The Magazine for ENERGY EFFICIENCY in Compressed Air Systems

COMPRESSED AIR BEST PRACTICES

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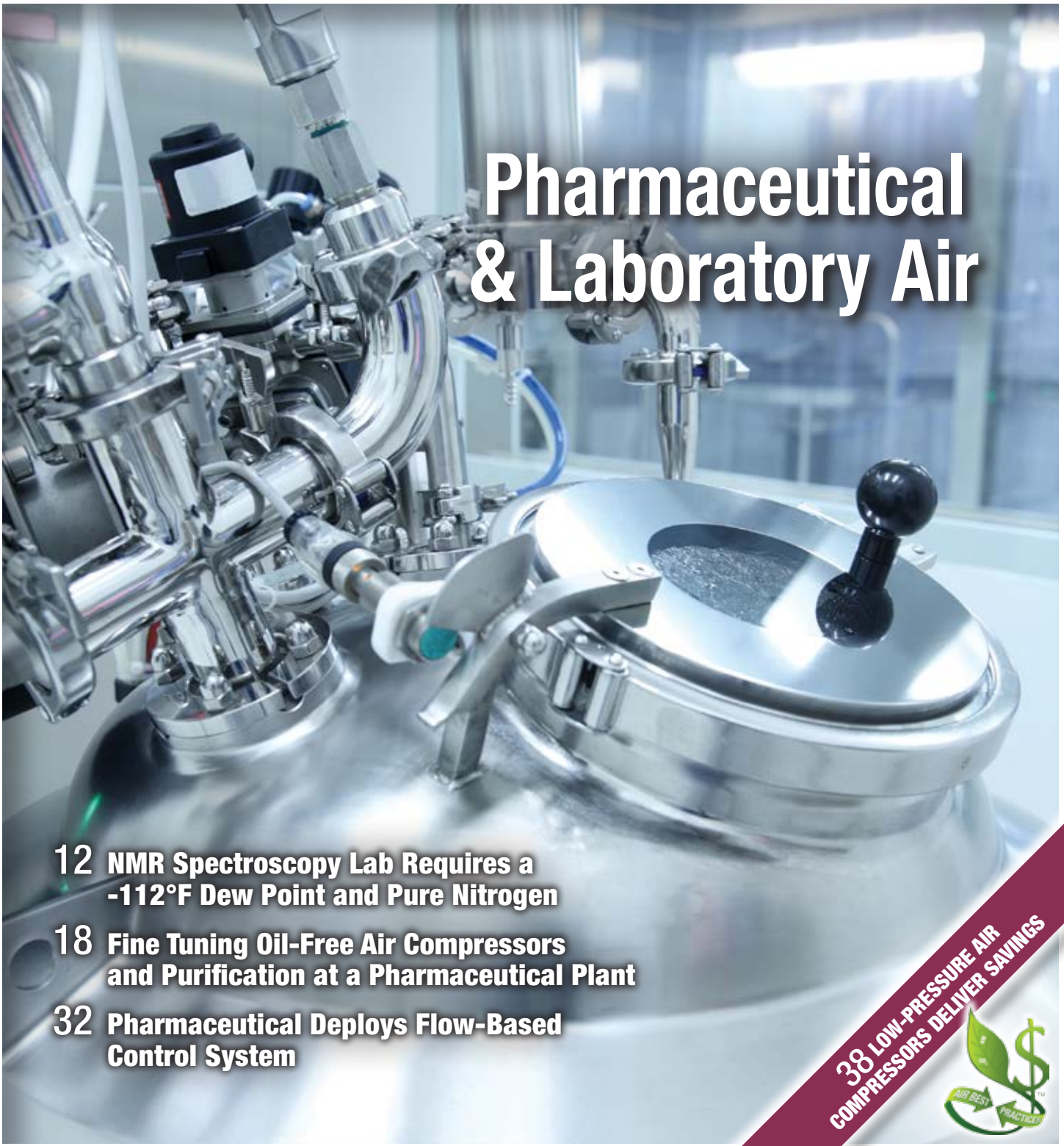
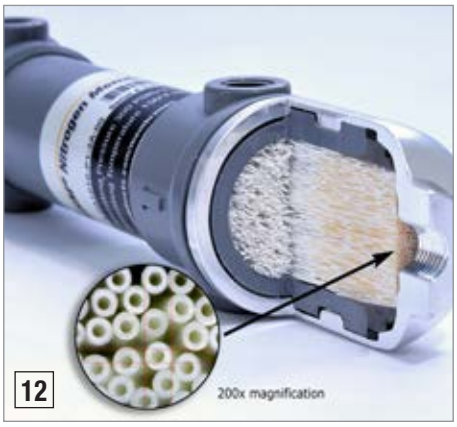
April 2017



Pharmaceutical & Laboratory Air

SUSTAINABLE MANUFACTURING FEATURES



COLUMNS

FROM THE EDITOR | Pharmaceutical and Laboratory Air

The compressed air industry does have the technology and know-how to deliver and monitor compressed air quality meeting virtually any specification. We go "Down Under", for the second straight month, to learn about a very challenging application at a Nuclear Magnetic Resonance (NMR) Spectroscopy lab, requiring both a -112˚F (-80˚C) compressed air dew point and 99% nitrogen purity. Liquid oil and oil vapor content also had to be monitored and at levels of < 0.005 ppm (0.005 mg/m3). Our thanks for sharing this application story go to Mr. Warwick Rampley, from Sydney-based firm, Basil V.R. Greatrex.

A compressed air audit shouldn't focus only on energy consumption. Compressed air quality (and breathing air) was an important part of an audit performed by Air Power USA's Don van Ormer at a pharmaceutical plant. It reviewed cycling refrigerated dryers, heatless desiccant dryers, heated purge desiccant dryers, condensate drains, and maintenance practices. The piping to a heated desiccant dryer, not yet commissioned, was undersized and this article examines the calculations recommended to solve this potential problem.

A large pharmaceutical company needed huge flow rates of 30 psig air to aerate multiple fermentation processes creating food-grade materials. Flow could vary from 12,000 to 35,000 scfm. The centrifugal and rotary screw air compressors did not efficiently co-exist. How does one get these technologies to work together? Tim Dugan, from Compression Engineering Corporation, provides us a very interesting article on deploying a flow-based control system delivering $400,000 in annual energy savings.

This is a full issue with articles on saving energy using nozzles and blowers and a Show Report from the 2017 IPPE. Ron Marshall, from the Compressed Air Challenge®, also provides an excellent article on a dense phase conveying system audit and the energy savings they received by switching to 40 psi rated oil-free rotary screw air compressors.

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

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INDUSTRY NEWS

Sullair Opens New, State-of-the-Art Training Center

Sullair, an industry leader in innovative compressed air solutions since 1965, announced it has opened a new, state-of-the-art training center in Michigan City, Ind.

The new Sullair training facility in Michigan City, Indiana.

The new facility will offer a larger, hands-on training area; a brand-new virtual reality (VR) air compressor training room; and a more convenient location.

"We believe this new training facility will help us better support our worldwide distributor network and end users," said Taylor Patz, Training Manager at Sullair. "We aim to better equip our distributors and end users to make them successful in their businesses and with Sullair products."

Located at 1100 West Kieffer Road, Michigan City, Ind., just off of Exit 34B on I-94 East, the new training facility is easily accessible for out-of-town visitors. In addition to the new VR compressor training room, the facility features two fully-loaded classrooms and a hands-on area heavily equipped with Sullair compressors and dryers. By the end of 2017, for the first time the facility will have oil free machines available for training.

"This facility will allow us to offer state-of-the-art training for all aspects of our business," added Patz. "Students will be able to simulate events that they otherwise would not have been able to, and they can truly work on compressors in a whole new way."

Using a VR headset and two handheld devices, students will be able to 'walk' 360 degrees around a virtual compressor. In addition, students will be able to participate in parts identification exercises to virtually 'grab' a compressor component, identify it, and install it on the machine. Cutaways will also allow students to see the insides of a machine while in motion.

The facility will offer two new courses for 2017. The "Advanced Microprocessor and VSD" course will get a new, second course added: "Master VSD." In addition, a new Stationary Level II course, "Master Stationary," has been restructured to a largely hands-on format versus lecture-based, a change driven by student feedback.

Sullair is adding a new course titled, "Master VSD", to the training program.

The Sullair training team will be stationed at the facility full-time, allowing distributors and end users greater accessibility.

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.

About Accudyne

Accudyne Industries is the parent company of Sullair, and a global provider of precision-engineered, process-critical and technologically advanced flow control systems and industrial compressors that deliver consistently high performance and give confidence to the mission of its customers in the most important industries and harshest environments around the world. Today, Accudyne is powered by ~2,700 employees with 14 manufacturing facilities, supporting a broad range of industries in more than 150 countries. For more information, visit www.accudyneindustries.com.

For more information, please contact (219) 861-5623 or training@sullair.com.

Atlas Copco Compressors USA Launches Online Store

Atlas Copco Compressors recently launched an online store where customers can purchase a variety of Atlas Copco compressors, including compressors up to 50 horsepower and airflows of 250 cfm.

"Customers are increasingly turning to the internet to research and purchase products, so we want them to have the same option when selecting an air compressor" said John Brookshire, President of Atlas Copco Compressors LLC.

Tired of downtime and scrap as a result of poor compressed air quality?

Moisture is found in compressed air lines and exhausting from valves and actuators on equipment thereby reducing component life and machine efficiency. Tired of draining water and oil from your compressed air lines every spring? Tired of cleaning or replacing pneumatic components well before their lifespan?

The Solution:

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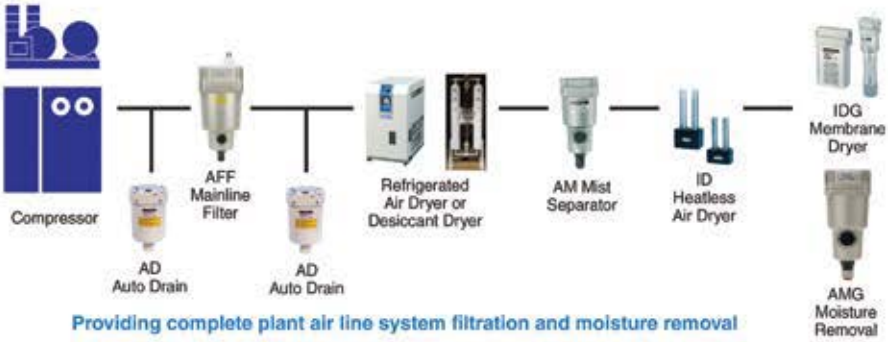
SMC Dryers provide low energy consumption and effiecient operation in sizes to work with air compressors from 1/3 to 100 horsepower (0.24kwW to 75kW) and flow ranges from 10 scfm to 400 scfm.

The SMC Dryer Advantage:

- ***Environmentally friendly R134a/R407C Refrigerant***
- ***Simple Control System, incorporating easy to read evaporator gauge***
- ***Stainless Steel Heat Exchanger providing long-life and low-pressure drops***



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INDUSTRY NEWS

In addition to compressors, the new e-commerce site offers a wide range of quality air treatment products. Dryers, filters (up to 1,200 cfm), electronic drains and oil-water separators are also available for purchase through the website.

"Whether customers need a new compressor or new quality air products, the online store will provide a quick and easy way for them to get what they need and get back to work," Brookshire continued. "We're excited to offer customers this option that reflects our ongoing commitment to sustainable productivity."

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and services focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 180 countries. In 2016, Atlas Copco had revenues of BSEK 101 (BEUR 11) and about 45,000 employees.

Atlas Copco Compressors LLC is part of the Compressor Technique Business Area, and its headquarters are located in Rock Hill, S.C. The company manufactures, markets, and services oil-free and oil-injected stationary air and gas compressors, air treatment equipment, and air management systems, including local manufacturing of select products. The Atlas Copco Group, which celebrated its 140th anniversary in 2013, is among the Top 100 sustainable companies in the world and a member of the Dow Jones World Sustainability Index. Atlas Copco has also been recognized by Forbes, Thomson-Reuters and Newsweek, among others, for its commitment to innovation and sustainability. Atlas Copco Compressors has major sales, manufacturing, production, and distribution facilities located in California, Illinois, Massachusetts, North Carolina, South Carolina, and Texas. www.atlascopco.us

To learn more, please visit https://atlascopcocompressorstore.com.

C.H. Reed, Inc. Acquires BruceAir Company

C.H. Reed, Inc., a leading provider of compressed air products and services in the mid-Atlantic area, has acquired BruceAir Company and facility. Based in Strongsville,

Ohio, BruceAir has been selling, installing and servicing all brands of compressed air products and related systems to customers in the surrounding northeast Ohio region for over 30 years. C.H. Reed is the authorized Quincy Compressor distributor in northeast Ohio and one of Quincy's largest independent distributors nationwide.

"BruceAir Company was a perfect fit to join our company," said Bob Shields, President of C.H. Reed, Inc. "This addition of expertise and manpower strengthens our presence and solution oriented capabilities in northeast Ohio. Along with our finishing and fluid handling group and our tooling, fixturing and material handling group, Reed can provide a total integrated solution to customers in this area." Bruce Bene, former owner of BruceAir, will continue his key role with the company and also assume the position of Branch Manager.

BruceAir will continue to operate under the same name and continue to serve all sectors across the region. BruceAir Company and C.H. Reed, Inc. personnel will be based out of the facility located at 19733 Progress Drive in Strongsville, Ohio.

"Reed's approach is to provide a value added solution that is cost effective and sustainable. We consider plant processes, productivity, energy reduction, rebate opportunities, environmental concerns, ergonomic matters, reliability, quality and safety. Many projects span more than one division, providing an integrated, efficient result on a turnkey basis," says Bob Shields. "We are somewhat unique in that respect."

Dave Henning of C.H. Reed, Inc. welcomes Bruce Bene to the Company (left to right).

INDUSTRY NEWS

About C.H. Reed

Founded in 1948 by Charles and Elizabeth Reed and still family owned, C.H. Reed, Inc. provides a broad based total solution of products, services and engineering through division specific product and service specialists in the three core competency areas of:

- Compressed Air
- Finishing and Fluid Handling
- Assembly Tools, Fixturing and Material Handling

Strategically located in Pennsylvania, Ohio, Maryland and Virginia in six facilities with over 110 employees including remote personnel, Reed covers the entire mid-Atlantic area.

For more information, visit www.chreed.com

Edgetech Instruments Lab Receives ISO Accreditation

Edgetech Instruments, Inc. announced their calibration laboratory is now accredited to the ISO/IEC 17025:2005 standard by Perry Johnson Laboratory Accreditation, Inc., accreditation number 92175. ISO/IEC 17025:2005 is the standard for which calibration laboratories must hold accreditation in order to be deemed technically competent. This formal accreditation is recognition of Edgetech Instruments Inc.'s calibration laboratory's competence.

Accreditation has been granted to perform calibrations for dew/frost point from -80˚C

to 20˚C, relative humidity from 5% to 95%, temperature from 10˚C to 50˚C and pressure from 1 psia to 300 psia. The full accreditation certificate can be viewed on Edgetech Instruments' web site.

Edgetech Instruments, Inc. now recertifies chilled mirror hygrometers made my other major manufacturers in addition to their own instruments. All recertifications and calibrations are performed against NIST traceable standards in Edgetech Instruments' accredited calibration laboratory.

About Edgetech Instruments

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

For more information contact tel: 508-263-5900, email: h2o@edgetechinstruments.com or visit www.edgetechinstruments.com

Alliance Calls on Congress to Pass Efficiency Bill

The Alliance to Save Energy called on Congress to move quickly to pass the bipartisan "Portman-Shaheen" energy efficiency bill

(S. 385) after Sens. Rob Portman (R-Ohio) and Jeanne Shaheen (D-N.H.) introduced the legislation in the 115th Congress on Wednesday, February 15, 2017.

"This is exactly the kind of legislation Americans want Congress to pass – bipartisan, common-sense policy that saves taxpayers money and drives economic activity and job creation," said Alliance President Kateri Callahan. "There are nearly 2.2 million energy efficiency jobs across the country – in manufacturing, installation, construction, engineering and other sectors. We added 130,000 efficiency jobs last year alone, and the policies in this legislation will only boost those numbers moving forward. This bill should have passed five years ago, so I urge leaders in both parties to put an end to the gridlock and finally move it across the finish line."

Sen. Shaheen is honorary chair of the Alliance while Sen. Portman is an honorary vice chair. They first introduced the Energy Savings and Industrial Competitiveness Act in 2011. It has stalled in each Congress since despite having broad bipartisan support. The bill made up the lead title of last year's comprehensive energy legislation that passed the Senate 85-12 in April but fell short of final passage as lawmakers adjourned for the year. The efficiency bill also passed the Senate Energy and Natural Resources Committee with a 20-2 vote.

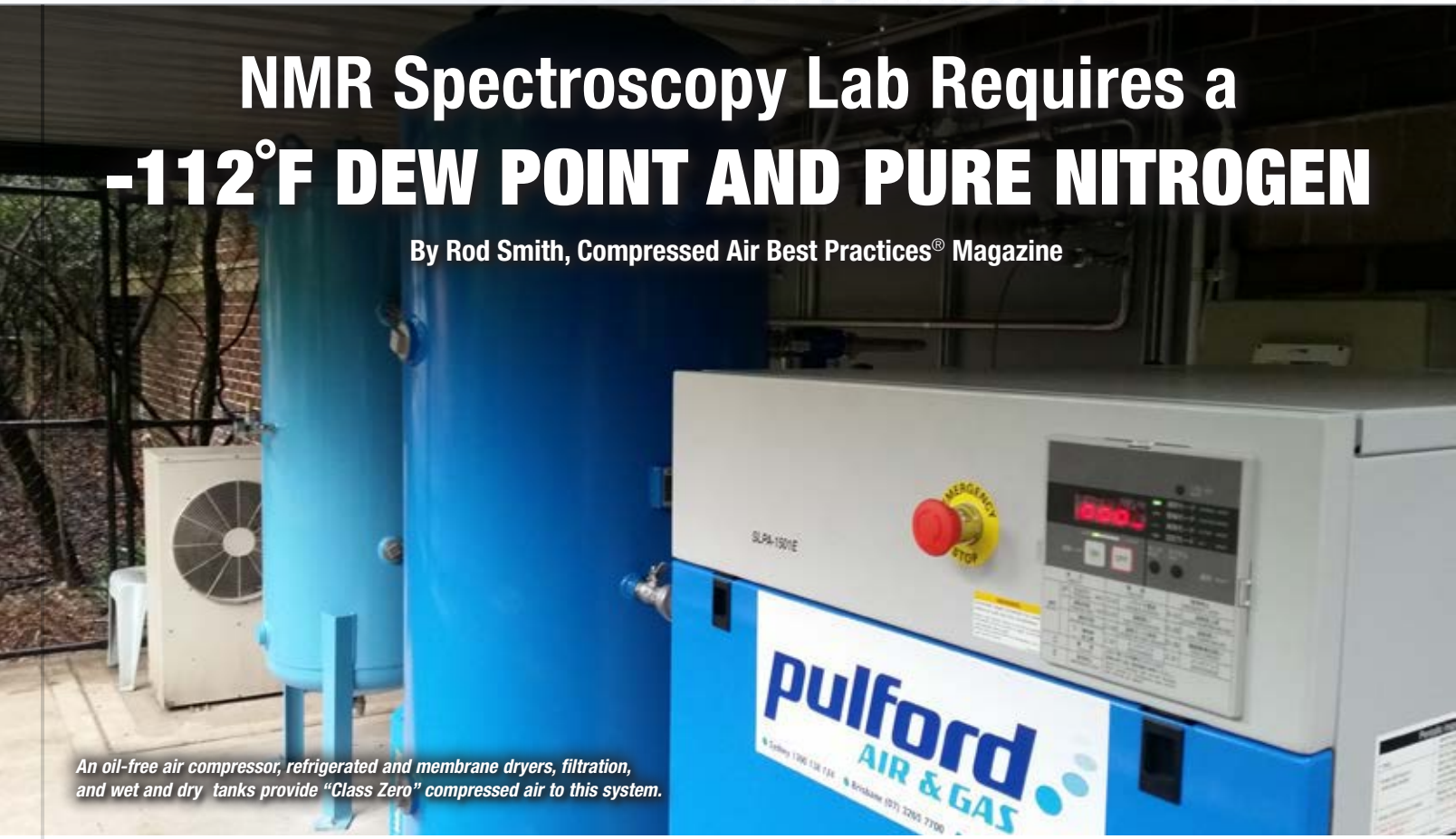
About the Alliance to Save Energy

Founded in 1977, the Alliance to Save Energy is the leading energy efficiency coalition in the nation – a nonprofit, bipartisan alliance of business, government, environmental and consumer leaders advocating for enhanced energy efficiency across all sectors of the economy. Our mission is to promote energy efficiency worldwide to achieve a healthier economy, a cleaner environment and energy security.

For more information, visit http://www.ase.org

NMR Spectroscopy Lab Requires a -112°F DEW POINT AND PURE NITROGEN

By Rod Smith, Compressed Air Best Practices® Magazine



An oil-free air compressor, refrigerated and membrane dryers, filtration, and wet and dry tanks provide "Class Zero" compressed air to this system.

Compressed Air Best Practices® Magazine interviewed Mr. Warwick Rampley, the National Sales Manager for Sydney (Australia) based, Basil V.R. Greatrex Pty Ltd.

Good afternoon (actually good morning), thank you for bringing this application to our attention!

Good morning. You are very welcome. This was a special job we thought your readers might find interesting. It's not every day one is asked to deliver a system able to provide both a reliable compressed air dew point of -80°C (-112°F) and high purity nitrogen. We work with some excellent technology suppliers and have engineered a rather interesting system.

Although our firm was founded in 1919, this application is one of the most demanding we've encountered. Basil V.R. Greatrex is a unique company as we focus only on compressed air measurement, compressed air quality and compressed air efficiency. We had the right skill sets for this job!

What is a NMR laboratory and what kind of test equipment is using compressed air and nitrogen?

In layman's terms, a nuclear magnetic resonance (NMR) spectroscopy facility analyzes samples to identify their components at an atomic level. This facility is located in the Sydney region and utilizes Bruker AVANCE spectrometers featuring a NMR superconducting magnet – a complex system producing a very strong, homogenous, and stable magnetic field required for NMR. The magnets are actually eight (8) feet tall and up to 5 feet in diameter. The magnets are kept in liquid helium at temperatures of around -200°F. The magnetic forces are so strong that there are strict guidelines limiting human exposure to the area – even a couple floors above the machine!

Compressed air and nitrogen are two key utilities, used by the magnets for cooling and moving samples in and out of the machines. The gas supply is determined by the electrical frequency of the system. The AVANCE instruction manual states:

- 200-400 MHz:
  Compressed air
- 500 MHz:
  Nitrogen gas with 95% purity
- 600-750 MHz:
  Nitrogen gas with 95% purity

This laboratory has three NMR systems outfitted with BCU-II cooling units operating at different frequencies (a 400 MHz system, a 500 MHz system, a 600 MHz system) installed. This is why we must supply both compressed air and nitrogen.

What are the compressed air specifications for the AVANCE system?

The Bruker instruction manual and "site guide" has quite a chapter titled "Utility Requirements" on this topic. Here is a

summary of the top-line compressed air specification.

- Water Content: -80˚C (-112˚F) pressure dew point
- Oil Content: < 0.005 ppm (0.005 mg/m^3)
- Solid Impurities: Filters should retain a minimum of 99.99% of particles < 0.5 micron in size or larger. Note: client specified a higher purity than this.

The Bruker site guide sets out the standards based on the size/type of NMR equipment being used and the cooling unit fitted. In this case there are 3 magnets of different sizes, all are fitted with a BCU-II cooling unit which cools compressed air to around -80˚C (-112˚F). Bruker specifies the compressed air must have this dew point as a minimum level to avoid damage to these three very expensive units estimated to be worth around $4 million AUD ($3 million U.S.). A sample may be spinning at 100,000 rpm and if it loses its gas supply, it may self-destruct. So, it's a 24/7 base load application with demand spikes when in use.

The hollow fiber membrane dryer provides a pressure dew point of at least -80˚C (-112˚F). Prefilters ensure no moisture, dust or oil vapor/liquid contaminate the membrane dryer.

NMR SPECTROSCOPY LAB REQUIRES A -112˚F DEW POINT AND PURE NITROGEN

The site guide also specifies an oil content of <0.005mg/m³ to avoid contamination of the samples and false positives on the results. Particles are a much lower standard requiring only <0.5 micron, however the site specified that given the other stringent requirements they did not want to risk their equipment and went for better than ISO8573.1:2010 Class 1. This effectively made the system a fully compliant Class 0 System.

Please describe the air compressor specification and what was installed.

The Bruker utility requirements specify an oil-free air compressor. It should be a membrane or Teflon coated piston or scroll air compressor with a fine dust inlet filter. To meet the specification, we worked with a local company, Pulfords Air and Gas, who provided us with an excellent oil-free rotary scroll (Anest Iwata) package featuring four scrolls each powered by a 4 horsepower (5.5 kW) electric motor. It's packaged in a single cabinet and the controller rotates through each air end to evenly distribute working hours. It also will automatically start and stop each air end depending on the compressed air demand.

Describe please the compressed air drying system.

Every part of the drying and filtration system is staged to give the best possible efficiency and results. The scroll compressors can produce very hot compressed air due to the elevated ambient temperatures we often experience in Sydney summers. We can see air compressor outlets at up to 25˚C (77˚F) above ambient temperatures, so they can reach 60˚C (140˚F). We even had one day this summer where we hit 48˚C (118˚F). Therefore, there is an oversized "wet" receiver allowing the compressed air to cool to more manageable levels while also condensing and separating out a large amount of the entrained moisture. This "wet" receiver is fitted with a Bekomat zero air-loss electronic drain. All of the equipment, including the zero air-loss condensate drain, is wired into the monitoring system so alarm conditions can be instantly detected - we'll get into that later.

Another challenge to purity is the fact there is a large car park located near the air compressors - so there are plenty of ambient hydrocarbons being ingested. The compressed air is filtered by a 1 micron filter, after the wet receiver, and then enters a refrigerant

dryer designed to cope with the high ambient temperatures we discussed. From there it is filtered further by a filter pack with a .01 micron filter, an activated carbon tower, and finally a .01 micron dust filter.

Special considerations are also made for the piping and fittings so no contaminants are introduced here. We have seen installations, in the past, where the wrong kind of teflon tape on fittings would cause dew point degradations of 15 degrees! This whole system uses welded stainless steel pipe. We do use a special type of teflon tape where necessary.

This system removes as many contaminants as possible before we get to the final stage. Membranes dryers can tolerate zero liquids or solid particles. This is why this pre-treatment system is so important.

The membrane dryers drive the dew point down to -80˚C (-112˚F)?

Yes. The compressed air is now dried further using a specially designed membrane dryer supplied to us by Titus Dryers. The membranes are able to drop the dew point to actually around -85˚C (-121˚F) where we see it stabilizing. Membrane dryers use no electricity and are incredibly effective and reliable at separating gaseous moisture from the compressed air stream. The differential partial pressure facilitates the molecular migration through the membrane as the faster-moving moisture molecules seek the low-pressure port (sweep air) while the compressed air continues to travel through the insides of the hollow membrane fibers.

The system is fully instrumented to measure oil vapor, particulates, nitrogen purity, dew point, pressure and kW consumption.

Finally there is a large dry air receiver installed so system demands do not impact the flows going through the drying and filtration system. The compressed air then enters the lab environment where it is delivered directly to one of the magnets after passing through one last filter set - just in case of equipment failure upstream. All the magnets are regulated at the point of use and receive a very steady pressure of 6 bar (88 psi).

How does the nitrogen supply work?

The other two magnets require nitrogen. We take a portion of this low dew point and purified compressed air and pass it through a TN2 nitrogen membrane generator supplied by Titus Air Systems. This unit provides a purity of around 99% where the specification calls for better than 95% purity. For now, the client wants to operate with this margin of safety. We may revisit the 99% purity level in the future in order to utilize less compressed air. The nitrogen is then stored in a small nitrogen receiver and delivered to the magnets through a filter set.

How is the compressed air system – particularly the dewpoint monitored?

The system is monitored using a Suto (Formerly CS-iTec) S331 local interface/ data logger that feeds information through

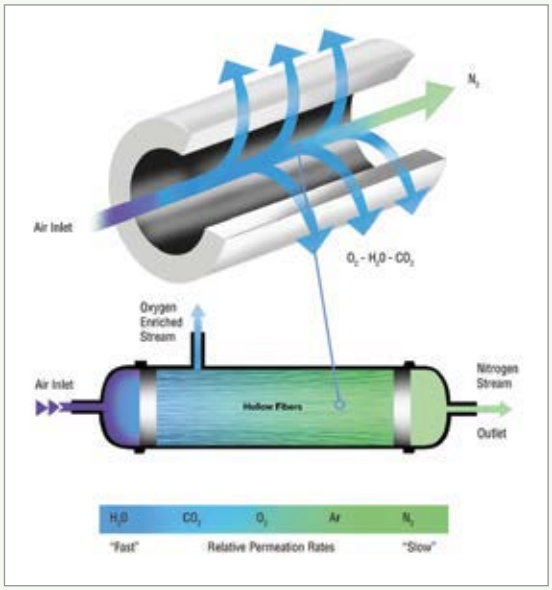
NMR SPECTROSCOPY LAB REQUIRES A -112°F DEW POINT AND PURE NITROGEN

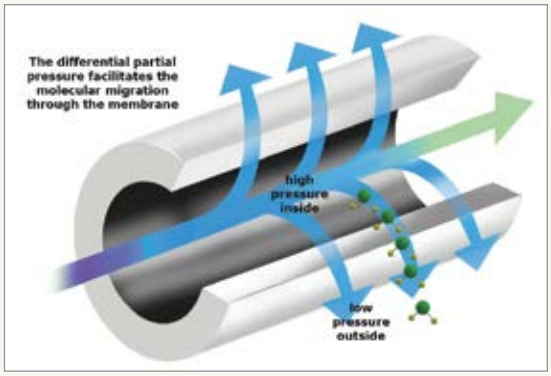
Using Membranes to Generate Nitrogen from Compressed Air

The Nitrogen Generator uses semi-permeable, hollow-fiber membrane technology to separate and recover nitrogen from compressed air. Atmospheric air generally contains 78% nitrogen, 21% oxygen and 1% other gases. The membrane uses the principle of selective permeation to produce high purity nitrogen.

Conceptually, the hollow-fiber membrane is like a porous drinking straw. Compressed air is forced through the center of the "straw". Each gas has a characteristic permeation rate, which is a function of its ability to dissolve and diffuse through a membrane. Oxygen is a "fast" gas and is selectively diffused through the membrane wall while nitrogen is allowed to travel along the inside of the fiber, thus creating a nitrogen rich product stream. The oxygen-enriched exhaust gas, or permeate, is vented from the membrane separator at atmospheric pressure. The driving force for the separation is the difference between the partial pressure of the gas on the inside of the hollow fiber and that on the outside.

A typical membrane separator contains thousands of fibers, which are bundled and encased at both ends in epoxy resin. The ends of the bundles are cut which leaves the fiber bores open on both ends, allowing the gas to travel from one end to the other. The bundles of fibers are enclosed in a suitable casing. The casing protects the fibers and routes the gas properly from feed to product end.





In the membrane separator, compressed air flows down the inside of hollow fibers. "Fast" gases - oxygen, carbon dioxide, and water vapor, and a small amount of "slow" gases, pass through the membrane wall to the outside of the fibers. These are collected at atmospheric pressure as the exhaust permeate, or waste, stream and should be vented to a safe location. Most of the "slow" gases and a very small amount of the "fast" gases continue to travel through the fiber until they reach the end of the membrane separator, where the product nitrogen gas is piped to the application.

Images provided courtesy of Titus Air Systems and PRISM® Membranes, Air Products and Chemicals, Inc.

to their software which can then be monitored anywhere in the world in real time. There are sensors on everything. The air compressor has a local display and a data logger providing power monitoring and ambient and outlet air temperatures.

Pressure sensors are placed at the wet and dry tanks, on all pre-filters and after-filters, and before and after both the refrigerant and the membrane dryers. Dew point sensors are installed after both the refrigerant and membrane dryers. Oil vapor and particles are measured and monitored. Nitrogen purity and pressure are monitored. Flow before and after the membranes is monitored. All the sensors are supplied by Suto. The system is automatically shut down and falls back to a boil-off nitrogen systems if it falls out of specification. Boil-off nitrogen is too expensive to use, as the continuous supply, hence forming part of the backup system.

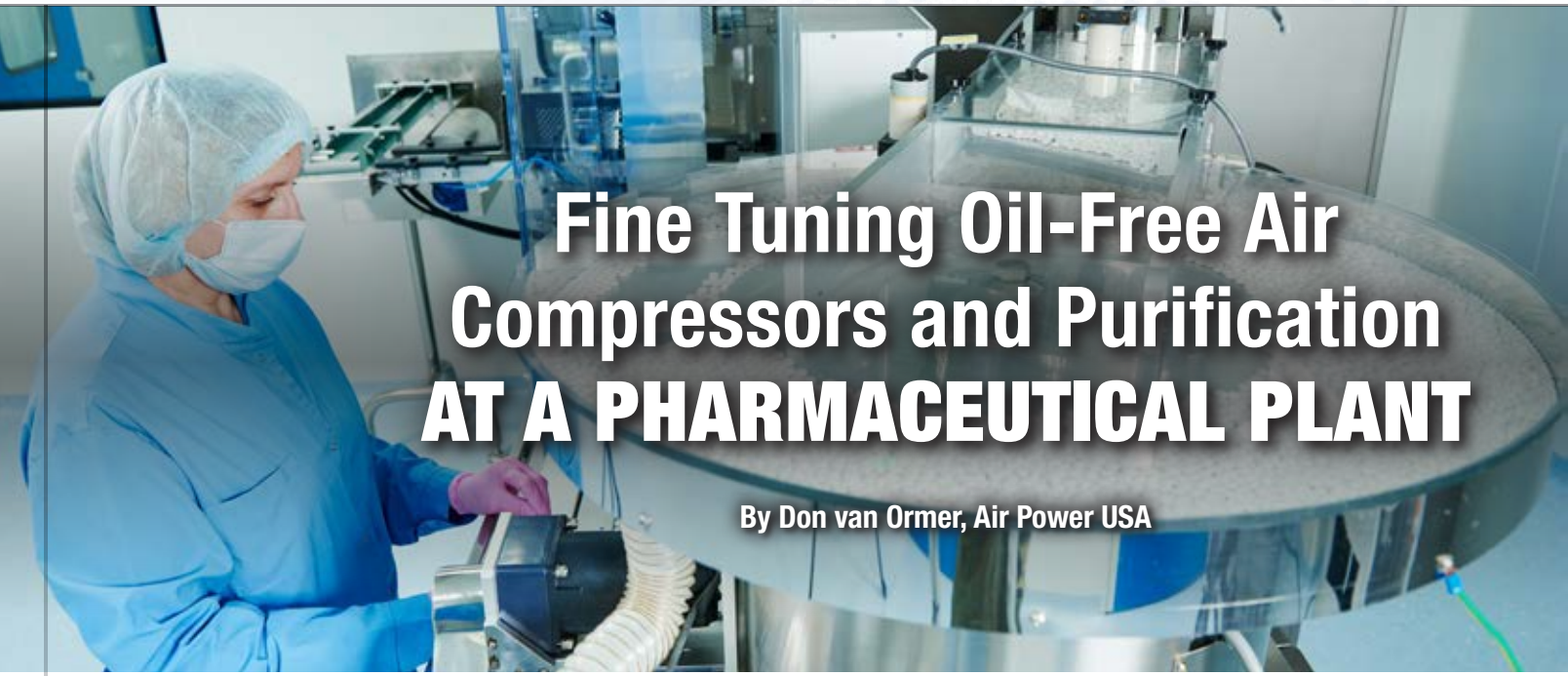
It's an amazing system. Any closing comments?

To conclude, the system has a measured and monitored pressure drop of <0.3bar from compressor to end user, the oil contamination is less than 0.003mg/m³ and particles are around 300 or less for the 0.1-0.5micron range and 0 for everything above that. The pressure dew point is -85˚C (-121˚F). It's really been interesting to have the opportunity to work with our vendors and with the client to see just how tightly a compressed air and nitrogen system can be controlled and managed.

Thank you for your time. BP

For more information, contact Warwick Rampley, National Sales Manager, Basil V.R. Greatrex, at email: warwick.rampley@bvrg.com.au or visit www.bvrg.com.au

To read more about ***Laboratory Applications,*** please visit www.airbestpractices.com/industries/pharmaceutical



Fine Tuning Oil-Free Air Compressors and Purification AT A PHARMACEUTICAL PLANT

By Don van Ormer, Air Power USA

A pharmaceutical product manufacturer spends an estimated $137,443 annually on electricity to operate the oil-free air compressors in its compressed air system. The compressed air system operates well and is providing the level of purification required. Our team visited the plant and identified a group of projects which could reduce compressed air demand and reduce energy costs by $42,248 – or 31% of current use.

The objective of this article, however, will be to illustrate the review we did of all the supply-side equipment. This includes the oil-free air compressors, dryers, filters, drains, oil-water separators and breathing air systems.

The Oil-Free Rotary Screw Air Compressors

The primary compressed air supply consists of three Kobelco, model KNW2-B/H, water-cooled, oil-free, two-stage rotary screw air compressors with 2-step (load/no load) capacity controls. All three units are rated for 215 horsepower at full-load. Their calculated full-load kW (at 125 psig) is 188 kW.

The sequence of operating the three Kobelco units are, first lead, second lag (or trim), and third standby. At the time of site review, the operating sequence of the compressors was #8 (newer Kobelco) in lead, #7 in trim and #6 in

TABLE 1. COMPRESSOR USE PROFILE – CURRENT SYSTEM

	COMPRESSOR: MANUFACTURER/MODEL	DEMAND (KW)	AIR FLOW (ACFM)	ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
				% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL ACFM
Mon thru Thursday Production: Operating at 125 psig discharge pressure for 4,716 hours							
6	Kobelco KNW2-B/H	188	1,090	OFF			
7	Kobelco KNW2-B/H	188	1,090	27%	51.3	11%	120
8	Kobelco KNW2-B/H	188	1,090	100%	180	100%	1,090
			TOTAL (Actual):	**231.3 kW**		**1,210 acfm**	
Fri thru Sun Production: Operating at 125 psig discharge pressure and 3,468 hours							
6	Kobelco KNW2-B/H	188	1,090	78%	145.8	74%	807
7	Kobelco KNW2-B/H	188	1,090	OFF			
8	Kobelco KNW2-B/H	188	1,090				
			TOTAL (Actual):	**145.8 kW**		**807 acfm**	
Holiday/Non-Production: Operating at 125 psig discharge pressure and 576 hours							
6	Kobelco KNW2-B/H	188	1,090	73%	136.6	68%	741
7	Kobelco KNW2-B/H	188	1,090	OFF			
8	Kobelco KNW2-B/H	188	1,090				
			TOTAL (Actual):	**136 kW**		**741 acfm**	

TABLE 2. COMPRESSOR USE PROFILE – PROPOSED SYSTEM

	COMPRESSOR: MANUFACTURER/MODEL	DEMAND (KW)	AIR FLOW (ACFM)	ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
				% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL ACFM
Mon thru Thurs Production: Operating at 125 psig discharge pressure for 4,716 hours							
6	Kobelco KNW2-B/H	188	1,090	OFF			
7	Kobelco KNW2-B/H	188	1,090				
8	Kobelco KNW2-B/H	188	1,090	84%	157.9	79%	864
			TOTAL (Actual):	**157.9 kW**		**864 acfm**	
Fri thru Sun Production: Operating at 125 psig discharge pressure and 3,468 hours							
6	Kobelco KNW2-B/H	188	1,090	OFF			
7	Kobelco KNW2-B/H	188	1,090				
8	Kobelco KNW2-B/H	188	1,090	53%	99.6	42%	461
			TOTAL (Actual):	**99.6 kW**		**461 acfm**	
Holiday/Non-Production Operating at 125 psig discharge pressure and 576 hours							
6	Kobelco KNW2-B/H	188	1,090	OFF			
7	Kobelco KNW2-B/H	188	1,090				
8	Kobelco KNW2-B/H	188	1,090	48%	90.2	36%	395
			TOTAL (Actual):	**90. kW**		**395 acfm**	

standby. With the appropriate maintenance, all three oil-free air compressors have operated reliably and met expectations.

The air system operates 8,760 hours per year. The load profile or air demand of this system is relatively stable during all shifts. Overall system flow ranges from 1,210 acfm during Monday through Thursday production, 807 acfm during Friday through Sunday production, and 741 acfm during holiday non-production periods.

The current units have capacity controls capable of translating "less air used" into a comparable reduction in electric cost. These controls will work effectively with the current piping and air receiver storage situation.

The system assessment identified sets of demand side efficiency projects able to reduce the demand on the air compressors. This translates into less energy used and will reduce the operating cost of the compressed air system. In the "compressor use profile" tables you can see how this allows the plant to turn OFF an air compressor and support plant

FINE TUNING OIL-FREE AIR COMPRESSORS AND PURIFICATION AT A PHARMACEUTICAL PLANT

operations, during all three shift load-profiles, with just one air compressor.

Here is a quick summary of the demand-side efficiency projects allowing us to turn OFF an air compressor.

- Repair thirty nine (39) tagged compressed air leaks
- Replace the open blow applications with engineered venturi nozzles designed to reduce the amount of compressed air used
- Repair vacuum generator control solenoid valve on line L04 instruction inserter
- Install level activated, electric or pneumatic actuated condensate drain valves on all three air compressors at the intercooler and aftercooler condensate traps
- Readjust moisture indicator sample air on both Hankison heatless desiccant dryers in Area 35 on the 2nd and 4th floors
- Repair large compressed air leak in a dust collector

The Compressed Air Dryers and Filters

The current compressed air drying system consists of several compressed air dryers located in different buildings at the facility. This includes refrigerated dryers and different types of desiccant dryers. All were functioning well. One unit had not been yet commissioned and we observed inlet piping too small in diameter, which we believe will lead to future problems. The appropriate pre and after-filters were installed and maintenance was changing them to maintain low pressure drops and air quality.

The Main Air Compressor Room

The main air compressor room has two Zeks 2000HSF cycling refrigerated dryers installed, capable of a 35˚F to 38˚F pressure dewpoint. At the time of the site visit, one dryer was operating and in satisfactory condition with no alarms or warnings present on the display screen. The other dryer was turned off and in manual standby.

Building A

A Zander ZEHD150 externally heated, heated-purge regenerative desiccant compressed air dryer is installed, capable of a -40˚F pressure dewpoint. The unit is operating well.

The heated purge air is required for regeneration of the off-line tower, which means, dry compressed air from the outlet of the dryer is passed through a heating element, mounted outside the two towers containing desiccant, which heats the air to 350˚F to 375˚F, before entering the off-line tower. The heated purge air then is used to strip the moisture from the desiccant bed. The normal switching cycle for this type of dryer is 4 hours drying of the compressed air in the on-line tower and 3 hours, 15 minutes heated purge air with a 45 minute cool down period. During the cool down, the heating element is turned off but the purge air, or sweep air, still passes through the off-line tower during the regeneration cycle. The cool down period is needed to try and eliminate temperature and dewpoint spikes at switchover that are commonly associated with heated-purge desiccant dryers.

Building A Upper Floors

Two Hankison HHS40 heatless desiccant dryers are installed and in good working order. They are capable of drying the compressed air from

-40˚F to -100˚F pressure dew point depending on the cycle option the customer has chosen. In this case the -40˚F pressure dewpoint has been chosen. The cycle time between drying and regenerating the off-line tower are shorter than those times of the heated purge dryers. Similar heatless desiccant dryer cycle times typically are 4 minutes and 10 minutes between switching times and the pressure dewpoint selected.

During the site visit, the Hankison HHS40 dryers located on the upper floors both appear to be in satisfactory operation with no alarms present or displayed on screen. Both dryers have moisture indicators mounted on units that change color at the presence of moisture in the compressed air at the outlet of dryer. The moisture indicator needs to sample the compressed air leaving the dryer through an adjustable needle valve, or in this case, a petcock was used. The petcocks were open too far, only a very slight bleed is necessary for the moisture indicator to sample the air. Any more than a slight bleed is a waste of air. We recommend the petcocks be adjusted accordingly.

Building B Under Construction

The HCO Building has a dedicated VanAir HI400 internally heated purge, regenerative desiccant compressed air dryer capable of a -40°F pressure dewpoint. The heating elements are installed inside the towers. At the time of site review, this dryer was not in operation due to construction of the new Building B having not yet been completed. We observed, however, piping issues which we believe will create future compressed air quality issues for this dryer.

The current piping for the dryer is 1-1/2" Type L copper. With 1-1/2" Type L copper piping, the pipeline velocities will exceed the recommended pipeline velocities of 20-30 fps. This will lead to a pressure drop that could be excessive, and with the high compressed air velocities through the dryer, this could cause poor dew point performance and fluidization of the desiccant bed. Fluidization of the desiccant bed can cause dusting - which is when desiccant beads rub together and break down. This will result in dryer control air and after-filters plugging prematurely affecting service life, and purge mufflers becoming plugged with the desiccant dust which will effect regeneration of the off line desiccant bed.

The piping from the header to the filters and dryer is 1-1/2" Type L copper with a cross-sectional area of 0.0123. Below is the calculation that will show on the velocity of the compressed air going to and from dryers and filters:

400 scfm rated flow for the dryer

0.0123 cross-sectional area of Type L, 1-1/2" copper piping

8.2 compression ratio

60 seconds

Formula: (400 scfm / 0.0123 / 8.2) / 60 = 66 fps (feet per second)

At 66 fps of compressed air velocity going to and from the dryer and filter package, there is a high probability of a significant pressure drop which can lead to fluidizing the desiccant bed and desiccant dusting.

FINE TUNING OIL-FREE AIR COMPRESSORS AND PURIFICATION AT A PHARMACEUTICAL PLANT

Decreasing the flow through the dryer to half its rated scfm capacity:

200 scfm (half dryer rated capacity)

0.0123 cross-sectional area Type L, 1-1/2" copper piping

8.2 compression ratio [(14.5 + 105 system pressure)(14.5)]

60 seconds

Formula: (200 / 0.0123 / 8.2) / 60 seconds = 33 fps

Even at half its rated capacity, the velocities the dryer and filters will see is 33 fps; still higher than the recommended 20-30 fps pipeline velocities.

By increasing the piping sizes from 1 ½" to 3", we expect the pipeline velocity to drop from 66 fps to 17 fps (feet per second) at 100% of rated flow (400 scfm). At 50% of rated flow (200 scfm), we expect pipeline velocities to drop from 33 fps to 9 fps.

In summary, we recommended repiping the new Building B dryer with 3" Type L copper to eliminate the potential for excessive pressure drop through the dryer and filter package and eliminate the potential chance of fluidizing the desiccant bed which can lead to desiccant dusting and poor performance of the dryer.

Condensate Drains and Oil/Water Separators

The condensate drains on the dryers and filters are pneumatic, level-actuated type condensate drains and do not need to be modified. The air compressor condensate drains, however, purge or pop every 1 second and need to be replaced. We recommend replacing the condensate drains on the air compressors with level-activated drains - electronic or pneumatic actuated type. Ensure when installing the condensate drains, at the intercooler, that the moisture trap also has a check valve installed

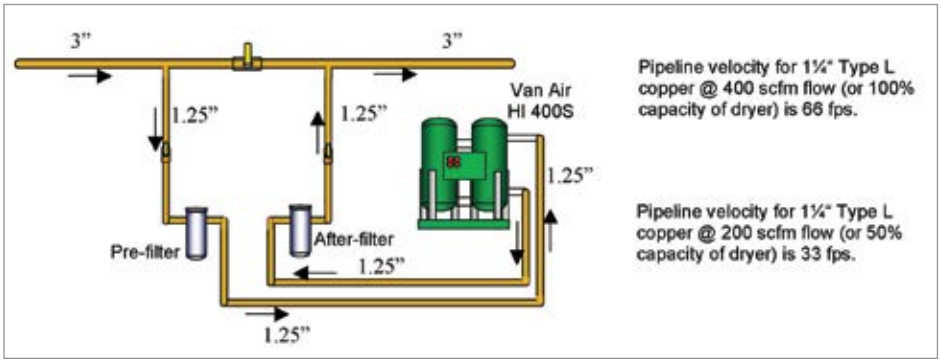


Figure 1: Building "B" Dryer Piping – Current System

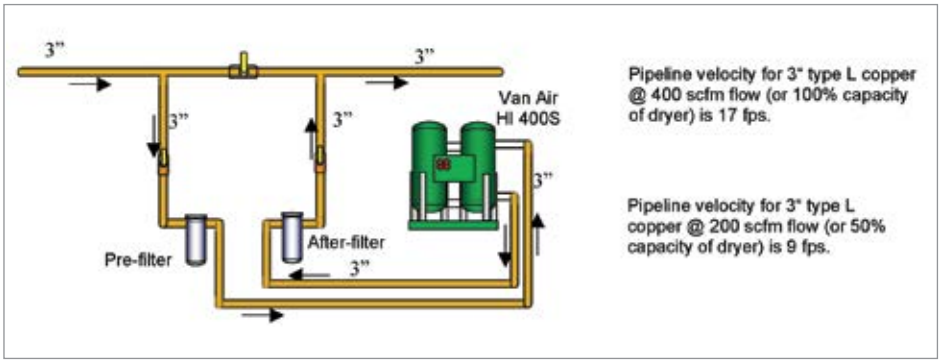


Figure 2: Building "B" Dryer Piping – Proposed System

to prevent condensate from being pulled into the intercooler. When the air compressor is unloaded, the intercooler pulls a negative pressure during this period.

We estimate the drains on the air compressors to be using 3 cfm (per year). Replacing the six drains will save 18 cfm equaling $2,219 in annual savings. We estimate the cost to acquire and install new drains to be $4,800.

We always recommend condensate level-actuated electronic and pneumatic drains. Drains come in a number of varieties, including ones that receive the signal to open from a condensate high level and the signal to close from a condensate low level. These drains waste no compressed air and are the best selection from a power cost standpoint. Their reliability is usually many times greater than the level operated mechanical drains.

Plant personnel stated that the condensate goes to a centralized water treatment plant conforming with local regulations. If this is true, and if discharge condensate meets the requirements of the local water treatment facility, there is no problem. The use of oil-free air compressors also minimizes the likelihood of oily condensate (unless there are ambient hydrocarbons being ingested by the air compressors). The–Federal EPA minimum is 10 ppm but local wastewater plants may have lower ppm requirements to achieve environmental compliance and avoid environmental penalties. The compressed air condensate handling process at all plants should be reviewed to ensure environmental compliance.

Air Suitable for Breathing

An important issue to note is the Deltech Del-Monox breathing air system needs to have both the catalyst cartridge and final filters replaced. Both catalyst cartridge and filters are past the recommended service interval. The CO_2 monitor mounted near the Del-Monox breathing air system shows 0.0 ppm CO and has been recalibrated.

Compressed air coming directly from air compressors and from standard compressed air dryers, does not comply with OSHA breathing air standards such as the latest versions of OSHA 1910.134 – or with the appropriate Canadian CSA Standards. One should also consult with local authorities for any local regulations.

Breathing air systems, like the Del-Monox purification systems are designed to remove excessive moisture, solid particulates (dust/dirt), oil and oil vapor, carbon monoxide, and hydrocarbon vapors commonly found in ordinary compressed air.

Conclusion

The bulk of our work, at this pharmaceutical plant, revolved around the compressed air use-reduction projects. Compressed air purity, if over-looked, can cause business-impacting product-rejects, production down-time, and even liabilities. It's extremely important, therefore, to regularly inspect and examine all aspects of a compressed air purification system, from the smallest condensate drain to life-sustaining breathing air systems! BP

For more information, contact Don van Ormer, Air Power USA, at don@airpowerusainc.com or visit www.airpowerusainc.com.

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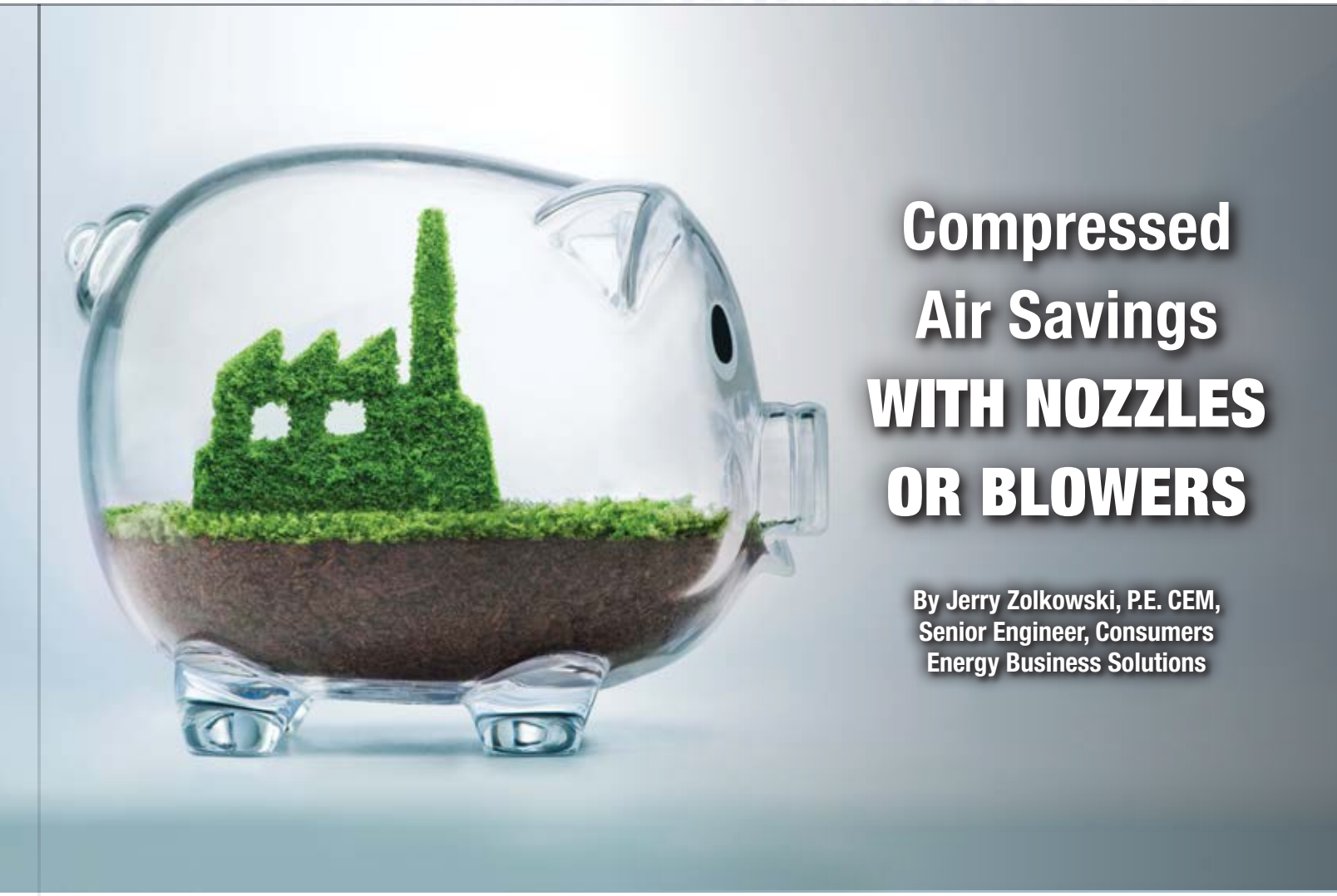

Compressed Air Savings WITH NOZZLES OR BLOWERS

By Jerry Zolkowski, P.E. CEM, Senior Engineer, Consumers Energy Business Solutions

Compressed air is used as a convenient and often necessary source of air flow to perform blow-offs, cooling, or drying. And since compressed air is a costly utility, a frequent recommendation in this magazine and audits is to reduce the compressed air use by using high efficiency engineered nozzles. Using these nozzles is a good practice as they are designed in a way that uses the compressed air to accelerate the surrounding air to deliver the same mass transfer effect as a standard nozzle (or tube) with a much larger orifice.

The savings from this switch can be estimated using the orifice sizes and a formula. While the formula is dependent on temperature and the condition of the inlet air, assuming standard conditions provides the following simplified equation:

$$CFM = 14.485 \times D^2 \times (psig + 14.7)$$

Where:

- D is the orifice diameter in inches
- Psig is the compressed air pressure in pounds per square inch (gauge not absolute)
- And CFM is the resulting flow rate in standard cubic feet per minute

This formula can be programmed into a calculator or spreadsheet. Putting it into

"A frequent recommendation in this magazine and audits is to reduce the compressed air use by using high efficiency engineered nozzles."

— Jerry Zolkowski, P.E. CEM, Senior Engineer, Consumers Energy Business Solutions

a spreadsheet with various pressures and orifice sizes produces the following cfm chart:

This can used to evaluate leaks as well as comparing nozzles. Screw compressor efficiencies at full load conditions and part load for VSD compressors are typically reported as 18-22 kW per 100 cfm on CAGI data sheets for compressors running at 100 to 120 psi. So conversion from cfm to kW can be done by assuming a compressed air efficiency of about 0.20 kW/cfm. The amount of energy use (kWh) is then obtained by multiplying by the running hours.

For example, a 1/8" open ended tube at 80 psig would consume 21.4 cfm using the chart. Multiplying by the compressor efficiency of 0.20 kW/cfm means this would require 4.28 kW input to the compressor. If this runs

COMPRESSED AIR LOSS TABLE (CFM)

PRESSURE PSIG	ORIFICE SIZE IN INCHES							
	1/64	1/32	1/16	1/8	3/16	1/4	5/16	3/8
	0.015625	0.03125	0.0625	0.125	0.1875	0.25	0.3125	0.375
2	0.1	0.2	0.9	3.8	8.5	15.1	23.6	34.0
5	0.1	0.3	1.1	4.5	10.0	17.8	27.9	40.1
10	0.1	0.3	1.4	5.6	12.6	22.4	34.9	50.3
20	0.1	0.5	2.0	7.9	17.7	31.4	49.1	70.7
30	0.2	0.6	2.5	10.1	22.8	40.5	63.2	91.1
40	0.2	0.8	3.1	12.4	27.9	49.5	77.4	111.4
50	0.2	0.9	3.7	14.6	32.9	58.6	91.5	131.8
60	0.3	1.1	4.2	16.9	38.0	67.6	105.7	152.2
70	0.3	1.2	4.8	19.2	43.1	76.7	119.8	172.5
80	0.3	1.3	5.4	21.4	48.2	85.7	134.0	192.9
90	0.4	1.5	5.9	23.7	53.3	94.8	148.1	213.3
100	0.4	1.6	6.5	26.0	58.4	103.8	162.2	233.6
110	0.4	1.8	7.1	28.2	63.5	112.9	176.4	254.0
120	0.5	1.9	7.6	30.5	68.6	121.9	190.5	274.4

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COMPRESSED AIR SAVINGS WITH NOZZLES OR BLOWERS

6000 hrs/yr it would use 25,680 kWh and cost $2,568 at an electric cost of $0.10/kWh. Replacing this with a high efficiency nozzle rated to use 13 cfm at 80 psi would save 8.4 cfm, 1.68 kW, 10,080 kWh, and $1,000. With a nozzle cost of about $50 this would be very attractive. This same type of analysis can also be used to assign a monetary value to air leaks.

Blowers

The ideal approach to optimize energy use is to not use compressed air at all by using a blower to provide the low pressure air flow. This has a much higher capital cost (and effort) except in cases where it would avoid the purchase of an air compressor. The savings analysis evaluates the cost of the current compressed air use by the nozzle or open pipe system as shown above, and then evaluates the cost of running the motor on the blower to obtain the difference.

For example, one site that manufactured metal parts for the automotive industry washed machining oils off the parts, and then proceeded to dry the parts using two air amplifiers at a line pressure of 90-100 psi. The wash line is a continuous conveyor holding a steady line of parts. This kept the blow-off running continuously. A flow meter installed on the line showed the flow rate to be 99 scfm. The plant chose to install a 15 hp blower rated at 800 cfm and then set the blower speed as needed with a VFD. The plant normally operates 8,000 hrs/yr. While this also increased volume capacity, it still demonstrated energy savings. Original energy use would be the following:

$$\text{Original Consumption} = (\text{Eff}_{ac}) \times (\text{CFM}) \times (t)$$

$$\text{Original Consumption} = (0.20\ \text{kW/cfm}) \times (99\ \text{cfm}) \times (8{,}000\ \text{hrs/yr})$$

$$\text{Original Consumption} = 158{,}400\ \text{kWh annually}$$

In this particular case post monitoring was performed by data logging the power use of the blower. The inverter frequency was set at 60 Hz. Staff recognized it would be possible to run at lower rates but had not yet attempted to do so. The power demand was steady at 8.8 kW. The new energy use is thus the 8.8 kW demand multiplied by the 8,000 hour run time which is 70,400 kWh.

The annual energy savings is the original consumption of 158,400 kWh less the new use of 70,400 kWh which is 88,000 kWh. This site has an average electricity cost of $0.08/kWh so the annual savings are $7,040. This qualified for an energy efficiency rebate of $7,000, and the full project cost was reported to be $23,500 including blower, inverter, hoses, enclosure, and installation. This project provided a simple payback of 2.3 years after rebate.

Blow-off applications using compressed air are common, and the compressed air used for them is costly. Many of these systems can use less compressed air through the use of high efficiency nozzles or blowers. High efficiency nozzles are typically easy and inexpensive to implement by adding a nozzle where there is presently a standard nozzle or an open tube, and the savings can be significant. The compressed air use can be eliminated entirely in some cases by using a blower. This offers greater savings than compressed air nozzles and preserves system capacity, but it requires effort and expense to implement. BP

For more information please contact Jerry Zolkowski, Senior Engineer, Consumers Energy Business Solutions, at email: Gerard.Zolkowski@dnvgl.com, or visit www.consumersenergy.com

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Compressed Air Technology at RECORD-SETTING 2017 IPPE

By Rod Smith, Compressed Air Best Practices® Magazine

The 2017 International Production & Processing Expo (IPPE) had a great year with 31,649 poultry, meat and feed industry leaders from all over the world in attendance, setting a new record. There were also 1,273 exhibitors with more than 533,000 square feet of exhibit space, another new record.

The Expo is the world's largest annual feed, meat and poultry industry event of its kind and is one of the 50 largest trade shows in the United States. IPPE is sponsored by the U.S. Poultry & Egg Association, American Feed Industry Association and North American Meat Institute.

There were 8,018 international visitors, a third new record, from 129 countries represented at the Expo. The largest group from a single country outside the U.S. was Canada with 1,383 visitors. The largest region represented was the Caribbean, Latin America, Mexico and South America with 3,226 visitors.

Doug Haislip, Lisa Perdue and Michael Camber in front of the Kaeser Portable Custom Enclosure (left to right).

A look inside the Kaeser Portable Custom Enclosure displayed in the booth.

"We are very excited about this year's record-breaking exhibit space floor and attendance numbers. The turnout for the 2017 IPPE was exceptional, and the feedback from attendees has been extremely positive regarding time spent on the trade show floor and in education sessions. We expect next year will be even more valuable for attendees and exhibitors alike," the three organizations said.

Compressed Air Technology for Meat and Poultry Processors

Kaeser Compressors

Kaeser Compressors had a very innovative booth displaying an example of Kaeser's expanded "Custom Engineered Solutions" capabilities. What looked like a very cool booth "back wall" turned out to be a full-bore shipping container holding a complete compressed air system inside! This Kaeser Portable Custom Enclosure had two AS30 rotary screw air compressors (with full exhaust air ducting), a TD76 cycling refrigerated air dryer, filtration, interconnecting aluminium piping, a 240 gallon receiver tank, and an oil-water separator. The whole system is controlled by a Sigma Air Manager 4.0 Controller.

Marketing Manager Michael Camber explained this Custom Enclosure was an example of Kaeser's significant investment in "Custom Engineered Solutions." The custom fabrication and engineering capabilities, in their Fredericksburg (Virginia) headquarters, have been dramatically expanded. Modified ISO shipping containers are built for easy transport and ruggedness. The enclosures can be customized in a wide variety of ways including steel welded frames with insulation and waterproof aluminium skin, designs for seismic and wind forces of up to 300 mph,

Kurt Peter and Sam Brinkman at the Compresyn booth (left to right).

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COMPRESSED AIR TECHNOLOGY AT RECORD-SETTING 2017 IPPE

and different lengths/widths/doors for truck transport and service access. The enclosures can house blower systems for wastewater aeration or complete plant compressed air systems for rental or permanent installation. This initiative is also very active with custom fabricated outdoor skids for instrument air systems for oil & gas, petro-chem, and natural gas pumping stations

Compresyn Lubricants

JAX lubricants are widely used in the meat and poultry processing industry in a wide range of processing equipment machines. The JAX booth also displayed their COMPRESYN synthetic food-grade lubricants for air compressors and vacuum pumps. Product Manager Kurt Peter explained their long experience with the food industry helped them create a special air compressor formulation designed for plant-wide compliance with food-grade oil specifications.

IPPE Conference Program and Bus Service for Poultry Companies

A week-long schedule of education programs, which updated industry professionals on the latest issues and complemented the exhibit floor, helped drive attendance. This year's educational line-up featured 25 programs, ranging from a conference on Listeria monocytogenes prevention and control, to a program on FSMA hazard analysis training, to a program on whole genome sequencing and food safety implications.

Multiple poultry companies took advantage of free bus service to transport their employees and growers to the 2017 International Production & Processing Expo (IPPE). More than 260 employees and contract producers from 11 poultry complexes as far away as North Carolina attended IPPE via the bus service. They included Amick Farms, Claxton Poultry, Fieldale Farms, Keystone Foods, Perdue Farms, Pilgrim's and Tyson Foods. The attendees were pre-registered through the Members to Atlanta (M2A) program. In addition, the attendees were provided Chick-fil-A lunch coupons, compliments of IPPE. IPPE will offer the bus service again in 2018 for meat, poultry and feed member companies of the U.S. Poultry & Egg Association, American Feed Industry Association and North American Meat Institute. For more information, please contact Larry Brown at l.brown@uspoultry.org.

Next year's International Production & Processing Expo will be held Jan. 30 – Feb. 1, 2018, at the Georgia World Congress Center in Atlanta, Ga. Show updates and attendee and exhibitor information will be available at www.ippexpo.org.

ABOUT IPPE

The International Production & Processing Expo (IPPE) is a collaboration of three shows - International Feed Expo, International Meat Expo and the International Poultry Expo - representing the entire chain of protein production and processing. The event is sponsored by the American Feed Industry Association (AFIA), North American Meat Institute (NAMI) and U.S. Poultry & Egg Association (USPOULTRY). BP

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Pharmaceutical Deploys Flow-based System to Control Centrifugal and Screw Air Compressors

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

➤ Introduction

What if you just acquired a delivery business that used to deliver large equipment, and now you are re-tooling it to deliver a random mix of small and large packages? You inherited two fairly modern 18-wheelers (4000 cubic foot capacity) and two ancient 26-foot (1500 cf) furniture trucks. The old boys don't always start, and need a lot of TLC to keep running. The new ones run beautifully, but are way over-sized for most loads over 4000 cf. Without consulting you, your new purchasing manager just spent a fortune on two new little 22-ft (500 cf) hybrid delivery vans. Now, your dispatcher has to match loads to trucks, and it is driving him crazy to figure it out. Before the hybrids were purchased, your dispatcher ran the big two new ones, with one full and the other taking the rest, mostly empty most of the time, and kept the old boys for standby in an emergency. Your fuel bill was astronomical, but it was simple. The big trucks get four mpg full and six mpg empty. Now you have these tiny new trucks, and you're scratching your head, "How do I manage the whole fleet at lowest cost, and still meet demand?" The new trucks are great, but too small! What if my demand changes daily, and varies from 3,000 cf to 9,000 cf?

How can one get Centrifugal and Rotary Screw Compressors to Work Together?

This is exactly the situation I had in a recent compressed air project. I helped the customer solve the problem and they saved over $400,000 per year in electricity through "Flow-based Controls."

A large pharmaceutical company needed huge flow rates of 30 psig air to aerate multiple fermentation processes which create food-grade materials. Flow could vary from about 12,000 scfm to 35,000 scfm. There were a variety of batch processes, mostly running independently. An hour-by-hour schedule for anticipated air flow is developed every afternoon for the next day. Based on that schedule, the boiler operators run the air compressors that can handle the load range for the whole day. See Figure 1 (pg. 34) for one week of actual projected data. In reality, the peak flow can be higher than anticipated. These flows are calculated from the sum of the hourly projected flows, and the anticipated peaks are not always happening at the same time. If the peaks are concurrent, the total can be higher. Conversely, the total minimum might be less.

The air compressors available to the site, including the new ones are shown in Table 1. Just prior to my getting involved, they had bought three small (350hp) single-stage VFD compressors. Together, they are slightly larger than half the size of one old Centac, and less than 30% of the size of a 3000hp Atlas Copco centrifugal. Prior to the VFD compressor installation, all the compressors were in local control, manually run to match anticipated demand for each 24-hour period. The large 3,000 hp units have good proportional control, and can run from full to min flow with very little pressure variation. The 1,250 hp units, however, aren't trusted by the boiler operators. Although their curves indicate that they should be able to provide at least 35 psig, when they are run at the same time as the large units, operators believe that they aren't developing capacity. They weren't sure if they surge or just blow off, but there is a problem that creates uncertainty to them.

Prior to installing the VFDs, they had to run two 3,000 hp units almost all the time. The anticipated peak was always at least 20,000 scfm, and they didn't think they could run a Centac and Atlas centrifugal at the same time. The Centacs had local control adjustment problems that didn't allow them to load up. After the installation of the VFDs, it wasn't clear to the operators what to do. Anticipated peak is higher than 25,500 scfm about half the time. Savings of about 1000 hp average are possible if this question can be answered satisfactorily, over $400,000/yr in electricity!

If you were the boiler operator in charge of starting the air compressors now, with the new VFDs installed, how would you run the compressors? You get one shot to decide, and need to leave them in that mode all day. Your decision needs to be based on the peak anticipated flow and size of compressor that you can reliably run, and with the set of compressors that can run together in a stable manner.

Since anticipated peak flow is rarely between 20,000 and 25,000 scfm peak, the sweet spot for running the VFDs, you would run the two Atlas centrifugals most of the time, and your new VFDs would sit idle. And your savings would be almost zero. That's the only alternative without master control.

If your engineers or suppliers think you should buy a "sequencer", don't believe them. See my 2011 Best Practices article for compressor master controls terminology and function, http://www.airbestpractices.com/system-assessments/compressor-controls/compressor-sequencer-problems-and-solutions.

Sequencers typically are designed for rotary screw air compressors of a similar size, and usually run the last-on compressor as "trim", either load-unload or VFD. You can't save any energy by doing that with the two big centrifugal air compressors, because they are already doing

PHARMACEUTICAL DEPLOYS FLOW-BASED SYSTEM TO CONTROL CENTRIFUGAL AND SCREW AIR COMPRESSORS

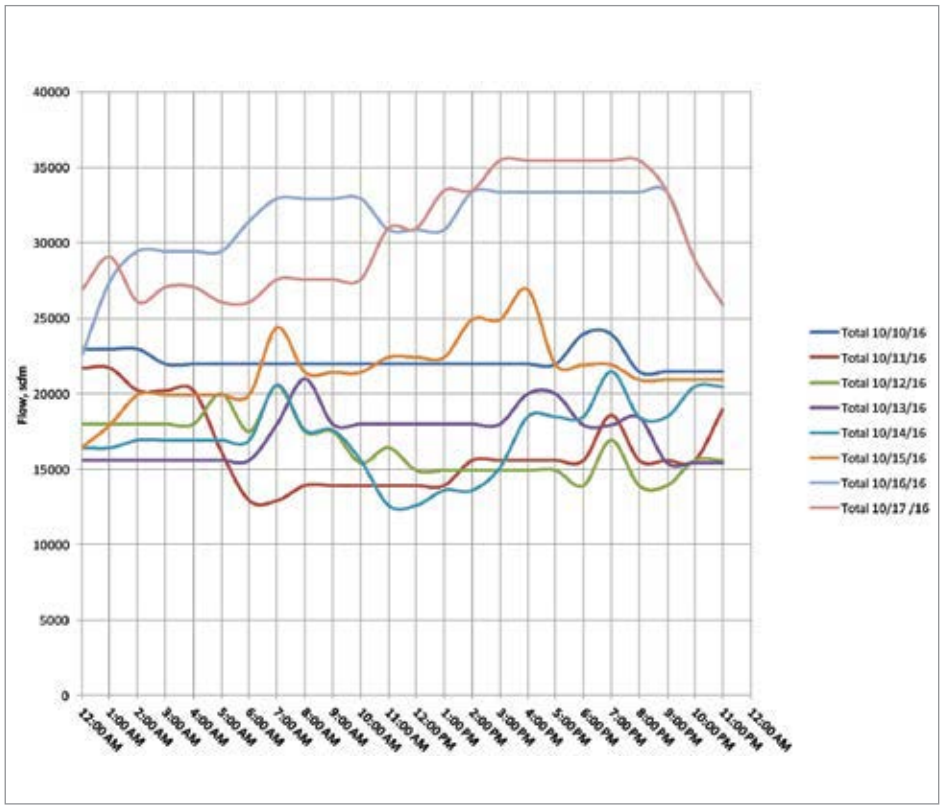

Figure 1. Typical One-Week Compressed Air Flow Profiles

TABLE 1. AIR COMPRESSOR INVENTORY

		FULL LOAD CAPACITY, SCFM	NOMINAL MOTOR POWER, HP
COMPRESSOR	Atlas Copco HR10-035-2 (Comp C)	19888	3000
COMPRESSOR	Atlas Copco HR10-035-2 (Comp D)	19888	3000
COMPRESSOR	IR Centac M83-2603 (Comp A)	8333	1250
COMPRESSOR	IR Centac M83-2603 (Comp B)	8333	1250
COMPRESSOR	(3) Atlas ZA4 VSD (Comps E-G)	5446	350
		TOTAL	X3
TOTAL		**101664**	**9550**

the best job they can at that. And the second unit is blowing off 1000 hp of air. You can't run the Centacs in and out, load-unload like a sequencer does, because pressure variances will be too high. You can't put the VFDs only in trim, because they aren't big enough to swing the demand variances that are anticipated in a given day, and the range won't match to the narrow window that is their sweet spot (20,000 to 25,500 scfm) most of the time.

Deploying Compressed Air Flow-Based Master Controls

What if you could repair the Centacs so that they can operate properly, and master control all seven air compressors so that the optimal set would run in any flow range? Sometimes run one set in one way, and sometimes run another set in another way, depending on total compressed air flow? That is called "flow-based control."

For instance, in the delivery truck analogy, what if you could automatically deploy the 18-wheeler and trim with the hybrids sometimes, or run an old truck fully-loaded and trim with an 18-wheeler at the top end? There are lots of combinations to think through. And you would need a logistics system that could quickly figure out which trucks to use in real time.

In our project, we were not allowed to automatically start and stop the 3,000 hp Atlas centrifugals due to customer and vendor perceptions of risk to the process and compressors. In reality, they could have been

TABLE 2. FLOW-BASED CONTROL STRATEGIES

STRATEGY NO.	FROM	TO	Base 1	Base 2	Base 3	Base 4	Trim 1	Trim 2	Trim 3
1	0	19888					HR10 C		
2	19888	25334	HR10 C				ZA E	ZA F	ZA G
3	25334	28221	Centac A				HR10 C		
4	28221	33667	HR10 C	Centac A			ZA E	ZA F	ZA G
5	33667	36554	Centac A	Centac B			HR10 C		
6	36554	42000	HR10 C	Centac A	Centac B		ZA E	ZA F	ZA G

auto-controlled. We were able to repair and adjust the Centacs so that they were able to fully load at required pressure, and remotely start and load. We were not able to control their pressure remotely, however. That would have required new inlet guide vane (IGV) and blow-off valve (BOV) controllers, new transmitters, and local PLCs, which was more than our customer wanted to spend on these older compressors.

We had the customer install a smart master control system from TTED called a PL4000, programmed to control different sets of base and trim compressors in each possible flow range, from zero flow to maximum. See Figure 2. The system was commissioned with zero blow-off. Projected performance assumed some blow-off, so this exceeded expectations! Table 2 shows how we did it.

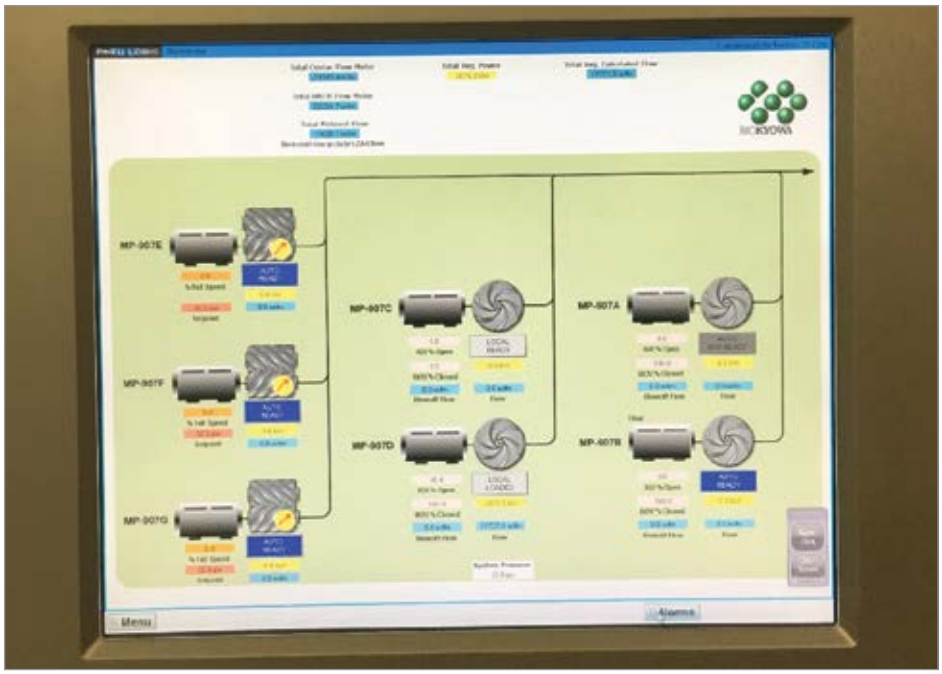

Figure 2. Flow-Based Control System

How Was This Done?

In simplified form, we merely had to have auto control of the Centacs and VFD compressors, a reliable flow metric, a table of flow ranges and compressors, and a solid algorithm to shift from one table to the other. Shifting the compressors has to happen without pressure varying more than the programmed operating range. If pressure drops to a floor (a differential below target pressure), the active strategy shifts up one. If flow drops below the lower threshold, the strategy shifts down one.

1. Installed Control and Monitoring Interfaces for Five Compressors

Ideally, we wanted to be able to control the set point, start/stop, and load-unload of all compressors. The problems were:

- The Centacs didn't have electronically-controlled IGV and BOV, so their set points couldn't be controlled remotely.
- The HR10's were only monitored remotely, not controlled.

PHARMACEUTICAL DEPLOYS FLOW-BASED SYSTEM TO CONTROL CENTRIFUGAL AND SCREW AIR COMPRESSORS

So we only could control five automatically, the two Centacs and the three VFDs. And we had to depend on operators to select the right number of HR10's to run each day. Typically that was one.

Next, we had to adjust the Centac local IGV's and BOV's and wire interfaces for load and start to the old Centacs. This required some maintenance, testing called "surge testing" and minor electrical modifications. We got the Centacs adjusted to fully load to about 35 psig (master set point was about 31 psig) without surging, and then wired start and load relays to the controls.

For the new VFD compressors, we had to get the Modbus gateway working that allowed the PL4000 to talk to the compressors, and give them a set point for VFD control, a start point below that, and a stop point above that.

2. Developed a Reliable Flow Metric

At first, we planned on using two flow meters, one for the HR10's and one for the Centacs, and calculate capacity of the VFDs based on motor speed. Then add them up. The flow meters were troublesome and unreliable, being thermal mass type in wet compressed air. And the vortex-shedding types were not pressure and temperature compensated, so we had to go to Plan B, calculated flow, as follows:

- VFD compressors: Got motor speed feedback for each compressor, and calculated capacity as % speed x full load acfm, if loaded.
- Centacs: Got motor current (via a current transmitter) and BOV valve operator pressure (via a pressure transmitter), and calculated capacity from estimated full load capacity and valve % open.
- HR10 Centrifugals: We got IGV, BOV, motor current, and pressure feedback from the PLC, via the network connection.
- We summed all compressors' flow to get total flow, and smoothed it mathematically to "de-bounce" the signal.

This metric turns out to be more reliable than from flow meters, because the measurement sensors are simpler and less likely to fail, and the calculations are not dependent on ambient conditions.

3. Implemented a Solid Algorithm

Table 1 is the commissioned algorithm. We didn't have to try many alternatives. The main issue in testing that was needed was the pressure settings. Without getting into two much technical detail, the trim compressor set points had to be adjusted multiple times to get to work in all flow ranges. Sometimes the VFD compressors controlled pressure as "trim" and the centrifugals were all base-loaded. Other times, the HR10 compressor controlled pressure as "trim" and the VFDs were off. The pressure ranges couldn't overlap.

4. Tested All Strategy Shifts

This is the most important part of testing, and the one that presents the most risk to the process if not done right. Thus, off-line

TABLE 3 BASELINE SYSTEM PERFORMANCE

		FULL LOAD CAPACITY, SCFM	NOMINAL MOTOR POWER, HP	AVERAGE FLOW, SCFM	PEAK FLOW, SCFM	AVERAGE PRESSURE, PSIG	AVERAGE POWER, KW	PEAK POWER, KW	SPECIFIC ENERGY CONSUMPTION, SCFM/KW	ENERGY CONSUMPTION, KWH/YR
COMPRESSOR	Atlas Copco HR10-035-2 (Comp C)	19888	3000	18981	19888	34	2144.0	2240.8	8.9	18,781,163
COMPRESSOR	Atlas Copco HR10-035-2 (Comp D)	19888	3000	8519	22112	34	1310.7	2491.4	6.50	11,481,813
COMPRESSOR	IR Centac M83-2603 (Comp A)	8333	1250	0	0	34	0.0	0.0	#DIV/0!	-
COMPRESSOR	IR Centac M83-2603 (Comp B)	8333	1250	0	0	34	0.0	0.0	#DIV/0!	-
TOTAL		**56442**	**8500**	**27500**	**42000**	**34**	**3455**	**4732**	**7.96**	**30,262,977**

TABLE 4. OPTIMIZED SYSTEM PERFORMANCE

		FULL LOAD CAPACITY, SCFM	NOMINAL MOTOR POWER, HP	AVERAGE FLOW, SCFM	PEAK FLOW, SCFM	AVERAGE PRESSURE, PSIG	AVERAGE POWER, KW	PEAK POWER, KW	SPECIFIC ENERGY CONSUMPTION, SCFM/KW	ENERGY CONSUMPTION, KWH/YR
COMPRESSOR	Atlas Copco HR10-035-2 (Comp C)	19888	3000	16121	19888	32	1817.7	2240.8	8.9	15,922,964
COMPRESSOR	Atlas Copco HR10-035-2 (Comp D)	19888	3000	0	0	32	0.0	0.0	#DIV/0!	-
COMPRESSOR	IR Centac M83-2603 (Comp A)	8333	1250	5392	8333	32	557.6	861.7	9.67	4,884,482
COMPRESSOR	IR Centac M83-2603 (Comp B)	8333	1250	2206	8333	32	228.1	861.7	9.67	1,998,197
COMPRESSOR	(3) Atlas ZA4 VSD (Comps E-G)	5446	350	1782	5446	32	218.7	606.0	8.15	1,915,634
		TOTAL	X3							
TOTAL		**61888**	**9550**	**25500**	**42000**	**32**	**2822**	**4570**	**9.04**	**24,721,278**

testing was essential. Another article is going to describe this. In a nutshell, the strategy up-shift point (lower pressure trigger) needs to be adjusted to not be too low to create a process problem, and the strategy down-shift flow points need to be adjusted to not allow a pressure spike, nor to create a "dead-band" problem where the shift-up has to immediately happen. We reproduced every strategy shift, by off-line testing, then tuned the system. Then, we watched the shifts occur in the live system, and did a small amount of additional tuning. This took several days, and multiple issues were discovered and corrected before going "live". Live testing was thus very smooth and uneventful.

Conclusion

This project really got started-up - and it really runs. This is not a "study" with "potential savings if …" We actually got the system to run with one 3,000 hp compressor OFF all the time, and the customer is trusting the automation system to run the best combination of the other "small" air compressors. The baseline and improved system performance is shown in Tables 3 and 4. The savings are over 5,500,000 kWh/year! That's a huge compressed air savings project. And total cost for the controls is less than the cost of one of the little VFD air compressors, which now can actually run in the mix properly. BP

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

To read more ***Air Compressor Control Technology*** articles, please visit www.airbestpractices.com/technology/compressor-controls

LOW-PRESSURE AIR COMPRESSORS DELIVER SAVINGS FOR LAFARGE CEMENT DISTRIBUTION

By Ron Marshall for the Compressed Air Challenge®

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The Lafarge Cement Distribution terminal located in Winnipeg, Canada has significantly reduced the site electrical demand and energy charges by changing the way they transport their cement. Two new low-pressure rotary screw air compressors have replaced two large high-pressure air compressors that previously powered their dense phase transport system. The resulting power reduction has saved the company 46 percent in transport operating costs.

Background

The Lafarge site receives bulk cement powder from the company`s other production facilities by rail car. A receiving facility containing rail car unloading equipment, a dense phase transport system, air compressors to power the transport, and other auxiliary equipment is situated about 1,200 feet by pipeline from storage silo facilities, where the product is distributed in smaller batches for transport by truck. When rail cars are unloaded, the cement powder is directed into a dense phase conveyor system consisting of two pressure vessels with receiving ports on the top of the vessel, and discharge ports at the bottom. When a vessel is full, the top is closed by a valve, the vessel is pressurized, and a fluidized plug of cement is transported by compressed air power through a long 6 inch pipe to the final destination in the storage silos. The system operates by alternately filling and blowing each vessel until the rail car is empty.

The facility previously used two 350 hp rated lubricated rotary screw air compressors to provide the 3,300 cfm of compressed air necessary for the blow. These compressors, and some auxiliary compressors and fans, consumed about 670 kVa of electrical demand and about 1,000,000 kWh per year in energy.

A few years ago the Lafarge site was subject to a compressed air audit performed by experts from Manitoba Hydro, the local power utility.

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The study found that the transport system was consuming about 60% of the total facility kVa demand. Based on this, an investigation of the transportation system was done to determine the characteristics of the system operation. Data loggers were placed to measure the air compressor discharge pressure, and the pressure as the compressed air moved into the transport system. The data showed that while the air compressors were producing air at 90 psi, the actual transport pressure averaged around 25 psi. A back-pressure valve had been installed to ensure the discharge pressure of the compressors did not fall to lower levels that would cause excess velocity in the internal lubricant separators. For lubricant style air compressors, having too low a discharge pressure will cause high lubricant carry-over and contamination of the cement.

Assessment Recommends Low-Pressure Oil-Free Air Compressors

Manitoba Hydro`s experts identified this application as a potential area for improvement if new low-pressure air compressors could be used instead. The pressure reduction at the back-pressure regulator represented a huge energy loss, there appeared to be no need to generate at such high pressure, other than to satisfy the pressure requirement for the compressor separators. Hydro predicted if the discharge pressure could be reduced, then both the kVa and energy consumption would reduce significantly. ``When the old air compressors started we typically saw our lights flicker, they were drawing so much power,`` said Matt Manness, the Facility Operations Manager. ``Now, with the new air compressors we hardly notice, except when it comes time to pay our electrical bill.``

Lafarge`s design team investigated the transport process and selected two 300 hp Atlas Copco lubricant-free screw compressors rated at about 40 psi maximum pressure. The units actually run at a discharge pressure of between 20 and 25 psi for the transport, saving power compared to full pressure. The supply piping was upgraded to a larger size to ensure low pressure-drop through the full length of the run. Verification was done by monitoring the system with data logging instruments and the new peak kVa has been verified at 332 kVa, a 50 percent reduction from previous levels, with the new energy consumption estimated at 537,000 kWh. Overall the electrical cost savings were verified at 46 percent, saving $63,000 per year. The project received a substantial utility incentive resulting in a project simple payback of about 2.5 years.

Figure 2: Cement product is transported about 1,200 feet to the silo storage using low pressure compressed air.

LOW-PRESSURE AIR COMPRESSORS DELIVER SAVINGS FOR LAFARGE CEMENT DISTRIBUTION

``Not only did we save on power costs, but the new air compressors require substantially less maintenance than the aging units we once had,`` says Manness. ``There is now no need for the frequent lubricant changes the flooded screws required. And, we have a nice new system that will be saving us power for years to come.``

Manitoba Hydro`s compressed air expert Ryan Connor indicates that this project came together in a typical way at just the right time. The energy audit sat under consideration for many years, but it had to wait until the right economic conditions existed before things moved along. Faced with older compressors requiring more and more maintenance, and rising energy costs, the change to the new air compressors became more attractive when a Lafarge energy reduction initiative spurred action. "This project is a perfect example of what Manitoba Hydro incentive programs can do for customers – identify energy savings opportunities and provide financial incentives to help lessen the burden of the capital costs," said Connor. "The verified energy savings were almost identical to the estimated energy savings. This was not only confirmed by direct measurement of the compressors energy consumption but also by a very clear drop on the customer's energy bill. Often times, people think that producing air at a higher pressure and regulating it down is the same as producing air at lower pressure. Lafarge's 46% savings in energy shows that's not the case – substantial savings can be achieved by producing at lower pressure. Don't use an air compressor to do a blower's job.""

Additional Savings

The original compressed air study identified some additional compressed air related energy savings. The transport building had two other compressed air systems, one to power a large bag house for pollution control, the other to run various pneumatic operations in the train unloading area. The study recommended combining the two systems into one by tying the systems together. A 50 hp load/unload compressor replaced an old inefficient

Best Practices for Compressed Air Systems Second Edition

Learn more about optimizing compressed air systems

This 325 page manual begins with the considerations for analyzing existing systems or designing new ones, and continues through the compressor supply to the auxiliary equipment and distribution system to the end uses. Learn more about air quality, air dryers and the maintenance aspects of compressed air systems. Learn how to use measurements to audit your own system, calculate the cost of compressed air and even how to interpret utility electric bills. Best practice recommendations for selection, installation, maintenance and operation of all the equipment and components within the compressed air system are in bold font and are easily selected from each section.

Figure 3: Five 400 gallon receivers were located in the facility basement to make an auxiliary compressor run more efficiently.

Figure 4: A single tower blower dryer runs off peak to save dryer power.

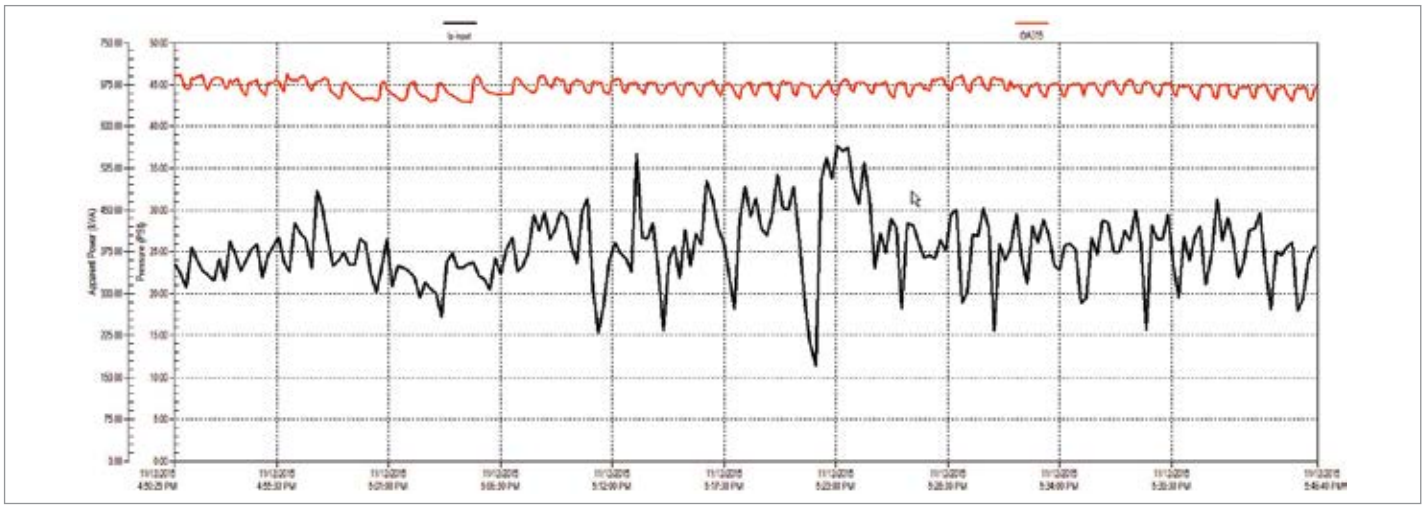

Figure 5: The lubricated compressors ran at 90 psi, but the transport system average pressure was 25 psi

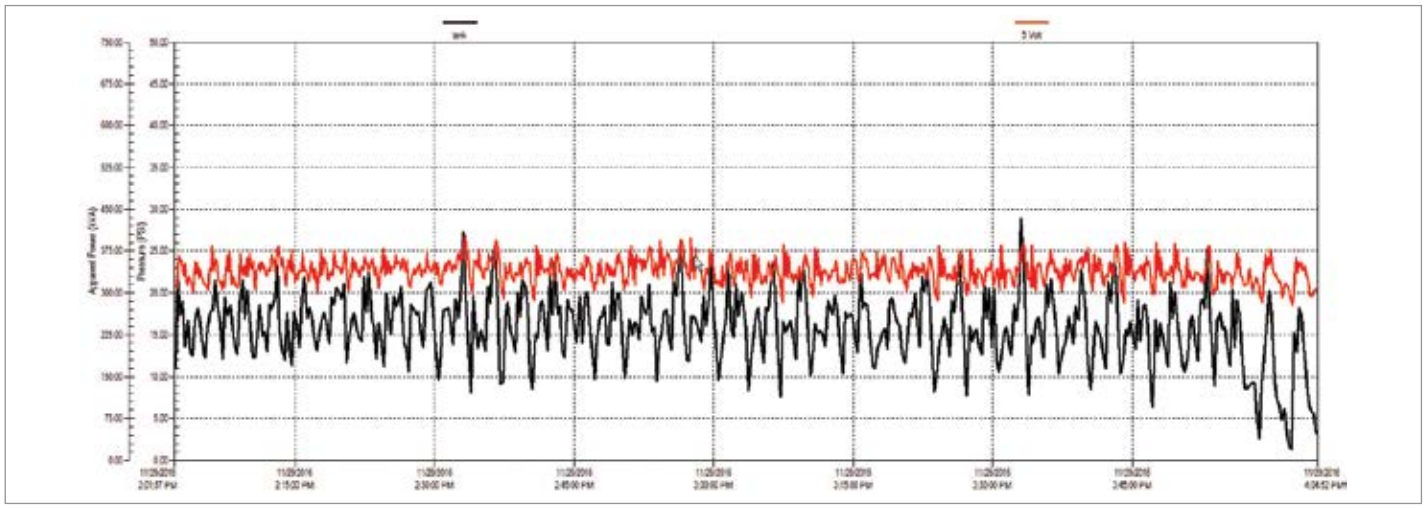

Figure 6: New compressors consume noticeably less power than the original units, making a noticeable reduction on the overall energy bill

modulating compressor. A fixed cycle desiccant dryer was replaced by a new single tower heated dryer. Large compressed air storage was installed in the system to ensure the new 50 hp compressor turns off between load cycles when lightly loaded, instead of running unloaded for long periods of time.

The train car unloading facility only operates for 8 hour shifts during weekdays. Instead of using a desiccant dryer that uses a flow of compressed air to regenerate the desiccant, the single tower heated desiccant dryer is used because there is extended downtime during night time hours. This dryer contains enough desiccant to dry all the compressed air during the day, and during the early part of the off hours the unit runs a heater and blower to regenerate the desiccant. Because the operation is off peak, it saves facility peak demand charges and therefore only incurs kWh costs at a lower effective rate.

The installed 50 hp air compressor has a smart control that counts the number of starts and stops per hour. If installed with very large storage, and run with a wide pressure band, these compressors will run start/stop during light loads, saving the additional costs of unloaded power consumption.

Further savings potential at the site is as follows:

- A low pressure blower used for auxiliary air in the unloading operations is being considered for replacement by tapping some the low pressure air from the main compressor supply,
- A main 50 hp fan for the baghouse appears to be oversized and is being considered optimization,
- The baghouse blast valve controls are being considered for retrofit by installing secondary storage capacity and reducing the frequency and duration of blasting cycles.

LOW-PRESSURE AIR COMPRESSORS DELIVER SAVINGS FOR LAFARGE CEMENT DISTRIBUTION

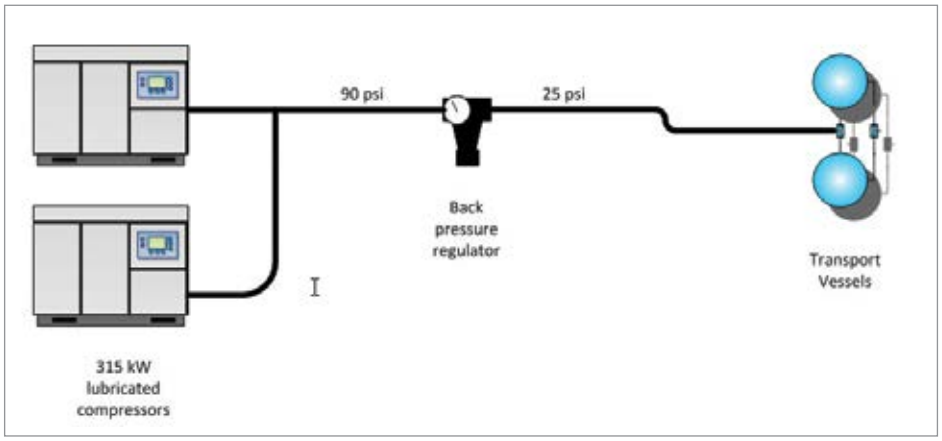

Figure 7: Original Compressor Configuration

Silo Compressor Savings

An additional small compressed air system in the Silo area was also optimized on recommendation by Manitoba Hydro. The previous system used a 25 hp load/unload compressor that was, on average, lightly loaded, with the compressor spending 70 percent of its operating hours running in the unloaded position. This compressor, nearing the end of its useful life, was replaced by a more modern VSD (variable speed drive) controlled air compressor.

A small heatless desiccant dryer was found to be uncontrolled, consuming its full rated purge flow, but only processing a fraction of its capacity. The dryer had on board dew point controls, but they were not activated. The unit was adjusted for proper control with a significant reduction in purge flow, reducing the compressor duty and saving power. Estimated savings for this project was 46 percent with a project simple payback of slightly over one year.

Conclusion

This project is an example of the excellent improvements that can be gained if a compressed air system assessment is done by experts that review both the supply and the demand. Measurement of energy baselines and pressure profiles are very important in determining if potential opportunities for savings exist. But just as effective is the understanding of how the compressed air is used.

Many energy organizations and power utilities offer financial support of compressed air studies and, just like in Manitoba, can also provide support for improvement projects. "Manitoba Hydro's expertise and financial support really helped start the ball rolling on this project," said Manness. "And the project really gained momentum once I realized the transport compressors were consuming about 10 percent of our total facility operating costs." And it looks like Lafarge's efforts have paid off handsomely.

For more information about the Compressed Air Challenge, contact Ron Marshall, email: info@compressedairchallenge.org or visit www.compressedairchallenge.org

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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Kaeser Launches Redesigned DSD125 – 175 Rotary Screw Compressors

Kaeser has redesigned their DSD 125 - 175 rotary screw compressors. With flows from 595 to 882 at 125 psig, these new models are up to 25% more efficient than the competition.

Kaeser's redesigned DSD125-175 models deliver 595 to 882 cfm at 125 psig.

The new DSD models deliver lower life cycle costs with their simple maintenance and reduced energy costs. Additionally, built-in heat recovery options multiply energy savings potential.

"T" models include an optional integrated dryer. The new compact design delivers consistent air quality without sacrificing floor space.

Series features include an enhanced cooling design, eco-friendly filter element, integral moisture separator with drain, and an Electronic Thermal Management system. Units also come standard with Sigma Control 2™. This intelligent controller 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.

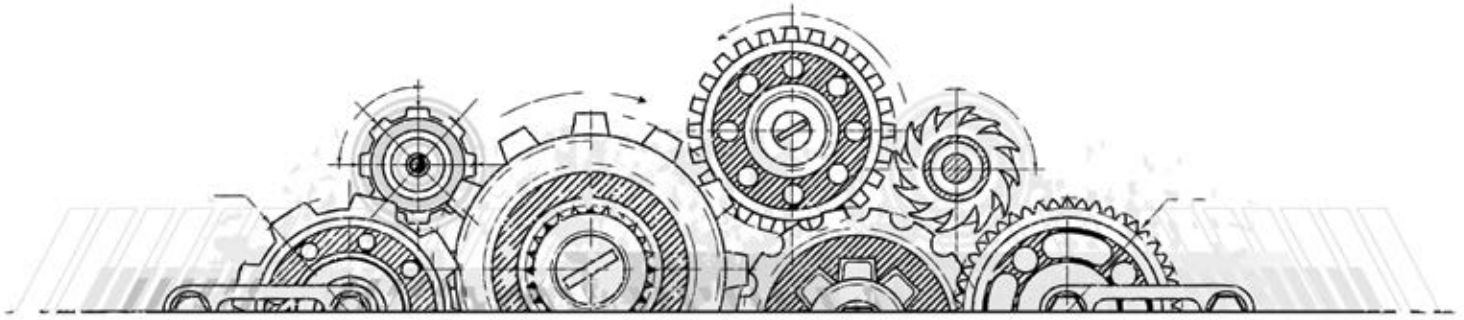
To learn more about these new models, visit www.kaesernews.com/DSD. To be connected to your local representative for additional information, please call 877-586-2691.

New Kobe Steel Compressor Package for U.S. Hydrogen Refueling Stations

Kobe Steel, Ltd. Announced it has started marketing the HyAC mini-A, an all-in-one, compact compressor package for stationary hydrogen refueling stations designed for use in the United States.

The HyAC mini-A consists of a high-pressure hydrogen compressor and a refrigerator sold together with a high-pressure storage tank unit and a dispenser as a set. The HyAC mini-A has a footprint 10 percent smaller than the HyAC mini sold in Japan since 2014.

Kobe Steel is the first Japanese manufacturer to sell hydrogen compressors and other associated equipment for hydrogen refueling stations overseas. The company is working in cooperation with



RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

California-based Kobelco Compressors America, Inc., a compressor subsidiary, to expand sales.

The United States is making progress on building a hydrogen infrastructure. California has opened 25 retail hydrogen refueling stations and plans to establish over 100 stations by 2024, according to the California Energy Commission.

Kobe Steel's HyAC mini-A Hydrogen Compressor Package

The Tatsuno Hydrogen Refueling Station

Kobe Steel has supplied about 30 percent of the Japanese market for stationary hydrogen refueling stations with the HyAC series. Launched in 2014, the HyAC series consists of two models: a single-unit, high-pressure hydrogen compressor, named HyAC, and a compact package consisting of the hydrogen compressor and other major equipment called the HyAC mini.

Owing to its success in Japan, Kobe Steel developed a new model, the HyAC mini-A, for sale in the United States. The HyAC mini-A comes with a dispenser made by Tatsuno Corporation, Japan's largest manufacturer of this product. This enables Kobe Steel to provide equipment from hydrogen compression to fueling FCVs, simplifying the need for customers to procure components separately and reducing onsite adjustment work.

As hydrogen refueling stations are often located in urban areas or on small sites, there is a strong need for compactness. For the U.S. market, Kobe Steel redesigned the layout of the HyAC mini-A to achieve a footprint 10 percent smaller than the Japanese model.

To meet the U.S. fueling protocol, the filling pressure of the HyAC mini-A was raised to 87.5 MPa. The U.S. fueling protocol is a U.S. standard for temperature and pressure when fueling FCVs. The HyAC mini-A is also equipped with a remote monitoring system.

The HyAC mini-A includes compact micro channel heat exchangers called DCHE, which are renowned for their remarkably small size. Kobe Steel has supplied over 100 DCHE heat exchangers for use in domestic hydrogen refueling stations.

Enhancing product development to meet market needs, Kobe Steel established a comprehensive test center for hydrogen refueling stations in March 2016 at its Takasago Works in western Japan. The new facility tests a variety of operating patterns of the refueling stations at close to actual operation and verifies fueling simulations.

Moreover, group company Shinko Engineering & Maintenance Co., Ltd. has developed simulation technology for selecting optimal equipment specifications for fueling FCVs with hydrogen. The Kobe

TECHNOLOGY PICKS

Steel Group is building a framework that can supply items necessary for the construction of hydrogen refueling stations.

Specifications of the HyAC mini-A

Filling Pressure	87.5 MPa
Filling Method	Cascade filling that meets SAE J2601 Fueling Protocol
Compressor Capacity (hydrogen supply capacity)	340 Nm3/h
High Pressure Storage Tank	87.5 MPa (composite reinforced pressure vessels)
Refrigerator (for pre-cooler)	Cooling by liquid brine

For more information, visit http://www.kobelco.co.jp/english/

New Mi-T-M Diesel Air Compressor/Generator Combination Unit

Mi-T-M Corporation announced the release of their new diesel 30-gallon air compressor/generator combination unit. With the convenience of two machines in one, the new air compressor/generator unit is perfect for industrial applications that require electrical power and air.

The new air compressor/generator features a 9.1 HP Kohler KD420 diesel overhead valve engine with electric start and glow plugs for easy starting in cold temperatures. The unit includes a 3000 watt generator and two stage compressor with a powder coated ASME coded 30-gallon receiver tank.

With a brushless alternator and a total harmonic distortion of less than 6%, the powerful generator features 100% copper windings, comes standard with 120 volt and 240 volt receptacles and provides power for industrial and contractor needs.

New Mi-T-M Diesel Air Compressor/Generator Combination Unit

The built-in air compressor features a splash-lubricated compressor pump, large canister intake filter, regulator and two gauges for tank and outlet pressure and a 16 ½ inch fly wheel. It's built to provide high capacity air flow to power a multitude of air tools.

For more information on Mi-T-M Corporation please visit www.mitm.com or call tel: 800-553-9053

New 316SS Case Enhances Ashcroft Pressure Gauges

Salt spray, chemical wash-down and corrosive environments are no match for Ashcroft industrial pressure gauges equipped with 316L stainless steel cases and rings. Newly offered on selected 1009, 1008S and 2008 models, these rugged enclosures will maximize reliability and long life when operating in nearly any conditions.

About Ashcroft

Ashcroft® Inc. manufactures gauges, thermometers, switches, transducers, transmitters, calibration equipment and isolators for pressure measurement, monitoring and control. Product brands include Ashcroft®, Heise®, Willy™ and Weksler®. As a global provider, Ashcroft® Inc. maintains a network of manufacturing facilities, sales offices and distributors worldwide.

For more information, visit www.ashcroft.com.

New IMI Norgren® 51D Pressure Switch

A small package with a large, bright display makes the new IMI Norgren® 51D pressure switch both easy to install and easy to read. In addition to ISOG and NPT thread configurations the switch can be mounted directly to your compressed air line, with a clip on a DIN rail or in a cabinet using the panel mounting kit. The 51D is suitable for all standard pneumatic applications, including filtered, lubricated or non-lubricated compressed air, and operates with high accuracy, resolution and repeatability.

RESOURCES FOR ENERGY ENGINEERS

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IMI Norgren® 51D pressure switch is designed for high accuracy and resolution for compressed air and neutral, non-combustible gas.

The easy-to-read LED display clearly indicates current pressure and comes with two programmable outputs (NO/NC) and four response time settings as well as a hysteresis mode or window comparator mode. IMI Precision Engineering offers a world-class portfolio of high performance products with brands including IMI Norgren®, IMI Buschjost®, IMI FAS®, IMI Maxseal® and IMI Herion®.

About IMI Precision Engineering

A world leader in pneumatic motion and fluid control technologies, IMI Precision Engineering works closely with customers to gain a deeper understanding of their engineering needs, and then connects its people, products and expertise to give their equipment and their business a clear advantage. IMI Precision Engineering offers a world-class portfolio of high performance products with brands including IMI Norgren®, IMI Buschjost®, IMI FAS®, IMI Maxseal® and IMI Herion®. IMI Precision Engineering's reputation rests on the innovation and technical expertise of its 6000-plus people, and an ability to deliver exceptional local service. A subsidiary of the $2.65 billion turnover engineering group IMI plc, IMI Precision Engineering has a sales and service network in 75 countries, technical centers in the USA, Germany, UK and China, and manufacturing facilities around the world.

For more information about the IMI Norgren® 51D pressure switch, visit store.norgren.com.

Energy Star Portfolio Manager Unveils New Waste Tracking Feature

The U.S. Environmental Protection Agency (EPA) unveiled a waste and materials tracking feature in its Energy Star Portfolio Manager, which is a free benchmarking and tracking tool for commercial building owners and managers. Reducing waste and

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TECHNOLOGY PICKS

reusing materials more productively through sustainable materials management over their entire lifecycles conserves resources, helps communities remain economically competitive and supports a healthy environment.

EPA's Energy Star Portfolio Manager is already used to measure energy, water and greenhouse gas metrics in more than 450,000 U.S. buildings, representing over 40 percent of U.S. commercial space, as well as in more than 10,000 buildings in Canada. Now owners and managers using Portfolio Manager will be able to benchmark 29 types of waste across four different management metrics alongside their existing sustainability management indicators. Types of waste include building materials, glass, paper, plastics, and trash.

Currently, U.S. commercial buildings and manufacturing activities are responsible for as much as 45 percent of the 150 million tons of waste in the United States that ends up in incinerators or landfills each year. The transportation, decomposition, and burning of this waste generates greenhouse gas emissions and other air pollutants.

The addition of waste tracking is the culmination of a year-long collaboration between EPA's Energy Star and Sustainable Materials Management programs and members of the industry to identify key performance metrics for waste and materials management.

To learn more or register for a free webinar on the new waste tracking feature: www.energystar.gov/trackwaste

To learn more about sustainable materials management: www.epa.gov/smm

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BEKO Technologies	9	www.bekousa.com
Chicago Pneumatic	10	www.cp.com
JORC Industrial	11	www.jorc.com
Sullivan-Palatek	13	www.sullivan-palatek.com
SPX Flow	14	www.spxflow.com/hankison
Anest Iwata Compressors	15	www.anestiwata.com
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Howden Roots	25	www.howden.com
MAT Industries	27	www.industrialairusa.com
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Problem:

An aerospace parts manufacturer was experiencing high maintenance costs as well as excessive downtime with their compressed air system. Their modulation control compressor caused unnecessary energy usage on the weekends and off peak times, resulting in exceptionally high energy costs. Additionally, problems with air quality led to product rejects and costly scrap rates.

Solution:

A comprehensive Air Demand Analysis was conducted to understand the plant's fluctuating demand. It revealed that the 200 hp modulating control compressor was grossly oversized. With proper controls and additional storage, two 50 hp compressors could efficiently handle the demand and save 871,500 kWh per year. A third 50 hp unit was added to ensure uptime and accommodate growth.

Result:

These sweeping changes created immediate and sustainable energy savings. The combination of more storage, more efficient compressors and master controls drove system specific power consumption down 77%—and that doesn't include the savings from leak reduction. As a direct result of the new air treatment equipment, the plant also saw improved product quality and reduced maintenance on the expensive production equipment that may surpass energy in terms of bottom line benefits.

Specific Power of Previous System:	93.89 kW/100 cfm
Specific Power of New System:	21.14 kW/100 cfm
Annual Energy Costs of Previous System:	$107,431/year
Annual Energy Cost Savings:	$ 87,151/year
Savings Due to Fixing Leaks	$ 12,500/year
Utility Rebate:	$ 92,000
TOTAL FIRST YEAR SAVINGS:	**$191,651**

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