often lower energy consumption by reducing the artificial demand caused by applying higher than required plant pressures to unregulated uses. This valve will be of little benefit if the majority of the plant loads are regulated. Its presence requires the compressor discharge pressure to be higher than a normal set point, consuming more energy.

Another disadvantage of installing PFC valves is they reduce the effectiveness of any downstream storage in helping with compressor control. These are trade-offs to be considered based on the characteristics of each plant.

Testing was done during the shutdown, showing the low-level leakage load has very little sensitivity to pressure reduction. The end use survey showed most production machine load is regulated. The conclusion is, the use of a PFC for this plant will have only a small benefit.

The existing PFC has been bypassed due to malfunction. The unit has likely been damaged by very high temperatures being released into the system by a dryer problem (more on this later). It is also located in a very poor location for service and adjustment. Due to the location, when the valve fails the staff must obtain a scissor lift to bypass, causing long production outages.

Estimated savings for this measure (reducing the discharge pressure with remote pressure sensing) would be 21,400 kWh (2.3 kW peak), worth $2,450 in annual electrical costs.

Leaks and Abandoned Uses

Air leakage and flow from unused air consuming equipment (abandoned uses) in a facility is usually significant unless

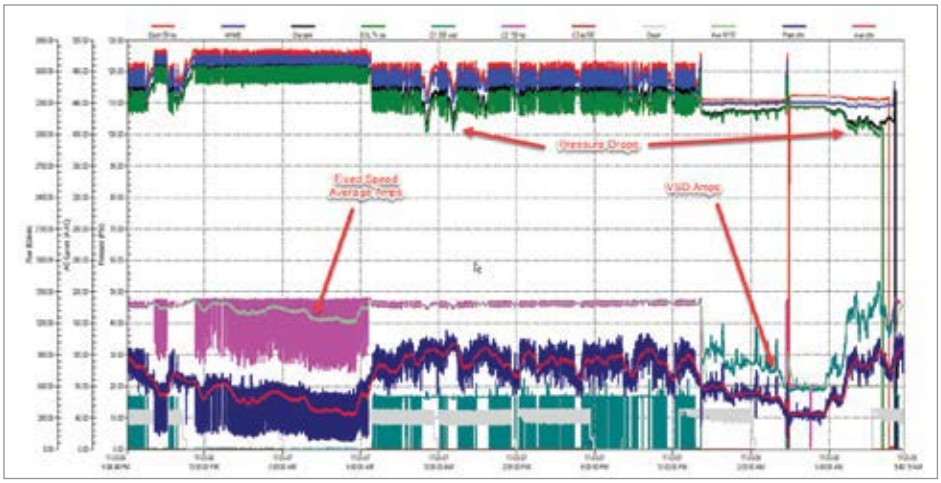

Figure 3: VSD was run for sanitation shift and showed much lower amps.

COMPRESSED AIR ASSESSMENT FINDS PROBLEMS AT A MEAT PROCESSOR

there is a regular system of monitoring, leak detection and repair.

Leakage testing was done using an ultrasonic detector. A total of 69 significant leaks, or wasteful items like open drains, were found at an estimated waste of about 120 cfm. About half of this flow is within the compressor room (not measured by the flow meter). If 100 cfm of the located leaks were repaired, and the compressor control corrected, then savings of about 122,000 kWh (14 kW peak) and $14,000 in annual cost reduction could be expected.

End Uses

End uses can often be optimized, or eliminated, for substantial savings in operating costs and improvements in air pressure. The following end uses were identified as candidates for replacement:

Cabinet Venting

This compressed air powered cabinet venting is used to prevent water infiltration into electrical panels during sanitation, and has been installed throughout the facility. This appears to be a low pressure application (regulators set to about 10 psi), air pressure about 2 psi and below by the time it reaches the panels. It is very wasteful to use compressed air generated at 125 psi for such low-pressure requirements.

Further to this, many leaks were detected on the compressed air lines placed for the venting of these cabinets due to physical damage or failure of components (see leak list). Flow tests were done on some of these venting systems, and flows of between 2 cfm and 8.9 cfm were found.

Estimated average flow is 3 cfm per venting system, with the number of venting systems estimated at 12. This would consume about 36 cfm of high pressure compressed air. This flow is only really required during sanitation shifts, representing about 23% of the total current operating time.

For this application only a slight positive is required. During sanitation duty, a low pressure compressed air source, such as an aquarium pump or blower system, should be considered. Estimated savings were 52,600 kWh (6 kW peak), worth $6,100 per year in reduced electrical costs. These savings would be offset by the electricity consumed by whatever ventilation method used.

Blowing

About 12 open blowing locations were found in the plant. The use of uncontrolled compressed air blowers is very energy intensive. If compressed air blowers must be used, then electronic control of each unit should be implemented, so the blow only happens where the product is in proximity. This can significantly reduce air consumption.

Observation of the blowing showed some of the blowers are not effective in removing the water from the packaging, and therefore, are a waste of energy.

It appears the blowers are turned off when there is no production, this is good practice. It is estimated about 32 cfm of blowing is on during production (not all blowers operate), about 45% of the time. Reducing blow load would save an estimated 14 cfm

Figure 4: Numerous compressed air connections have been added to electrical panels.

Figure 5: Example of blow nozzles.

Figure 6: This air motor drives a short conveyor

of compressed air, worth 16,400 kWh (1.9 kW peak) and $2,350 per year in electrical costs.

Air Motors

A number of air motors drive conveyor belts in the plant. Air motors consume about 10 times the equivalent hp than a direct drive motor, and what's worse they consume the most air when they are unloaded.

Estimated air motor flow during production is 32 cfm (each motor consumes 18 cfm). Estimated average air motor flow over full system hours is 14 cfm. Estimated savings would be 16,000 kWh and $2,450 per year. Conversion to electric drive would consume an estimated $200 in electrical energy to offset some of these savings.

Coolers

A flow of compressed air is being directed onto the access door handles in a meat smoker (a hot area). Due to the cost of compressed air, this is a less than optimum way to provide protection against heat. You may want to consider providing insulation on the handles.

Measured air flow was 4 cfm for each cooler, this application continues to run even during shutdown. If this was eliminated, it would reduce energy consumption by 6,000 kWh (0.7 kW peak), worth $700 per year in savings.

Air Dryer

The existing air dryer is a heated blower desiccant style, rated at 1,500 cfm. This dryer was malfunctioning during the measurement period and purging excessively, causing it to run the heater and blower more than necessary during the production shift. The unit was regenerating 42% of the time, where with the dry winter moisture, loading the unit should have been regenerating less than 20% of the time.

Due to the malfunction, the unit was putting out compressed air at temperatures measured as high as 141 ˚C. Compressed air hitting the flow control valve was about 70 ˚C, a possible cause of the valve failure. This temperature may have also damaged the flow meter.

The compressor service company was called by the operators, and the dryer was discovered in the wrong operating mode (blower cooling mode). The unit was switched, so it operates with compressed air cooling, reducing the outlet temperature significantly. The problem with the dew point control should be investigated, perhaps the measurement probe needs changing (a maintenance item). It could have been damaged by the high temperatures.

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COMPRESSED AIR ASSESSMENT FINDS PROBLEMS AT A MEAT PROCESSOR

Reduction in dryer regeneration power, if the control is repaired, will save an estimated 83,000 kWh (9.5 kW peak) per year, worth about $9,600 per year in reduced electrical costs.

Filters

Pressure loss across the air dryer and filters was seen at 9 psi at only 1,000 cfm. This indicates excessive pressure drop (should be about 6 psi at full flow of 1,500 cfm). Normally, the main inlet coalescing compressed air filter and particulate outlet filter on a desiccant dryer have a 3 psid to 10 psid pressure loss across them, throughout the life of the filter. Savings can be gained by upgrading filters to more efficient units, or installing parallel filters (doubling the capacity), as there is a 1% hp reduction for every 2 psid reduction in pressure. Dual parallel filters, if installed with isolation valves, allow the filters to be changed even during full production. Install airless drains on the filters. Estimated savings for this measure would be about 9,100 kWh (1.0 kW peak), worth about $1,000 per year.

Condensate Drains

Both inlet and outlet dryer filter drains, and the drains on each compressor drops were passing significant air due to manual drainage. Upgrading the compressor, receiver and receiver drains to low loss airless units, rather than cracking open the manual drains, or using leaky drains (small dry tank in compressor room has leaking drain), would save energy. The drain on the spare compressor was measured at 6 cfm. Estimated savings would be 21,000 kWh (2.4 kW peak), worth $2,500 per year if all these drains were upgraded.

Compressor Room Environment

The compressors are located in a hot room with numerous large refrigeration compressors. The inlet cooling air is very warm, causing higher than desired discharge temperatures adding extra moisture load on the air dryer, causing it to consume more energy. Every 12 ˚C in extra discharge temperature doubles the amount of water in the air.

The heat of compression from the compressors is being redirected into the room through air dampers with a summer/winter mode. In summer, the air is directed outdoors, in winter the 138 kW of compressor heat is directed into the compressor room. Thermal imaging showed some of this hot air was being directly sucked into the cooling air intake of the compressors. Discharge temperatures showed outlet temperature of 31 ˚C even on a very cold day.

Consideration should be given to operating in summer mode all year-round, in order to keep the hot air away from the intake and to help keep the compressor room as cool as possible.

Heat Recovery

Air compressors produce significant amounts of heat able to be recovered for process requirements, such as hot water pre-heat, boiler make-up pre-heat or to supplement building heat. Most compressor suppliers can provide optional heat recovery systems with their compressors for these purposes. This should be considered in this location, as the compressor heat is not currently being effectively recovered (heat is rejected into an already hot room). There will be about 600,000 kWh of heat available for recovery per year. If this is used for hot water pre-heat could displace up to 41,000 m^3 of natural gas heat, worth about $5,000 per year.

Summary

Sufficient potential exists for up to an estimated 52% savings in compressed air operating costs over the present configuration. The installation of wet receiver capacity, low loss drains, repair of dryer control, better compressor control, lower plant pressure, reduced inappropriate use and reduced leakage would save an estimated $79,700 per year in compressed air electrical operating costs. More effective heat recovery might save an additional $5,000 per year in natural gas costs. BP

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

TABLE 3. SUMMARY OF THE ESTIMATED SAVINGS

	VSD			
MEASURE	**$ SAVED**	**% SAVED**	**KWH SAVED**	**KW SAVED**
Base Control	$38,394	25.0%	333,861	6.0
Pressure	$2,271	1.5%	19,744	2.3
Leaks	$14,053	9.2%	122,196	13.9
Drains	$2,456	1.6%	21,361	2.4
Dryer Purge	$0	0.0%	-	-
End Uses	$11,942	7.8%	103,839	11.9
Filters	$1,049	0.7%	9,118	1.0
Dryer	$9,577	6.2%	83,282	9.5
Total	**$79,741**	**52%**	**693,400**	**47.0**

To read more about ***System Assessments,*** please visit www.airbestpractices.com/system-assessments/end-uses.

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Kaeser i.HOC Integrated Dryers Available with Oil-Free Screw Compressors

Available on both fixed and variable speed CSG-2 and DSG-2 models from 50 to 250 hp, i.HOC (integrated heat of compression) dryers use the by-product heat from air compression to regenerate the desiccant without any additional heating energy to power the drying process. This ensures reliable air drying with maximum efficiency and lower energy costs, even when air demand varies. Additionally, i.HOC oil-free rotary screw compressors have a relatively small footprint without sacrificing serviceability.

The i.HOC oil-free screw compressor models feature an integrated heat of compression dryer.

Unlike other systems, i.HOC takes advantage of all the available heat. As a result, the dryer reliably achieves low pressure dew points, even in demanding environments with low pressures, high temperatures or low load operation. A high-efficiency, variable speed radial blower compensates for any pressure lost in the drying process, and automatically adapts to changing operating conditions. Full flow regeneration, together with an additional patented process, ensures dependable drying, without additional electrical heaters or coolers, even with ambient temperatures as high as 115 °F. Furthermore, built-in heat recovery options give sustainable energy savings and contribute to lowering a plant's carbon footprint.

i.HOC units come standard with Sigma Control 2™. This intelligent controller manages the entire drying process, controlling the radial blower and drum drive of the dryer. Sigma Control 2 automatically adjusts to dynamic operating conditions, and changes in air demand to maintain reliable and consistent pressure dew points. Additionally, it offers unsurpassed compressor control and monitoring with enhanced communications capabilities for seamless integration into plant control/monitoring systems and the Industrial Internet of Things (IIoT).

About Kaeser

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

For more information, visit www.kaesernews.com/ihoc . For more information or to be connected with your local authorized Kaeser representative, please call (877) 586-2691.

Edgetech Instruments Announces the Model DX Dew/Frost Point Sensor

The Model DX primary method chilled mirror dew/frost point sensor is the newest addition to the Edgetech Instruments' line of direct insertion hygrometer sensors. With an integral PRT temperature sensor, wider operating range and improved temperature stability, the new DX can be inserted into the process stream or used to monitor the local environment. The Model DX also includes an integrally mounted temperature sensor. A single penetration reduces installation cost and improves relative humidity accuracy, as the temperature and dew/frost point are measured at the same location. The Model DX expands Edgetech Instruments' sensor choices for easy installation.

Active cooling gives the Model DX sensor enhanced stability and a dynamic range of -40 °C to +95 °C dew/frost point over a wide range of ambient conditions, while active sensor temperature compensation and isolation eliminate drift. An integrated micro aspirator option gives faster response in static environments, and an integral barometric

The Model DX has active cooling, giving the sensor enhanced stability and a range of -40 °C to +95 °C dew/frost point.

TECHNOLOGY PICKS

pressure measurement option is available on request. Integrated filter options are also available for use in dirty environments.

The Model DX Chilled Mirror Sensor can be used with Edgetech Instruments DewMaster and DewTrak II dew/frost point hygrometers. This can be done over a wide dynamic dew/frost point range of 40 ˚C to +95 ˚C, with a temperature depression of 65 ˚C from ambient temperature. It can be located remotely at distances up to 100 feet. Its compact design reduces the space needed for installation.

About Edgetech Instruments

Edgetech Instruments designs and manufacturers accurate and reliable absolute humidity hygrometers, relative humidity transmitters, humidity probes, moisture and dew/frost point analyzers, relative humidity calibrators, dew/frost point generators and oxygen measurement instrumentation. Edgetech Instruments products are manufactured, calibrated, certified and serviced to the highest industry standards in a modern, ISO/IEC 17025:2005 accredited and ISO 9001:2008 registered facility located in Hudson, Massachusetts. All calibrations and certifications are traceable to NIST. For more information, visit www.edgetechinstruments.com

Airleader Introduces Master II Controller TOUCH

Airleader is a leading German manufacturer of the award winning air Compressor Master Controller Professional. The demand logic is second to none delivering higher energy savings than OEM offered controllers or sequencers. The Airleader Web-Server comes as a part of our master controllers because we believe without a monitoring system it is impossible to keep your compressed air system tuned.

The Airleader Master II Controller TOUCH was introduced at COMVAC 2017 and is now available in North America. The Master II Controller comes with a standard touch screen in a Fiberglass NEMA 4 or a Metal NEMA 1 enclosure.

The Master II Controller TOUCH can function as a continuous data logger, storing data in 10-second averages.

With the increasing interest in capturing compressed air data at the supply and demand sites, the Airleader Master II Controller Touch can be ordered as the flex version with additional 64 analog and 96 digital inputs.

The Master II Controller TOUCH can also function as a continuous data logger. Data is stored in 10-second averages and can be downloaded as required to do investigation (base-line) and verification reports such as custom utility incentives project. The OPC or ModBus Server is available to transfer any data points into a third-party monitoring system.

For more information, please visit our website at www.airleader.us.

Presair Unveils Low Cost Pressure Monitoring Solution

Presair, a leading manufacturer in pneumatic switching technology, released a pressure monitor providing a low cost solution to original equipment manufacturers and facilities worldwide. The pressure monitor provides notification and prevents issues before downtime occurs. Versions are tailored to meet the needs of manufacturers. The monitor notifies personnel using visual, audio and even text alerts when air pressure rises or falls in a system.

Presair's pressure monitor is a simple, economical solution without all the complicated components of a programmable logical controller. Other pressure monitoring devices incur a high cost upwards of a thousand dollars or more. The Presair pressure monitor costs less than one hundred dollars. Companies have quickly found the value of a pressure monitor by increasing uptime resulting in higher productivity.

Installing the pressure monitor is as simple as connecting the switch to the pressure source and plugging the notification device into a 120V outlet.

The pressure monitor includes an adjustable or factory set air pressure switch (UL approved) ranging from 1 to 125 psi, a red stack light and an optional audible alarm. Additionally, we tied this application into another product of ours, Nanospark. By connecting our airline monitor to Nanospark, we receive text and email notifications, as well as historical reporting when the airline pressure was down.

The Presair product line consists of air, pressure and vacuum switches, along with push button actuators and foot pedals, for

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The pressure monitor includes an adjustable or factory set air pressure switch (UL approved) ranging from 1 to 125 pounds per square inch (psi).

commercial and residential use. These devices use a change in air pressure to precisely trigger at a specified vacuum or pressure level range of electrical switches up to 25A 250VAC. Using air to trigger the electrical switch allows the more dangerous electrical system to be fully isolated from hazardous environments. This makes the actuators waterproof, shock proof and explosion proof.

About Presair, A Division of Senasys Inc.

Presair was founded in 1974 and has enjoyed many years as a successful manufacturer of pneumatic switching and controls.

The Presair product line was acquired by Senasys in 2014. The company manufactures quality-engineered air, pressure and vacuum switches used in a wide range of applications from pool/spa to medical instrumentations. The business has grown over the years by developing new product lines in-house as well as acquiring complimentary and related components.

For more information about the Presair pressure monitor or to purchase, visit our website www.presair.com/monitor.

New Martech Services Personal Air P-20 Breathing Unit

Compliance with the OSHA requirement for Grade "D" Breathable Air can be accomplished with the use of a Personal Air Breathing Unit - Model P-20, manufactured by Martech Services Company.

According to Tom Wright, Martech Services Company's director of sales and marketing, when used properly, a Personal Air Breathing Unit will work with the existing filtered compressed air supply. The Personal Air Breathing Unit will provide Grade "D" Breathable Air for a proper NIOSH approved respirator, and with the provided 54" tool air hose assembly, it will allow for a bypass of air for a paint spray gun. The Personal Air Breathing Unit is a 20 scfm system.

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TECHNOLOGY PICKS

This will allow for use with full hoods, equipped with vortex cooling tubes, if so desired. The Personal Air Breathing Unit works with the existing filter compressed air supply. The existing filter must provide air quality equal to what is required for a flawless paint finish. The Personal Air Breathing Unit is a complete, belt mounted system, with a built-in filter and filter monitor, along with a carbon monoxide monitor with both audible and visual alarms. The monitor runs on a single battery, and continuously monitors the air for compliance with current OSHA standards.

With the ever-increasing awareness and need to properly protect workers while working in contaminated air spaces, systems are available, designed for multiple users at the same time. Accessories can even increase, or decrease, the temperature of the air supply for improved user comfort.

Major corporations look to Martech Services Company for their air supplied system needs. National dealer equipment programs and major paint manufacturers, alike, have chosen Martech as their preferred source. Additionally, each system is back by a one-year warranty and supported by a toll-free sales and service telephone support staff, around the clock, 7 days a week.

The Model P-20 Personal Air Breathing Unit is a complete, belt mounted system, with a built-in filter and filter monitor, along with a carbon monoxide monitor with both audible and visual alarms.

More information on the Personal Air Breathing Unit, Model P-20 can be obtained by calling Martech Services Company at 1-800-831-1525, or visit www.breathingsystems.com.

Siemens Releases NEMA 1 and UL Type 1 Wall-Mounting Kits

Siemens announced the availability of wall-mounting kits for its Sinamics G120C and G120 PM240-2 modular drives. These low-cost kits allow easy, fast installation of the drives and conform to NEMA 1 and UL Type 1 standards for interior applications. These wall-mount kits are designed in accordance with UL 61800-5-1 standards for AC drives.

The wall-mount kits are available in different power ranges from 1/2 hp to 200 hp and voltages from 230 V to 690 V.

Available in power ranges from ½ hp to 200 hp and voltages from 230 V to 690 V, the kits offer streamlined, compact design for use with all drive frame sizes of the corresponding Siemens drive units. Each kit provides best-in-class space-savings and direct access to the drive-mounted operator panel for simple commissioning, condition monitoring and even troubleshooting.

The new kits accommodate all G120C, PM240-2 and PM240P-2 power modules, control units and operator panels in the Sinamics drive family. Standardized designs permit efficient side-by-side mounting with minimal clearance, while multiple conduit knockout holes allow separate power, motor, I/O and network cabling. Seven different kits are currently available to fit all drive units from AA to F frame sizes.

For more information, please visit: www.siemens.com/global/en/home.html

Silvent Launches Pro One Air Gun in 77 Countries

Silvent has launched the new and innovative air gun, Pro One. The developing project has been ongoing for several years, and now the air gun will be available for purchase in 77 countries. Even before the launching, the Pro One has been awarded with two design awards, the Red Dot Product Award and International Design Excellence Awards (IDEA).

The air gun is one of the most used tools in production environments, but it unfortunately also creates a number of workplace injuries. The thought behind Pro One is to improve the work environment and minimize the amount of occupational injuries when blowing with compressed air. The air gun is a result of several years of research and close collaboration with users.

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TECHNOLOGY PICKS

Efficient, Quiet and Durable

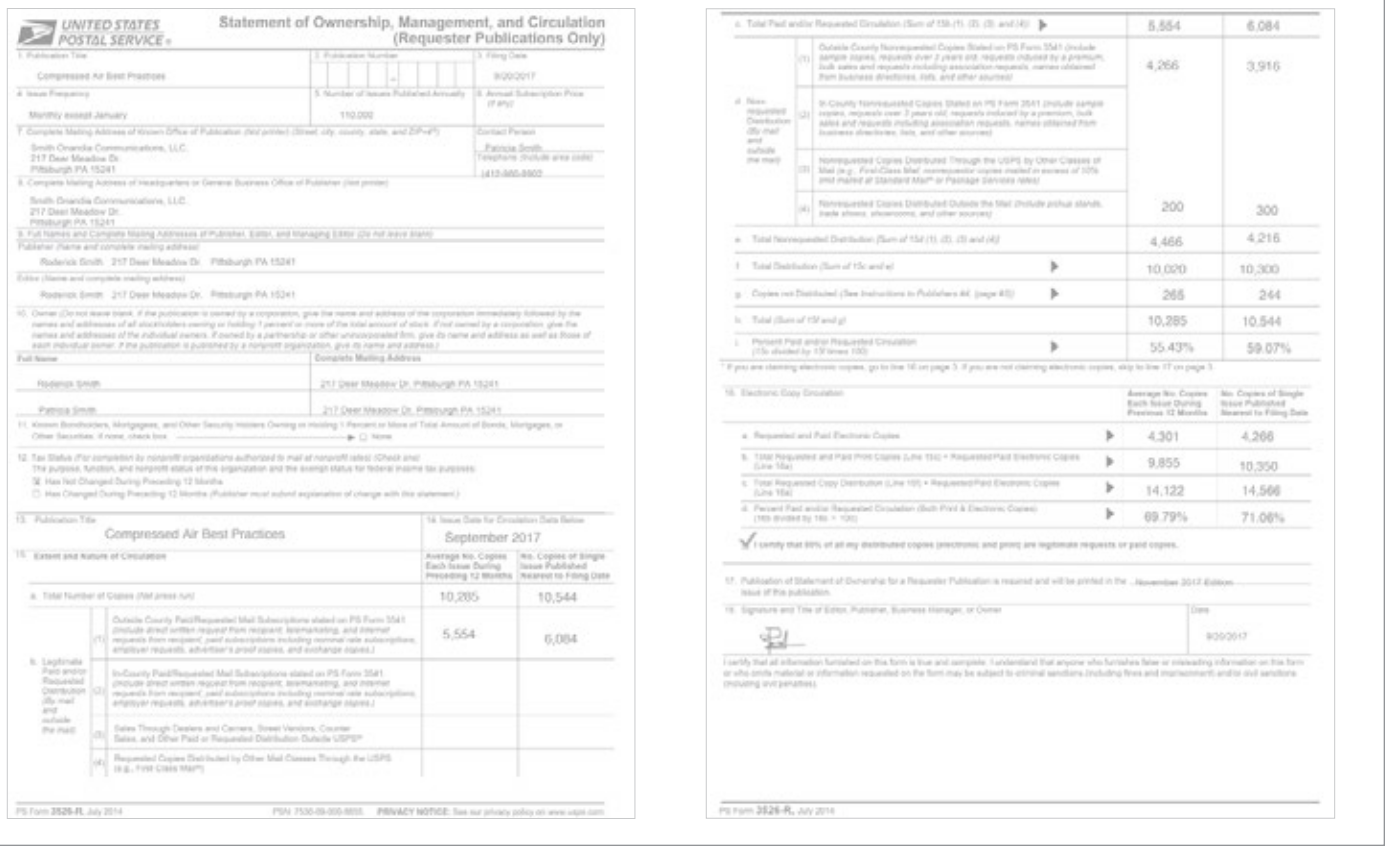
Pro One is a robust hand tool designed for professional industrial use worldwide. The air gun is fitted with a specially designed, patented nozzle in stainless steel. This allows an effective blowing force and a low noise level. The nozzle creates a concentrated jet of air, reducing turbulence, thus enabling a more targeted, effective blowing force. Pro One has a lightweight, slim design. The ergonomic handle allows several different grips to make work easier, and reduce the risk of repetitive strain injuries.

The Pro One is fitted with a specially designed, patented nozzle in stainless steel.

"The unique design of the nozzle enables a reduction in sound level of more than 10 dB(A). The ear perceives this as a half of the noise level, which in turn reduces the risk of hearing damage and makes a big difference for both the operator and the surrounding people," says Rasmus Tibell, Silvent AB's head of technology. Pro One is approved by SUVA and meets OSHA's requirements for blowing with compressed air.

About Silvent

Silvent helps manufacturers with energy optimization and improved working environment. The headquarters are located in Borås, which is where all research and development takes place. The company has unique expertise in the area of compressed air dynamics. Silvent's products and customized solutions for blowing with compressed air are used by leading manufacturers and brands worldwide. Today, Silvent's products are available in 77 countries, and in 2016 the company's sales brought in SEK 125 million. Silvent is part of the Lifco group which are listed on Nasdaq Stockholm. For more information, visit www.silvent.com/us.



UNITED STATES POSTAL SERVICE

Statement of Ownership, Management, and Circulation (Requester Publications Only)

Compressed Air Best Practices

September 2017

		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)		10,285	10,544
b. Legitimate Paid and/or Requested Distribution (By mail and outside the mail)	(1) Outside County Paid/Requested Mail Subscriptions stated on PS Form 3541 (include direct written request from recipient, telemarketing, and internet requests from recipient, paid subscriptions including nominal rate subscriptions, employer requests, advertiser's proof copies, and exchange copies.)	5,554	6,084
	(2) In-County Paid/Requested Mail Subscriptions stated on PS Form 3541 (include direct written request from recipient, telemarketing, and internet requests from recipient, paid subscriptions including nominal rate subscriptions, employer requests, advertiser's proof copies, and exchange copies.)		
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d. Nonrequested Distribution (By mail and outside the mail)	(1) Outside County Nonrequested Copies Stated on PS Form 3541 (include sample copies, requests over 3 years old, requests induced by a premium, bulk sales and requests including association requests, names obtained from business directories, lists, and other sources)	4,266	3,916
	(2) In-County Nonrequested Copies Stated on PS Form 3541 (include sample copies, requests over 3 years old, requests induced by a premium, bulk sales and requests including association requests, names obtained from business directories, lists, and other sources)		
	(3) Nonrequested Copies Distributed Through the USPS by Other Classes of Mail (e.g., First-Class Mail, nonrequestor copies mailed in excess of 10% limit mailed at Standard Mail® or Package Services rates)		
	(4) Nonrequested Copies Distributed Outside the Mail (Include pickup stands, trade shows, showrooms, and other sources)	200	300
e. Total Nonrequested Distribution (Sum of 15d (1), (2), (3) and (4))		4,466	4,216
f. Total Distribution (Sum of 15c and e)		10,020	10,300
g. Copies not Distributed (See Instructions to Publishers #4, (page #3))		265	244
h. Total (Sum of 15f and g)		10,285	10,544
i. Percent Paid and/or Requested Circulation (15c divided by 15f times 100)		55.43%	59.07%

16. Electronic Copy Circulation	Average No. Copies Each Issue During Previous 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Requested and Paid Electronic Copies	4,301	4,266
b. Total Requested and Paid Print Copies (Line 15c) + Requested/Paid Electronic Copies (Line 16a)	9,855	10,350
c. Total Requested Copy Distribution (Line 15f) + Requested/Paid Electronic Copies (Line 16a)	14,122	14,566
d. Percent Paid and/or Requested Circulation (16b divided by 16c × 100)	69.79%	71.06%

I certify that 50% of all my distributed copies (electronic and print) are legitimate requests or paid copies.

17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the November 2017 Edition issue of this publication.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner — Date: 9/20/2017

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

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THE MARKETPLACE

JOBS

FIELD SERVICE TECHNICIAN

GENERAL MACHINERY

General Machinery is looking for a Field Service Technician in the Mobile, Alabama area. We are looking for an individual with experience working on primarily rotary screw compressors. The technician will travel to the customer job site with the ability to perform routine compressor maintenance, as well as troubleshoot and perform on site repair. Knowledge and experience with reciprocating compressors, as well as with air dryers will also be an asset. Candidate will need basic computer skills, as well as the ability to properly communicate with customers.

Please send resume and a cover letter to info@generalmachinery.com. To learn more about us please visit www.generalmachinery.com.

WEST COAST DISTRIBUTION AREA MANAGER

Mikropor America Inc. is seeking exciting, self-driven & performance oriented compressed air professionals to join our team. The focus of the position is to assist distributors in growing their business through the application and sale of Mikropor products. We are searching for a team member to cover our West Coast Territory.

Mikropor America Inc., headquartered in Michigan City, Indiana, offers a broad range of energy efficient solutions for the compressed air industry such as: Refrigerated and Desiccant Air Dryers, Nitrogen Generators, Air/Oil Separators, Compressed Air Filtration, Air Intake Filters, Oil Filtration and aftermarket replacement filtration elements for compressed air.

To learn more about us visit www.mikroporamerica.com Please send resume with cover letter to nitin@mikroporamerica.com.

TECHNOLOGY

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Reach 13,000+ readers of Compressed Air Best Practices® Magazine with Marketplace Ads every month!

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TECHNOLOGY

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BUILT BETTER

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Success Story

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Sweet Savings!

A compressed air audit opens a world of savings opportunities

PROBLEM: One of the world's leading candy and gum manufacturers had no idea how much their compressed air system was costing them. Four compressors (totaling 290 hp) supplied the air needed for pneumatic controls, packaging, and wax line extrusion applications. Excessive water in the compressed air lines, steep maintenance costs, and high noise levels had them looking for a new solution.

SOLUTION: A comprehensive Air Demand Analysis (ADA) established a demand profile for the plant and showed how they were using compressed air throughout the week. It also identified areas of waste and inefficiency. By installing a 100 hp variable frequency drive compressor and two 75 hp fixed speed compressors, they would have all the air needed—with one of the fixed speeds acting as a back-up. This split system solution would bring energy—and noise levels—well under control. A Sigma Air Manager 4.0 master controller could provide on demand energy reports so they would always know how their system was performing and what it was costing.

RESULT: In just over 9.5 months, the project has paid for itself. Annual energy costs have been cut by more than 800,000 kWh. Part of these savings came from reducing the plant pressure from 125 psi to 100 psi. Additionally, the new energy efficient dryers installed have taken care of the moisture concerns. Needless to say, these savings couldn't get any sweeter.

Specific Power of Previous System:	47.16 kW/100 cfm
Specific Power of New System:	17.77 kW/100 cfm
Annual Energy Cost of Previous System:	$128,756
TOTAL ANNUAL ENERGY SAVINGS:	**$80,235**
Utility Incentive:	**$80,200**

Let us help you measure and manage your compressed air costs!

Kaeser Compressors, Inc. • 866-516-6888 • us.kaeser.com/CABP

customer.us@kaeser.com