The Magazine for ENERGY EFFICIENCY in Compressed Air Systems

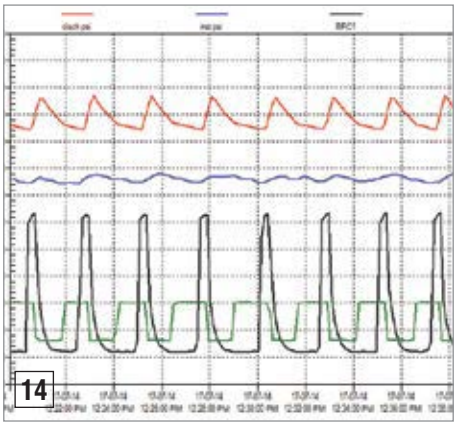
COMPRESSED AIR BEST PRACTICES

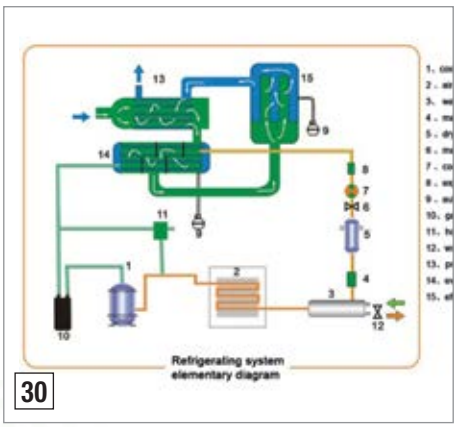
airbestpractices.com

December 2017

System Control

SUSTAINABLE MANUFACTURING FEATURES





COLUMNS

FROM THE EDITOR | Compressed Air System Controls

A rock crushing facility is inadvertently using a 60 horsepower (45 kW) oil-free rotary screw air compressor as a base load unit and a 325 horsepower (250 kW) lubricated fixed-speed rotary screw as a trim compressor to feed 100 to 200 cfm during demand peaks. Ron Marshall provides us with an excellent audit story detailing how this section of a mine realizes it is spending $291,000 in annual energy costs to support this very inefficient arrangement with an average specific power of 28.1 kW per 100 cfm. Air compressor control (a VSD compressor) and desiccant dryer purge control technology provide this mine with solutions able to bring their energy costs down 55% to $159,000 per year.

A North American zinc producer spends an estimated $516,000 annually on electricity to operate their air compressors. Provided to us by Don van Ormer, from Air Power USA, this system assessment recommended a group of projects able to reduce these energy costs by fifty-one percent (51%) to an annualized $270,000. This article highlights a few of the demand-side projects able to reduce compressed air use by 1,090 scfm.

Compressed air dryers, in order to perform properly, need the air compressors to send air at the design pressure and temperature to the dryer inlets. Tim Dugan, from Compression Engineering Corporation, provides us with an interesting review of regenerative and refrigerated compressed air dryer fundamentals and what happens when they face inlet conditions they weren't designed to handle.

Compressed air and chiller system automation and controls were well represented at the 2017 World Energy Engineering Congress, held September 27-29 at the Georgia World Congress Center in Atlanta, Georgia. Our publications also had the opportunity to chair two sessions at the conference. I hope you enjoy our show report.

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

ROD SMITH, *Editor, tel: 412-980-9901, rod@airbestpractices.com*

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INDUSTRY NEWS

Quality Compressed Air Services Expands in Louisiana

Quality Compressed Air Services, Inc. (QCAS) announced it has recently acquired the assets of AAA Pesco, Inc. based in Marrero, Louisiana. Due to this acquisition, QCAS has moved its New Orleans, LA branch location to 730 Barataria Boulevard in Marrero, LA.

Quality Compressed Air Services is based in Jackson, Mississippi.

QCAS also recently broke ground on an expansion to its Jackson, MS location. With this expansion, QCAS will increase its square footage by 65% in order to accommodate the growth of its repair and rebuild facility.

About Quality Compressed Air Services, Inc.

Quality Compressed Air Services, Inc. provides service, sales, parts, and rental solutions for compressed air systems and nitrogen generating systems. QCAS prides itself on being client-focused with a commitment to respond to service needs 24/7. QCAS is based in Jackson, MS with facilities also located in Baton Rouge, LA; Lafayette, LA; and New Orleans, LA. For more information, visit www.qcas-inc.com.

Maqpower Compressor Appointed Sullair Distributor in Los Angeles

Sullair, an industry leader in innovative compressed air solutions since 1965, is pleased to announce Maqpower Compressor Corporation has been appointed an authorized distributor for Sullair Commercial and Industrial Products in the greater Los Angeles area. As an authorized distributor, Maqpower will provide full customer sales and support for Sullair equipment, parts, service, and warranty. Located in Whittier, CA., Maqpower will be representing Sullair Products in Los Angeles, Orange, Riverside, San Bernardino and Ventura Counties.

"Sullair is very excited to have a distributor offering such a highly trained and experienced compressor team to serve customers in Southern California," according to Tim Sohnlein, Sullair's Commercial and Industrial Products director of sales. "We are excited about the end-to-end capabilities Maqpower brings to the market. Their expert sales and service capabilities will be a tremendous asset in ensuring customers receive the compressed air solutions best suiting their application."

Maqpower Compressor Corporation, a longtime Sullair distributor serving portions of Mexico, carries the full line of Sullair oil flooded compressors from 5 hp to 600 hp, plus the complete line of oil free and centrifugal compressors up to 30,000 hp. Additionally, they offer the complete Sullair air treatment system. This includes compressed air dryers/filters/drains, industrial vacuum systems, flow controllers and Sullair Genuine Parts.

"We are very excited to introduce Maqpower to the Southern California marketplace and have great pride in promoting Sullair Compressor Products as we have been doing for over 3 decades," says Javier Tamez, Maqpower's CEO. "We are a family-centered business focused on trust and integrity, with both our customers and employees. Training our employees and customers is part of our commitment to ensure we follow compressed air best practices when engaging with our valued customers. Maqpower's strong relationship with Sullair allows us to offer true value to our customers…and consistency, with our trained and knowledgeable personnel, resulting in opportunities to improve system reliability and save energy by improving efficiency."

About Sullair

Sullair was founded in Michigan City, Indiana in 1965, and has since expanded with a broad international network to serve customers in every corner of the globe. Sullair has offices in Chicago and facilities in the United States, China and India — all ISO 9001 certified to assure the highest quality standards in manufacturing.

For more than 50 years, Sullair has been on the leading edge of compressed air solutions. We were one of the first to execute rotary screw technology in our air compressors. We made history by teaming up with Dow Chemical to produce one of the industry's longest-lasting compressor fluids. Our machines are famous all over the world for their legendary durability. As the industry moves forward, Sullair will always be at the forefront with quality people, innovative solutions, and air compressors built to last. We have centered our operations around three key pillars: innovation, durability and people. For more information, visit www.sullair.com. Sullair is A Hitachi Group Company.

Ingersoll Rand Selected for 2017 Dow Jones Sustainability Indices

For the seventh consecutive year, Ingersoll Rand, a world leader in creating comfortable, sustainable and efficient environments, has been named to the Dow Jones Sustainability World and North America Indices. Continued placement on this index series showcases the company's position as an economic, environmental and social leader among peer companies.

Ingersoll Rand products and services heat, cool and automate homes and buildings, as well as enhance commercial and industrial productivity, keep transported food and perishables safe and fresh and deliver fun, efficient and reliable transportation solutions. Our business operations reflect a longstanding commitment to innovation, sustainability and corporate citizenship aimed at leading the way to a better world.

"There's more to a company's purpose than generating great financial results," said Michael W. Lamach, Ingersoll Rand's chairman and chief executive officer. "We have an obligation to anticipate and address pressing global trends that impact the way we live, work and move. That's why our focus on business, social and environmental sustainability guides both what we do and how we do it. Inclusion on the Dow Jones Sustainability World and North America Indices over the past seven years is an honor, and recognizes the longstanding positive impact our people have on the world."

The Dow Jones Sustainability Indices launched in 1999 as the first global sustainability benchmarks. The indices are offered cooperatively by RobecoSAM and S&P Dow Jones Indices. The indices serve as benchmarks for investors who integrate sustainability considerations into their portfolios. They also provide an effective engagement platform for companies who want to adopt sustainable best practices.

Ingersoll Rand Climate Commitment

Ingersoll Rand made a commitment to significantly reduce greenhouse gas (GHG) emissions from its products and operations by 2030. The company's Climate Commitment pledges to:

- Cut the refrigerant GHG footprint of its products by 50% by 2020, and incorporate lower global warming potential (GWP) alternatives across its portfolio by 2030.
- Invest $500 million in product-related research and development over the next five years to fund the long-term reduction of GHG emissions.
- Reduce company operations-related GHG emissions by 35% by 2020.

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To date, the commitment has supported the avoidance of approximately 6.7 million metric tons of CO_2e globally, the equivalent of avoiding annual CO_2 emissions from energy used in more than 700,000 homes. To support the commitment, Ingersoll Rand launched EcoWise™, a portfolio of products designed to lower environmental impact with next-generation, low-global warming potential refrigerants and high efficiency operation. By 2030, the company expects to reduce its carbon footprint by 50 million metric tons.

About Ingersoll Rand

Ingersoll Rand (NYSE:IR) advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands — including Club Car®, Ingersoll Rand®, Thermo King® and Trane® — work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. We are a $13 billion global business committed to a world of sustainable progress and enduring results. For more information, visit www.ingersollrand.com.

About S&P Dow Jones Indices

S&P Dow Jones Indices LLC, a part of McGraw Hill Financial, is the world's largest, global resource for index-based concepts, data and research. Home to iconic financial market indicators, such as the S&P 500® and the Dow Jones Industrial Average™, S&P Dow Jones Indices LLC has over 115 years of experience constructing innovative and transparent solutions fulfilling the needs of investors. More assets are invested in products based upon our indices than any other provider in the world. With over 830,000 indices covering a wide range of asset classes across the globe, S&P Dow Jones Indices LLC defines the way investors measure and trade the markets. To learn more about the company, please visit www.spdji.com.

Vaisala Partners with DryKeep

Vaisala, a global leader in environmental and industrial measurement, has announced it is working alongside DryKeep to enhance the moisture monitoring capabilities of its transformer dry-out system, through the installation of Vaisala's HUMICAP® MMT162 sensor. The partnership comes as DryKeep aims to meet increasing demand

for installation of its transformer monitoring display systems across the U.S.

The MMT162 is a capacitive thin-film polymer sensor, developed by Vaisala to provide moisture measurements in liquid hydrocarbons, including those used to insulate transformers. As DryKeep ramps up production of its SMART controller, displaying real-time moisture and temperature values for transformers, Vaisala will supply its MMT162 sensor as required on a project basis.

"Transformer technology is frequently being pushed to the limits in terms of how long it is expected to perform, and there is a greater need for up-to-the-minute information in order to meet this demand," said Steven Jiroutek, Vaisala's business development manager. "Equipping DryKeep's controller with our MMT162 sensor will allow it to accurately monitor moisture levels within transformers, and clearly communicate this information to site engineers and maintenance personnel - reducing the need for costly manual interventions."

As load demands on aging substation power transformers increase worldwide, preventing catastrophic faults and breakdowns has become a key concern of asset owners and operators. Any disruption to transformers' continuing performance can result in significant financial losses for asset owners, and one of the most persistent causes of such disruption is the presence of moisture in transformers.

The threat of moisture and its ability to take a power transformer offline lies in its ability to deteriorate the mechanical properties of the paper insulation, and the dielectric properties of transformer's insulation system. This threat exists regardless of how harsh or benign the regional climate is. Atmospheric conditions allow moisture to enter, or it can seep in during transformer maintenance.

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Vaisala partners with DryKeep to enhance the moisture monitoring capabilities of its transformer dry-out system.

Unfortunately, moisture is also a byproduct of aging transformer oil and insulation, ensuring, even if the equipment is completely sealed from external sources, internal build-up of moisture will still occur.

Another important factor is the effect moisture has on the speed of degradation. As moisture increases the insulating materials degrade faster, producing yet more moisture, and setting up a vicious cycle of accelerating damage.

Assessing moisture levels has traditionally been a manual process, involving laboratory analysis of oil samples extracted by engineers. However, the DryKeep system allows continuous monitoring of moisture and temperature levels via a 7-inch, touch-operated LCD screen attached to the transformer itself.

By using Vaisala's MMT162 sensors and proprietary algorithms, the DryKeep system calculates the percentage of moisture in the insulation paper before removing it. Vaisala has been providing this technology to DryKeep since 2013, upgrading the functionality to ensure high-quality, continuous moisture monitoring.

"The old way of doing things was good for the time because that's all that was available, but by using reactive strategies they were not necessarily dealing with the actual problem," said Ed Vance, DryKeep's director. "They were fixing it temporarily, until the next time the moisture built up, and all the while the mechanical properties of the paper were deteriorating fast."

"The MMT162 sensor allows us to control the drying process and send historical data and trend analysis to the operator - and this can all be done without shutting down the transformer."

About Vaisala

Vaisala is a global leader in environmental and industrial measurement. Building on 80 years of experience, Vaisala provides observations for a better world. Our instruments and systems are used in over 150 countries in demanding industries, including airports, pharmaceuticals, and power generation. Vaisala sensors are used in the harshest places on earth - arctic, maritime, and tropical environments - and even on Mars. Headquartered in Finland, Vaisala employs approximately 1,600 professionals worldwide and is listed on the NASDAQ Helsinki stock exchange. For power generation and transmission industry, Vaisala provides unique measurement equipment for online monitoring of transformer insulation oil. Our reliable solutions support in planning and

optimizing the preventive maintenance of power transformers, and thus help to extend their lifetime and reduce the risk of unexpected and costly outages. For more information visit, www.vaisala.com or www.twitter.com/VaisalaGroup.

New EXAIR Website

EXAIR.com® is the new digital home of Intelligent Compressed Air® products for the industry. EXAIR's new website has improved the product selection process by providing descriptions immediately on the homepage. An improved account management and ordering process streamlines access to historical orders, allows one click repeat orders and eases editing of your information. This website is fully responsive in order to provide a consistent experience, whether using a PC, tablet or smartphone. A comprehensive search functionality enables users to quickly locate model numbers and related information.

In addition to these new features, EXAIR.com continues to provide the critical tools any user will need for a successful application. For example, 3D models and CAD drawings, product videos, complete performance data, installation and maintenance guides, air savings calculators, case studies, slide presentations and a huge application database to learn what these Intelligent Compressed Air® products can

EXAIR's new website has improved the product selection process by providing descriptions immediately on the homepage.

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achieve. An expert level of customer support from our experienced Application Engineering staff is available immediately through online chat. The FAQ section covers every product line for fast access to common questions. Download the current price list or choose to have it mailed within the latest catalog from the Get a Catalog button.

For more information, visit www.exair.com/index.php.

Endress+Hauser Acquires IMKO

The Endress+Hauser Group is further enhancing its quality measurement portfolio through the acquisition of IMKO Micromodultechnik GmbH, a manufacturer of innovative moisture measurement systems. IMKO's headquarters will remain in Ettlingen, Germany, and the company's 19 employees have been retained.

"The area of moisture measurement developed by IMKO further enhances our existing offering for process instrumentation with an additional key quality parameter," says Dr. Andreas Mayr, Endress+Hauser GmbH+Co KG's managing director, whose portfolio will be complemented by the new company. "Additionally, the technology that IMKO employs is very similar to technologies we use for level measurement," explains Dr. Mayr.

Innovative Technology

The IMKO systems measure moisture with time domain reflectrometry (TDR), a technology based on the time of flight of reflected radar waves. This provides information regarding the dielectric constant of a material, in turn relating directly to the material's moisture. "This innovative technology offers major advantages over other technologies," emphasizes Dr. Mayr. "The measurement is not influenced by the material's conductivity. IMKO's systems are precise, reliable and cost-efficient."

Today, IMKO's systems are used to measure moisture in buildings and soil, for environmental monitoring, and also in process engineering applications for the food & beverage, chemical and life sciences industries. "With this acquisition, we are pursuing our strategy to support customers in future from the laboratory to the process," says Dr. Mayr, who is also responsible for Technology and Marketing within the Executive Board of the Endress+Hauser Group.

Long-Term Perspective

IMKO was founded in 1984 by Kurt Köhler. The 67-year-old innovator was looking to place his company in capable hands to ensure its continued success. "Endress+Hauser is in a position to address new customer segments for our products and open up international markets," said the company founder. "As a family-owned company, Endress+Hauser furthermore represents the same values that mark the corporate culture at IMKO."

Endress+Hauser's acquirement of IMKO will be effective October 1, 2017. The companies have agreed to keep the details of the transaction confidential. A search for a new managing director at IMKO is currently underway. Kurt Köhler will stay on for one year to help oversee the transition.

About The Endress+Hauser Group

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering.

The Group employs 13,000 personnel across the globe, generating net sales of more than 2.1 billion euros in 2016.

With dedicated sales centers and a strong network of partners, Endress+Hauser guarantees competent worldwide support. Our production centers in 12 countries meet customers' needs and requirements quickly and effectively. The Group is managed and coordinated by a holding company in Reinach, Switzerland. As a successful family-owned business, Endress+Hauser is set for continued independence and self-reliance.

Endress+Hauser provides sensors, instruments, systems and services for level, flow, pressure and temperature measurement as well as analytics and data acquisition. The company supports customers with automation engineering, logistics and IT services and solutions. Our products set standards in quality and technology.

We work closely with the chemical, petrochemical, food & beverage, oil & gas, water & wastewater, power & energy, life science, primaries & metal, renewable energies, pulp & paper and shipbuilding industries. Endress+Hauser supports its customers in optimizing their processes in terms of reliability, safety, economic efficiency and environmental impact.

Founded in 1953 by Georg H Endress and Ludwig Hauser, Endress+Hauser has been solely owned by the Endress family since 1975. The Group has developed from a specialist in level measurement to a provider of complete solutions for industrial measuring technology and automation, with constant expansion into new territories and markets.

For further information, please visit www.endress.com/media-center or www.endress.com

Air Compressor Control at REMOTE MINING COMPLEX

By Ron Marshall, Marshall Compressed Air Consulting

A large mining complex in a remote northern region of the world invited a compressed air auditor in to assess the efficiency of a problematic system. Site personnel and their air compressor supplier were concerned a system in one of the buildings was not running optimally, and wanted to know what size of compressor to install in the facility. The auditor found significant savings in this target system, but even larger potential savings were found in other ancillary systems in the complex, as part of an extra investigation conducted while at the site. Overall, the potential energy savings total more than half of a million dollars, if all recommendations are implemented. Due to the remote location, this facility pays a significant cost per kWh, therefore, potential project paybacks are very attractive.

Figure 1: The dusty environment causes maintenance issues at this site.

Initial Findings at Rock Crushing Target System

A rock crushing facility, one of many separate systems on the mine site, has a compressed air system consisting of two air-cooled screw compressors, one 250 kW (325 hp) 7.4 bar rated lubricated fixed speed for a plant air system, and one 45 kW (60 hp) 7.5 bar rated oil free compressor for a separate instrument air system. Historical operating hours show, until a few years ago, the small 60 hp oil free compressor fed the complete plant most of the time. A dewpoint controlled heatless dryer rated at 297 cfm conditions the instrument air. Only the instrument air used in the plant is passed through the dryer, the general plant air is undried. The dryer has a general-purpose coalescing filter installed before the air dryer, and a particulate filter on the outlet. Check valves exist at the discharge of the air compressors and between the plant and instrument air systems to prevent wet air from contaminating the dry instrument air.

The compressors and dryer are located in the basement area near a crushed rock unloading area, with poor air quality and ventilation. As a result, there is a fair amount of dust on the compressed air equipment. The compressed air is directed through the plant processing area by a system of steel piping.

A large 3,800-gallon wet receiver tank is located in the compressor room at the discharge of the large compressor. A 1,060-gallon dry receiver is located at the outlet of the air dryer for this instrument air compressor. The condensate drains used in the facility are timer drains. Most of the pressure loss in the facility is across the drying and filtering system. Leakage detection was done with only a few small leaks noted, nothing significant was found, and as such not reported. The plant personnel are doing a good job finding and repairing leaks.

AIR COMPRESSOR CONTROL AT REMOTE MINING COMPLEX

Compressed Air System Baseline

The compressed air system's electrical power consumption was monitored using data loggers connected to the compressors. System flow has been calculated using compressor rated flow (from compressor nameplate), and multiplying by the compressor duty cycle (no flow meter was installed). Pressure loggers measuring pressure gradient were located at the compressor discharge and after the air dryer and filters. The captured baseline is shown in Table 1.

Baseline

Based on the baseline energy consumption the site electrical cost, the typical annual operating cost of this system would be about $291,000 per year.

The readings and observations during the measurement period showed the air

TABLE 1. ROCK CRUSHING FACILITY BASELINE

BASELINE	UNITS	AVERAGE	ANNUAL KWH
Discharge ave	psi	96.4	
Dryer Out ave	psi	94	
C1250kW	kW	69.3	607,068
C245kW	kW	34.5	302,220
Dryer	kW	0	-
Total	kW	103.8	909,288
Peak	kW	0	
SpecificPower	kW/100cfm	28.1	
Flow*	cfm	369	
Dryer Purge	cfm	45	
Operating	hours	8,760	
Cost (annual)			$ 290,972

* calculated

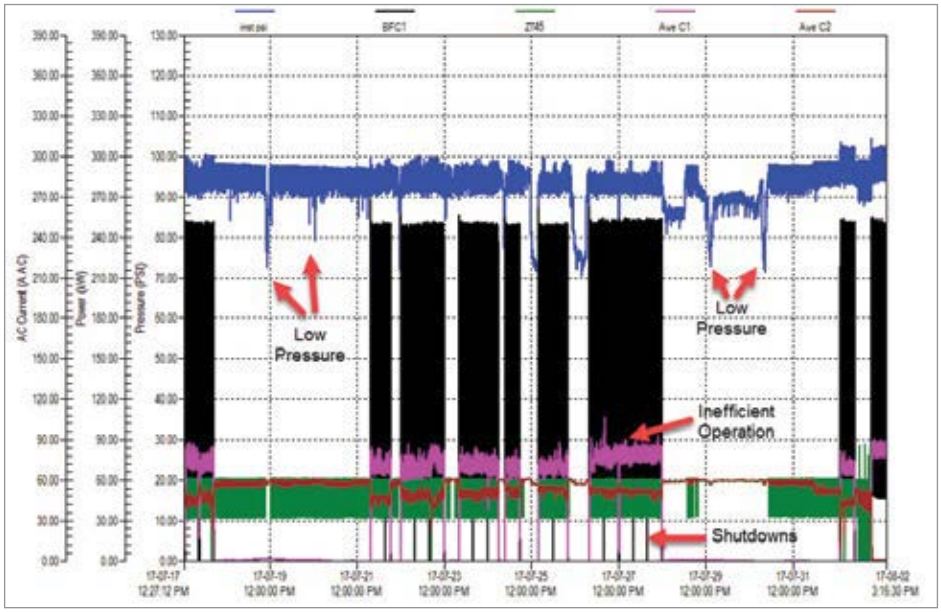

Figure 2: Compressed Air Profile During Measurement Period

compressor(s) are producing compressed air at a poor efficiency of 28.1 kW/100 cfm (normal is about 20 kW/100 cfm). This poor specific power is caused by excessive unloaded run time of both compressors. The actual plant loading is only slightly above the capacity of the 45 kW compressor, yet the only other available unit is a 250 kW compressor. The 250 kW compressor spends most of its operating hours in the unloaded condition, because it is much too large for the average flow. Compressor control settings limitations, actual pressure bands and the presence of check valves makes this problem worse because the small compressor also runs partially loaded at the same time. During some unnecessary purge operations, problems with the uncontrolled dryer purge control consume additional compressed air. Poor compressor room ventilation, and the presence of excessive dust is also causing less than optimum ambient conditions, as well as compressor shutdowns.

Compressed Air System Operating Profile

The following graphic shows a profile of the compressed air crushing system operations over the last part of the measurement period. During this time the 250 kW compressor was manually shut down between production cycles to save energy. Although this is an excellent practice, there are multiple periods of time where the plant flow exceeded the capacity of the small compressor. This causes the pressure to fall to low levels, because the 250 kW unit is not in automatic and could not start to support the pressure. During this time, the small compressor was operating quite efficiently, because a fixed speed compressor should be running near full capacity.

When the two compressors were both running together the system efficiency fell to low levels. The existing control settings and the check valves caused both compressors to operate

AIR COMPRESSOR CONTROL AT REMOTE MINING COMPLEX

in part load condition at the same time. This caused significant periods of unload run time for both compressors.

Compressor Control Problem

Analysis of the captured data shows, in normal operation, the plant compressed air demand is only slightly above the capacity of the 45 kW instrument air compressor (240 cfm). Peak demands during the measurement period were as high as 500 cfm. When the compressed air demand increases over the capacity of this small compressor, the only option to maintain adequate pressure is to start the large compressor and run it lightly loaded. Unfortunately, when the large compressor runs, the check valves block the actual system pressure from reaching the small compressor control. This causes the small compressor to keep running inefficiently by loading and unloading at the same time. Essentially, a large 1,600 cfm compressor is started to feed a 100 to 200 cfm shortage of compressed air. Table 2 shows the operation profile and the compressor pressure setpoints.

TABLE 2. COMPRESSOR SETPOINTS

	C1	C2
	250KW	45KW
Unload (psi)	104	100
Load (psi)	94	90

These settings make the large compressor the lead unit whenever it is active.

With these setpoints, the small compressor should normally turn completely off when the large compressor runs, minimizing its wasted unloaded run power. However, due to the check valves at the compressor discharge and before the plant air wet tank, the small compressor cannot "see" the true system pressure when it unloads. Leakage in the compressor supply lines (the compressor condensate drain leaks) between the check valves, causes the pressure to fall at a faster rate than the actual plant air receiver pressure, as the air drains out of the lines. This causes the small compressor to reload at its 90 psi setpoint before the large compressor gets a chance to load at 94 psi. A special test was done, bypassing the check valves and tying the two compressors to the same header by opening a crossover line. When this was done the small compressor timed out and shut off, saving power.

It is very inefficient to run two compressors in load/unload mode at the same time to produce the air only one compressor could produce. In this mine's case, it is also very inefficient to run the large compressor, rated at about 1,600 cfm, solely to feed about 370 cfm of average load. The unloaded run power of the large compressor (49 kW when no compressed air is being produced) is actually higher than the fully loaded kW of the small compressor (43 kW).

Normally, if the small compressor was in good condition, the recommendation would be to simply add a second 60 hp compressor to work with the existing unit. However, the existing compressor is in poor condition, so it would be best to replace it with a new compressor with a larger capacity and VSD control.

TABLE 3. ESTIMATED POTENTIAL SAVINGS

	VARIABLE SPEED		
MEASURE	$ SAVED	% SAVED	KWH SAVED
Base			
Existing	$0	0.0%	
Control	$1 07,700	37.0%	336,564
Pressure	$4,226	1 .5%	1 3,206
Leaks	$4,000	1 .4%	1 2,500
Drains	$2,400	0.8%	7,500
Dryer Purge	$1 8,001	6.2%	56,252
End Uses	$23,1 48	8.0%	72,339
Filters	$1 ,972	0.7%	6,1 64
Dryer	-$2,303	-0.8%	-7,1 96
Total	**$1 59,1 45**	**55%**	**497,329**

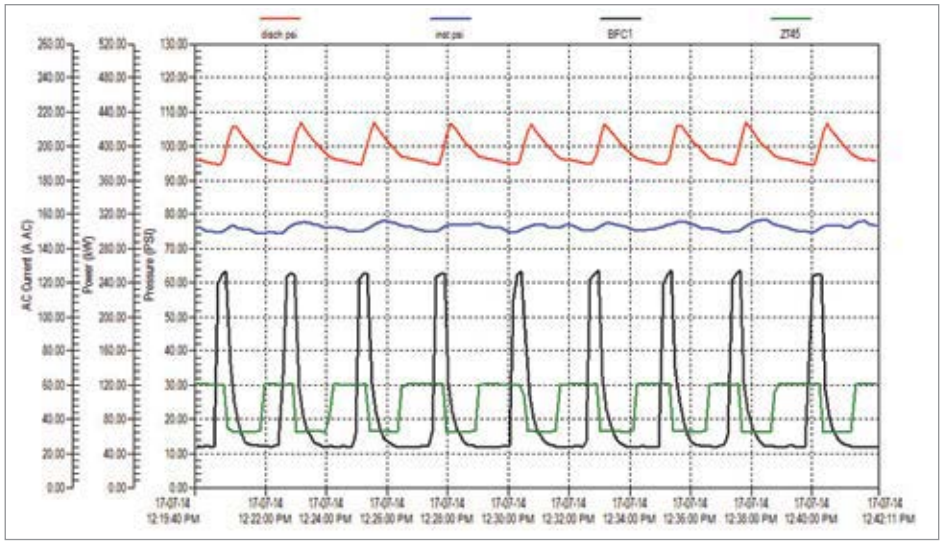

Figure 3: Both compressors are loading and unloading at the same time.

Figure 4: Air vibrators like this could be the reason a second compressor has to run.

Some increased efficiency could be gained by controlling the system pressure to slightly lower levels of 90 psi. VSD control above minimum speed would maintain a constant plant pressure, reducing the compressor power, and slightly reducing the plant demand.

Potential Energy Conservation Measures

Some specific potential opportunities are as follows:

Recommendations:

- Replacement of the 60 hp (45 kW) instrument air compressor with a new 110 kW (150 hp) VSD controlled compressor would save 336,600 kWh, annually worth $107,700 per year in operating costs (37%).
- Remove the check valves from the compressor discharge and from before the plant air receiver. Run the system with the main crossover valve open to tie all compressor discharges together.

AIR COMPRESSOR CONTROL AT REMOTE MINING COMPLEX

- Set the new VSD compressor to 90 psi (current average 96 psi) target pressure. This would save 13,200 kWh and $4,200 in operating costs.
- Replace air powered vibrators with electric for $21,500 annual savings.
- Repair faulty air dryer dew point control or replace air dryer with purgeless design, for $18,000 annual saving.
- Upgrade system filters to mist eliminator or oversized design.
- Replace timer drains with more efficient airless drains.
- Upgrade ventilation to ensure compressors remain clean.

Summary of Crushing Building Savings

Sufficient potential exists for up to an estimated 55% savings in compressed air operating costs over the present crushing building configuration. The installation of a 110 kW VSD compressor, low loss drains, the replacement of the air dryer with more efficient purge control, lower plant pressure and reduced inappropriate uses, would save an estimated $159,000 per year in compressed air electrical operating costs. See a summary of the estimated potential savings in Table 3.

Investigation of Other Site Systems

While investigating the other systems in the complex, an initial survey of the compressor operating hours was done. It was found that many of the systems had a poor ratio of loaded to running hours. There may be excellent potential for additional savings over and above those found in the target system.

Some additional systems:

- Process Plant consisting of three 110 kW lubricated screw compressors (two main, one spare) with heatless desiccant instrument air dryer.
- Truck Shop general air system consisting of two 90 kW lubricated screw compressors (one main, one spare) with heatless desiccant dryer.
- Truck Shop tire fill system with two 45 kW lubricated screw compressors (one main, one spare) with heatless desiccant dryer.
- Powerhouse 1 starting air with one 37kW lubricated screw compressor, no dryer.
- Powerhouse 1 service air with two 37 kW compressors (one main, one spare) with heatless desiccant dryer.
- Powerhouse 2 starting air with one Quincy 37 kW modulating compressor and no dryer.
- Powerhouse 2 service air with two 37 kW compressors (one main, one spare) with internal refrigerant dryers.
- Batch plant with an 18 kW screw compressor and non-cycling refrigerated dryer.

Figure 5: PH1 Starting compressor has very little unloaded run time in start/stop mode.

TABLE 4. BASELINE FOR ADDITIONAL SYSTEMS

BASELINE	KW (AVE)	KWH	CFM	$ANNUAL	SP
Process Plant	170.8	1,496,208	741	$478,787	23.0
Truck Shop General	31.0	271,560	26	$86,899	119.2
Truck Shop Tire	12.2	106,872	14	$34,199	87.1
PH1 Start	2.3	20,148	4	$6,447	62.2
PH1 Service	21.0	184,836	45	$59,148	46.7
PH2 Start	28.8	252,288	19	$80,732	151.6
PH2 Service	11.0	138,408	19	$44,291	57.9
Batch Plant	9.8	89,931	5	$28,778	196.0

Compressed Air System Baseline

The compressed air system electrical power consumption was monitored for eight selected systems, using data loggers connected to the compressors. System flow was calculated using compressor rated flow (from compressor data or on the nameplate), and multiplied by the compressor duty cycle (no flow meters were installed). The determined baseline is shown in Table 4.

The readings and observations during the measurement period showed the air compressors were producing compressed air at poor efficiency for all systems, as noted by the specific power. Levels of around 18 to 20 are normal for an optimized system using large compressors of 100 hp or greater. For smaller compressors, levels 20 to 25 are normal, depending on the discharge pressure.

In general, the specific power relates to the compressor operating mode. For load/unload compressors the ratio of compressor loaded run time, compared to the total operating hours (loaded plus unloaded) determines the specific power. In order to achieve lower specific power with this mode, the unloaded run time must be minimized either by running the compressors in start/stop mode or installing a properly sized VSD compressor. In systems with multiple compressors, only one VSD compressor is required for the complete system. This VSD compressor should be equal to, or larger than, the fixed speed compressors to avoid undesirable control gap problems.

For compressors running in modulation mode (PH2 starting air and Batch Plant), the least efficient way to operate a screw compressor, the system can be optimized by running the existing compressors in start/stop mode. This can be done by providing very large storage and a wide pressure band, if they have the capability of doing so. The PH2 start compressor does not appear to have the internal circuitry for this. The Batch Plant compressor had the correct electronic control, but the compressor needs to be replaced due to mechanical problems.

The simplest and most effective way to optimize this system, is to simply install a VSD compressor and a cycling dryer. The compressor installed on the PH1 starting

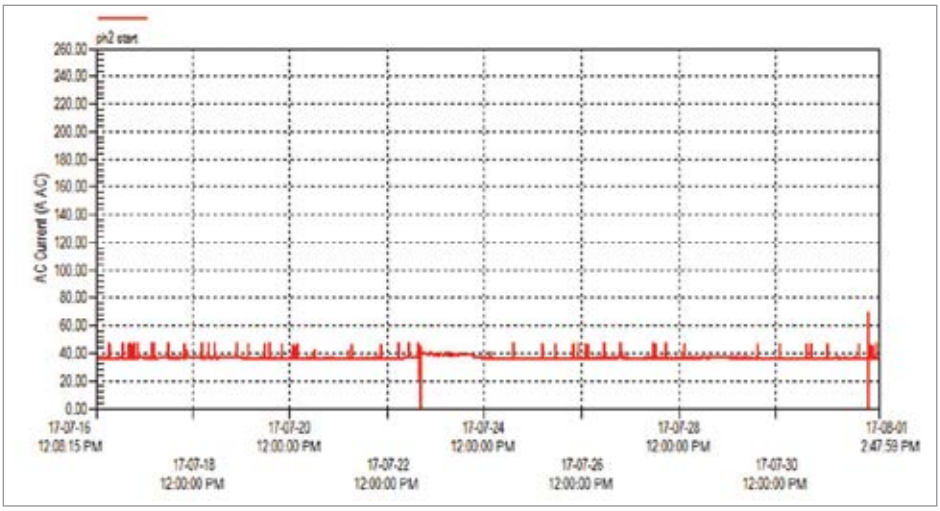

Figure 6: PH2 modulating compressor consumes constant power even at light loads.

AIR COMPRESSOR CONTROL AT REMOTE MINING COMPLEX

air system is an example of a unit running in start/stop mode due to large storage. It should be noted its annual operating cost is significantly lower than all the others. Some further tweaking of the compressor settings on PH1 could gain even more savings by eliminating the remaining small amount of unloaded run time.

Uncontrolled operation of desiccant air dryers is another reason for high operating costs and low efficiency. If you compare the flow produced by PH1 Service compressors to the PH2 service, the difference in flow, 45 cfm to 20 cfm, is due to malfunction of the PH1 desiccant air dryer purge control. This is likely due to the poor condition of the onboard dew point probe.

TABLE 5. ESTIMATED POTENTIAL SAVINGS

	$	%	KWH
Process Plant	$135,961	28%	424,878
Truck Shop General	$73,190	84%	228,717
Truck Shop Tire	$28,510	83%	89,093
PH1 Start	$3,966	62%	12,393
PH1 Service	$53,259	90%	166,434
PH2 Start	$69,403	86%	216,883
PH2 Service	$32,889	74%	102,777
Batch Plant	$26,901	93%	84,067
Total	$424,077		1,325,242

Compressed Air System Operating Profiles

In essence, all systems monitored were operating in load/unload mode with timed shutdown, except for the PH2 starting air and the Batch Plant. Internal to the control of the compressor type installed in most systems, is a starts per day setting. This allows a certain set maximum number of starts per hour, and will completely turn off the compressor. This eliminates unloaded run time between load cycles, if the compressor has not exceeded the maximum number of starts. This can completely eliminate the unload run time, saving power. The allowable number of starts per hour varies depending on the compressor size, for example, smaller compressors are capable of more starts. This feature can be used with the existing large storage receiver capacity and a wider pressure bands to

completely eliminate wasteful unloaded run time for all small compressors, about 75 hp and below.

For larger compressors (Process Plant and Truck Shop Service Air), the only option is to install a VSD controlled compressor in each system, or run a combination of smaller compressors (one being a VSD) matched to the existing fixed speed units. Generally, the installed VSD unit should be one size larger than any installed fixed speed units to prevent a condition called control gap, where the compressors fight for control.

Potential Energy Conservation Measures

Analysis of the information collected showed potential opportunities existing, that could result in significant reductions to the energy consumption of the compressed air system. These reductions in the energy consumption could potentially save about $424,000 per year in annual electrical costs.

Extra Savings Summary

An example of the savings that can be gained is shown in the following profile of the PH1 starting system compressor operation (Figure 4). It can be seen, other than a few cycles of extended unloaded run time, the compressor loads and then completely shuts off, reducing the wasteful run time. This is the reason this system has significantly lower costs than all the others. The occasional periods of unloaded run time could be eliminated by simply widening the compressor pressure band or adding storage receiver capacity. As an example, the PH2 starting system is running at less than 10% capacity, yet consuming about 70% of full load power (Figure 5).

Basic energy conservations measures recommended in these systems:

- Installation of properly sized VSD compressors in each large system, 90 kW and above.
- Operation in start/stop mode with large storage for smaller systems.
- Repair or recalibration of faulty air dryer dew point controls.
- Better operation of internal refrigerated dryers so they shut off with compressors.
- Replacement of timer and manual drains with airless style.

See a summary of the estimated potential savings in Table 5.

Conclusion

About $580,000 total, in potential energy savings were identified in only a few days of study. This is just as effective in generating profits as finding a large chunk of a valuable resource, like gold or diamonds. If implemented, the energy conservation measures generate these savings year after year. This is a good example of what can happen when a system is assessed with instrumentation. Plans at this site are to have a closer look at the mine air, and some other additional systems, to see if more savings can be gained. BP

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

To read more about ***Air Compressor Control System Assessments*** please visit, www.airbestpractices.com/system-assessments/compressor-controls

ZINC PRODUCER REDUCES Compressed Air Use by 1,090 scfm

By Don van Ormer, Air Power USA

A zinc producer spends an estimated $516,000 annually on electricity to operate the air compressors in a compressed air system at its north American plant. The current average electric rate, at this plant, is 5 cents per kWh, and the compressed air system operates 8,760 hours per year. This system assessment recommended a group of projects able to reduce these energy costs by fifty-one percent (51%) to an annualized $270,000. The simple payback of the project was 15 months – without taking into account potential

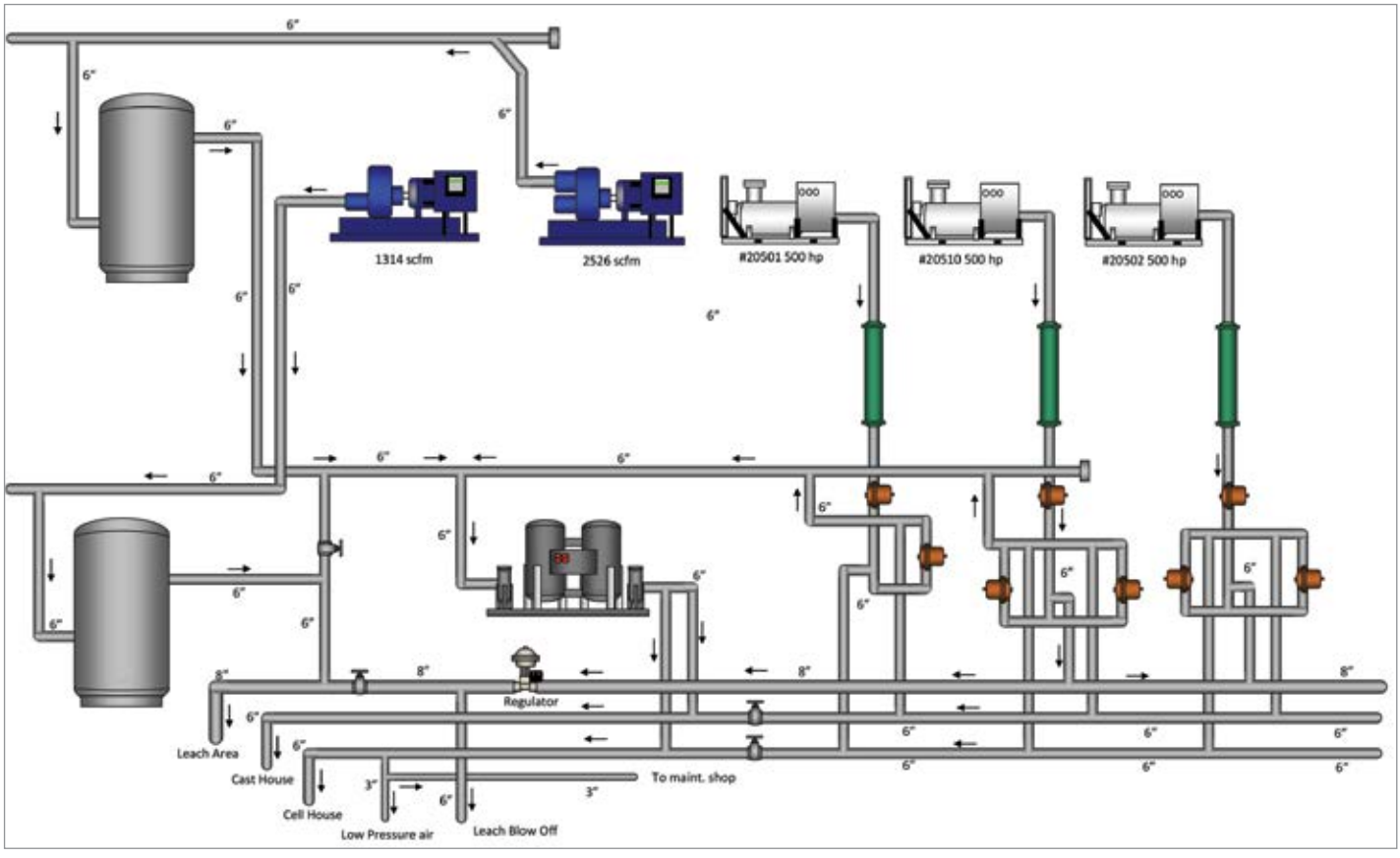

Figure 1. Current Compressed Air System – Zinc Plant

incentive dollars from the local utility. Due to article length constraints, this article will highlight a few of the demand-side projects which could reduce compressed air use by 1,090 scfm.

The Current Compressed Air System

The compressed air system consists of one large central air compressor room with a small system in Building A, and another separate compressed air system in Building B. Building A is connected to the main compressed air system, but the air compressor has not run for a long time. Currently, most of the plant air is directed around the existing dryer due to the piping layout.

There is a high-pressure system with an average system pressure of 100 psig. This system is producing a range of flows between 3,300 and 3,800 scfm. There is also a low-pressure system with an average system pressure of 28 psig. This system is producing an average of 1,102 scfm.

All of the plant's main air compressors are water-cooled with cooling water from open evaporative type cooling towers.

There are three lubricated rotary screw air compressors and two oil-free centrifugal air compressors. They have all been very reliable performers, with the appropriate maintenance, and many have been installed for 25+ years.

On the high-pressure side, the plant has three Ingersoll-Rand model SPA500VA, single-stage, oil-cooled, 500-hp class, rotary screw compressors (4,160 volts). Each unit is rated for 2,500 acfm or 2,250 scfm at 110 psig pulling 577 Bhp (457 kW). These units have modulation control with blow down and are all approximately 1980 vintage machines.

The plant also has an Ingersoll-Rand C3529M3, 3-stage centrifugal rated for 2,367 scfm at 110 psig and draws 559 Bhp or 439 kW. This unit has inlet butterfly valve (IBV) and blow off valve (BOV) controls.

The low-pressure system has an Ingersoll-Rand single-stage oil-free centrifugal (Model CD26LPD) 200-hp class compressor. This unit delivers 1,314 scfm at 36 psig, but is currently running with a 21 to 30 psig set point. Back-up air is from high-pressure crossover air from two separate regulators.

The Ingersoll-Rand unit will cut in at 21 psig and cut out at 31 psig. When the unit operates in load/no-load control and short cycling, it appears sometimes the low pressure safety valve will lift and be over-pressurized through the old crossover 8" regulator system. This compressor can deliver 1,377 scfm at full load. With idle calculated in,

ZINC PRODUCER REDUCES COMPRESSED AIR USE BY 1,090 SCFM

the average flow of this low pressure system is approximately 1,102 scfm at an average pressure of 28 psig. This compressed air system feeds Agitation in the Leach area. The average tank in Leach uses 40-60 scfm setting on a flow meter. There appeared to be a few cracked open drains in this system along with a few holes in the Leach area piping.

The high-pressure system has one main compressed air dryer, an Ingersoll-Rand Model 4300EHB. This desiccant dryer is rated for 4,300 scfm at 100 psig at 100 ˚F and has a 78 kW external-mounted heater with a 15-hp blower. This dryer is running, but seems to have a lot of air by-passing.

This system assessment recommends significant changes to the supply-side configuration primarily focusing on installing a new 14" header and a remote monitoring system enabling the plant to monitor kW, flow and pressure. Other supply-side recommendations include new compressed air treatment equipment and storage. Due to article length constraints, we will highlight a few of the demand-side projects implemented to reduce unnecessary uses of compressed air.

Compressed Air Use (Flow) Reduction Projects Deliver 1,090 scfm in Savings

Compressed air use (flow) reduction projects were identified totaling 205 cfm in the Extrusion/Main Plant area and 162 cfm in the Assembly area. Due to article-length constraints, we will expand a bit on two of the projects – compressed air leak management and blow-off air in the extrusion plant.

TABLE 1: AIR COMPRESSOR USE PROFILE – CURRENT SYSTEM

UNIT #	COMPRESSOR: MANUFACTURER/MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (ACFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL ACFM
Production Shift: Operating at 105 psig discharge pressure for 5,110 hours							
1	SPA 500 VH	457	2,250	87%	393	57%	1282
2	SPA 500 VH	457	2,250	Off			
3	SPA 500 VH	457	2,250	Off			
4	C3524M3	488	2,367	90%	439	85%	2011
			TOTAL(Actual):	**832 kW**		**3,293 scfm**	
Production Low Psig: Operating at 30 psig discharge pressure and 8,760 hours							
1	CD26LPD	145	1,377	81%	125	80%	1102
			TOTAL(Actual):	**125 kW**		**1,102 scfm**	
Production Warm Months(5): Operating at 105 psig discharge pressure and 3,650 hours							
1	SPA 500 VH	457	2,250	87%	393	57%	1,282
2	SPA 500 VH	457	2,250	75%	343	20%	450
3	SPA 500 VH	457	2,250	Off			
4	C3524M3	488	2,367	90%	439	85%	2,011
			TOTAL(Actual):	**1,175 kW**		**3,743 acfm**	

"The current average electric rate, at this plant, is 5 cents per kWh, and the compressed air system operates 8,760 hours per year. This system assessment recommended a group of projects able to reduce these energy costs by fifty-one percent (51%) to an annualized $270,000."

— Don van Ormer, Air Power USA

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ZINC PRODUCER REDUCES COMPRESSED AIR USE BY 1,090 SCFM

TABLE 2. COMPRESSED AIR LEAK LIST

#	LOCATION NAME	DESCRIPTION	CFM
1	Compressor Room Dryer	1/2 union leaking on airline under dryer	6.7
2	J Vap US Filter Press 1	Filter regulator leaking- open drain	3.2
3	J Vap US Filter Press 1	1/4 tubing leaking- hole in tubing	3.2
4	J Vap US Filter Press 2	Filter leaking- open drain	4.1
5	J Vap CV133	Threaded fitting on back of solenoid leaking	4.2
6	J Vap US Filter Slurry Tank PVR 301	Threaded fitting on back of PVR 301 leaking	2.2
7	J Vap Airdrop behind Slurry tank 2	Filter/regulator leaking - open drain	3.4
8	J Vap Airdrop by door behind Filtrate tank	Filter leaking- open drain	4.4
9	J Vap 2nd Floor Airdrop behind filter press	1/4 tubing leaking at filter/regulator	1.4
10	J Vap 2nd Floor Airdrop behind filter press	Regulator leaking at threads on gauge	2.4
11	Casting Air supply Receiver	PRV leaking	2.2
12	Cast House Zinc test	Ball valve open on drip leg	2.1
13	Cast House Zinc test 2nd floor airline to Bag House	Regulator leaking	1.8
14	Cast House Zinc 2nd Floor dust collector airline	Ball valve leaking	2.6
15	Cast House Zinc test 2nd Floor	Ball valve leaking- open	1.6
16	Cast House Dust Collector 1	Ball valve leaking from stem	3.0
17	Cast House 1st floor Dust collector Airdrop	Threaded fitting on bottom of filter leaking	2.4
18	Cell House	Air line to cylinder leaking	3.3
19	Cell House	Cylinder leaking	4.1
20	Cell House	1/2 tubing leaking	2.3
21	South Stripper control panel	Solenoid inside panel leaking	1.8
22	South Stripper	Cylinder leaking	2.4
23	North Stripper	Cylinder leaking	2.4
24	Cell House Basement	1" ball valve leaking	4.0
25	Purification Agitation Blow off	1/4" hole in pipe leaking	4.5
26	Purification Pipe Rack by Road	Valve leaking- open	3.8
27	Purification 3rd floor	Sight glass leaking on control valve	4.0
28	Purification 3rd floor	Valve leaking at seal bolt	3.0
29	Roaster F&K Pump	Ball valve- open drip	4.2
30	Roaster Area airdrop by gear system control panel	Filter leaking- open drain	4.1
31	Roaster 2nd level	Lubricator from drain	5.0
32	Roaster 2nd level	1" filter leaking at drain	3.1
33	Metals BLD Recovery 2nd Floor	Filter leaking- open drain	3.9
34	Metals BLD Recovery 2nd Floor	Regulator leaking	3.4
35	Metals BLD Recovery 1st Floor	1/2 ball valve leaking	2.3
36	Purification 3rd floor	Sight glass leaking on control valve	5.6
37	Purification Pipe Rack by Road	Valve open	5.8
38	Filter BLD Upper level airline behind tank 05136	1/2" pipe leaking-hole in pipe	5.5
39	Filter BLD lower level airdrop by condensate return	1" pipe leaking at threads	1.8
40	Filter BLD lower level mezzanine	1/2" pipe leaking-hole in pipe	5.0
41	Leach Airline by stairs 05-051067-in	Compression fitting leaking	2.5
42	Leach Airline PH System by work Boot	1/2" nipple leaks at threads on T	3.7
43	Leach Control Valve behind agitator 05040	Control valve leaking inside	6.2
44	Leach under mezzanine upper level control booth	1" pipe leaking at threads	4.3
45	Leach dust Collector on top of tank 05011	1/2' pipe leaks at threads	2.1
46	Oxide Washing Plant mrp-xv-3025-auto	1/2" union leaking	3.4
47	Oxide Washing Plant mrp-xv-3026-auto	Union leaking	2.8
48	Oxide Wash Plant filter press	Nipple at T leaks at threads	1.9
		Total Cfm	**162.9**

Project #1. Replace 17 Timer Drains with Zero Air-Loss Condensate Drains – 51 scfm Savings

We estimated each of the 17 timer drains were wasting 3 cfm each of compressed air. Timer drains are unable to close when not needed. There were 11 of these drains in the main compressor room alone. We recommend electronic or pneumatic-actuated, level-activated condensate drains. The cost of this project (including labor) was estimated at $8,500 and the annual savings at $5,760.

Project #2. Repair 48 Identified Compressed Air Leaks – 163 scfm Savings

A partial survey of compressed air leaks was conducted at the plant and 48 leaks were identified, quantified, tagged, and logged. Potential savings totaled 163 cfm for the 48 leaks that were identified. The cost of this project (including labor) was estimated at $8,300 and the annual savings at $18,500.

Project #3. Replace High Pressure Blow-Offs with Low-Pressure Cooling Fans – 340 scfm Savings

Potentially inappropriate uses of compressed air are demand-side applications that may be more efficiently handled by another power source rather than compressed air. Blow-off air is a very common inappropriate use. Four different areas in the plant were found to be using compressed air for personal cooling purposes. Installing new 1 KW high performance fans should correct this inappropriate use of compressed air. The cost of this project (including labor) was estimated at $10,000 and the annual savings at $38,400.

Project #4. Replace 29 Air Vibrators with Electric – 255 scfm Savings

Air vibrators are used to keep product or packaging moving or separated – e.g., keeping lids separated prior to sealing. If a plant employs air vibrators that use about 10 cfm

TABLE 3. SUMMARY OF KEY PERFORMANCE INDICATORS AND PROJECTED SAVINGS

SYSTEM COMPARISON	CURRENT SYSTEM			PROPOSED SYSTEM	
	PRODUCTION	PRODUCTION WARMER MONTHS (5)	LP PRODUCTION	PRODUCTION	LP PRODUCTION
Average Flow (cfm)	3,293	3,743	1,102	2,279	1,102
Compressor Discharge Pressure (psig)	105	105	30	105	30
Average System Pressure (psig)	100	100	25	100	25
Electric Cost per cfm	$64.55 /cfm/yr	$57.29 /cfm/yr	$49.68 /cfm/yr	$82.64 /cfm/yr	$49.68 /cfm/yr
Electric Cost per psig	$1,062.88 /psig/yr	$1,072.00 /psig/yr	$273.75 /psig/yr	N/A	$273.75 /psig/yr

each, they will require about 2.5 hp or more to produce the same as a similar electric vibrator, which might use about 0.25-hp input energy. The survey identified 29 air vibrators which can be replaced with electric vibrators. The net savings would be 255 scfm. The cost of this project (including labor) was estimated at $20,800 and the annual savings at $28,800.

Conclusion

In this article we have highlighted four simple, but important ways to reduce compressed air demand at a zinc facility. These projects were part of a larger system assessment involving the installation of supply-side air compressor controls, header piping and air dryer changes able to reduce pressure drop and translate compressed air use reductions into electric cost energy savings at the air compressors. 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 Dryer Fundamentals – THE LAST 25 YARDS

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

➤ Introduction

In my last article, I described some fundamentals of water and air mixtures, like how much water vapor can air hold, and why. I also explained that most of the water is supposed to be removed in the compressor aftercooler, separator and drain, about 75%, leaving the last 25% to the dryer. Just 25 yards to a touchdown, one good run and you're in. However, if the after-cooler is fouled, or the drain is not functioning, the load on the dryer can more than double. You're 4th and 20 and at the 50. Unless the dryer is way over-sized, it won't have a chance. Your dryer will never be able to score for you. You're going to have to punt!

Basic Theory

Before I launch into some practical dryer system and component issues, probably more pressing to the audience, let me cover some basic theory.

Impact of Temperature on Refrigerated Air Dryer Effectiveness

To review from the last article, the maximum water load air can carry at a given pressure is solely dependent on the temperature. The temperature affects the maximum "partial pressure" water vapor can exert. Since the outlet of a compressor after-cooler is always saturated, or 100% relative humidity (RH), water vapor is at the "saturation pressure." Thus, a higher temperature compressor outlet dramatically affects the water vapor load on the dryer. For every 10 °F increase, the mass of water increases about 35%. See Figure 1 for two manufacturers' correction charts for refrigerated air dryers.

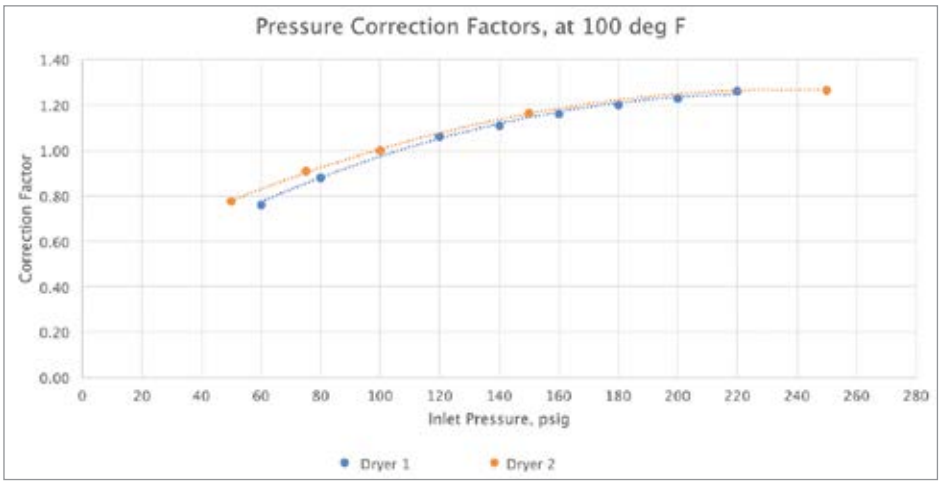

Figure 1. Typical Refrigerated Air Dryer Correction Factors for Temperature

What impact does pressure have on the water-holding ability of air? What impact does it have on the dryer's ability to dry? To answer this, I need to review some terms introduced in my last article, dig a bit deeper, and talk about pressure more.

Impact of Temperature on Regenerative Adsorption and Regeneration Effectiveness

This is more of an art than a science. Activated alumina, the typical desiccant in regenerative dryers, adsorbs moisture at high density, and releases moisture at low density. So, the adsorption efficiency declines as density reduces. Higher inlet temperature is lower density. Some manufacturers have dramatic de-rates for higher inlet temperatures, more than the refrigerated air de-rates. See Figure 2.

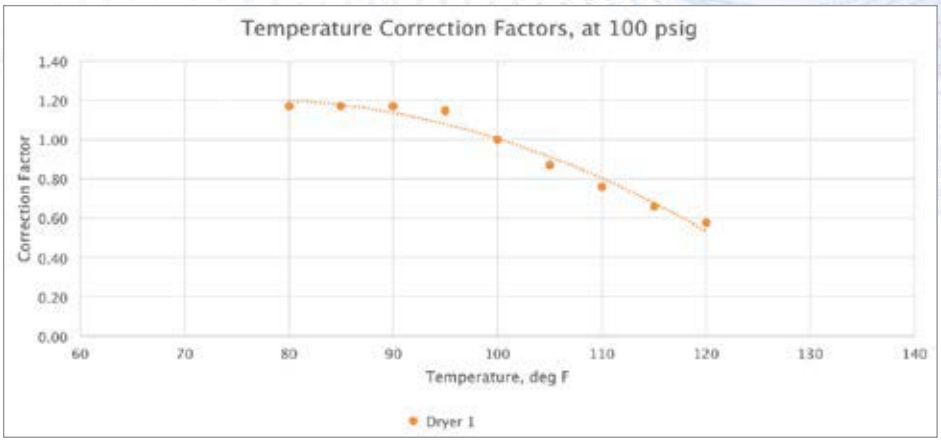

Figure 2. Typical Regenerative Air Dryer Correction Factors for Temperature

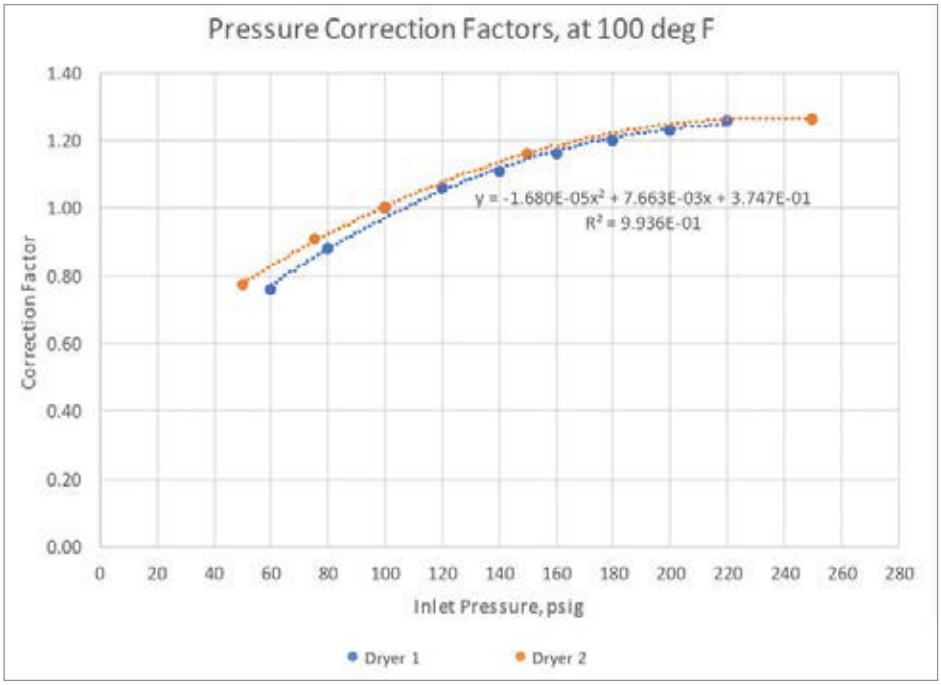

Figure 3. Typical Refrigerated Air Dryer Correction Factors for Pressure

Impact of Pressure on Total Water in Air

The governing equation is:

- Water/air mass ratio = 0.622 x Pv / Ptot = 0.622 x Pg x RH / (Ptot + 14.7)

  Where:

  - RH = relative humidity, the ratio of how saturated the air is, 0 to 1 ratio
  - Pg = "saturation pressure," the maximum partial pressure water can exert, fully saturated – solely based on temperature, psig
  - Ptot = gas mixture total "gauge pressure," psig
  - 0.622 = the molar mass ratio of water vapor to air (18.02 / 28.97)

Since Pg and RH are on top, temperature and humidity at any point in the air stream increase the mass of water. So, at the inlet of the dryer, this is caused by higher temperature (remember the 35% per 10 °F rule). The RH is always 100% at the dryer inlet. However, note Ptot is on the bottom of the equation. Higher pressure reduces the water/mass ratio, and the thermal load on the dryer. Pressure "squeezes out" the water vapor, turning it into liquid, and reduces the remaining water in the air. A 10 psi increase in compressor discharge pressure results in approximately 9% reduction in the water load on the dryer, and vice-versa.

Impact of Pressure on Velocity in Dryer

To simplify, higher gas velocity reduces a heat exchanger or separator's effectiveness. The heat transfer coefficient goes up a bit, but the transmit time will reduce, decreasing the achievable temperature differential. The velocity equation is:

- Velocity increase = (Prated + 14.7) / (Pact + 14.7) - 1

  Where:

  - Prated = dryer rated inlet pressure, psig (typically 100 psig)
  - Pact = actual dryer inlet gauge pressure, psig

COMPRESSED AIR DRYER FUNDAMENTALS – THE LAST 25 YARDS

So, a 10 psig lower pressure would increase velocity by about 10%. This increased velocity has multiple impacts on the dryer, including an increase in pressure drop, and a reduction of the heat exchanger's (evaporator's) effectiveness.

Impact of Pressure on Pressure Drop

Pressure drop is related to the square of velocity. As described above, velocity is related to pressure. Since we measure pressure, not velocity, the governing equation is:

- Pressure drop increase = $[(\text{Prated} + 14.7) / (\text{Pact} + 14.7)]^2 - 1$

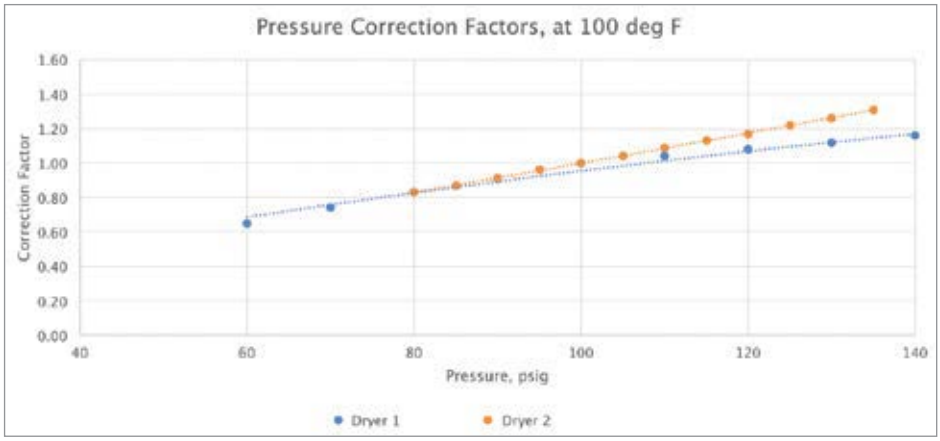

Figure 4. Typical Regenerative Air Dryer Correction Factors for Pressure

So, a 10 psig lower pressure would increase pressure drop by about 20%. If the original pressure drop for the dryer, filters and piping was 10.0 psid, it would now be 12.0 psid.

Impact of Pressure on Refrigerated Dryer Heat Exchanger Effectiveness

Based on empirical testing, refrigerated dryer manufacturers publish "de-rates" for lower pressures. Lower pressures have a larger negative impact on performance, than higher pressures' positive impact. See Figure 3 for correction factors for two manufacturers' refrigerated air dryers. Numbers below 1.00 are de-rates. There is significant concurrence between these two manufacturers.

Impact of Pressure on Regenerative Adsorption and Regeneration Effectiveness

This is also more of an art than a science. Theoretically, higher velocity creates lower

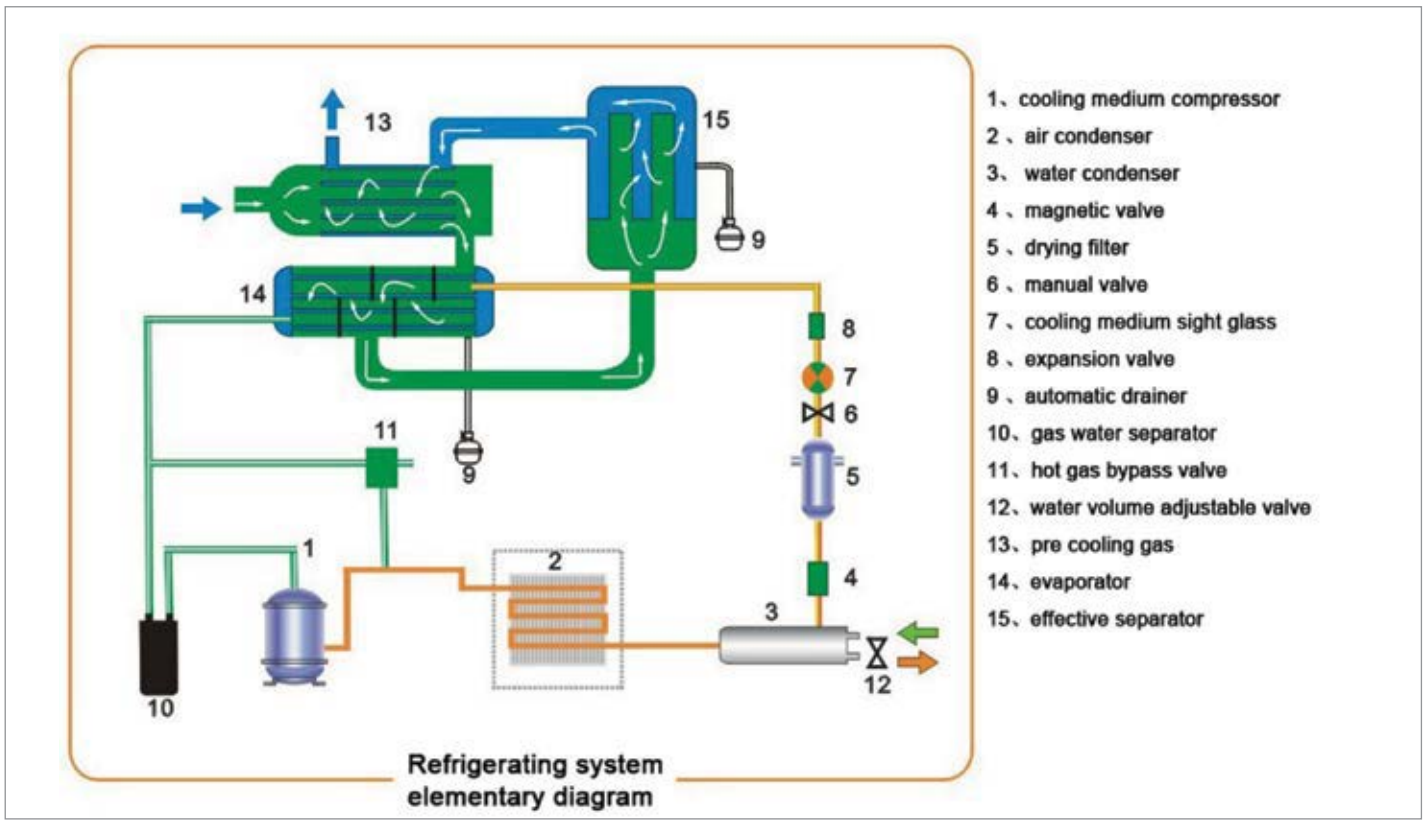

Figure 5. Typical Air-Cooled Refrigerated Air Dryer Diagram

retention time, reducing the desiccant's ability to adsorb the water vapor. Two different manufacturers' correction factors are shown in Figure 4. There is significant divergence between these two.

Practical Implications

This article will now move from theory to practice, and discuss dryer package issues impacting the amount of water vapor that will be removed.

Refrigerated Dryer Package Issues

Refer to Figure 5 for a typical air-cooled refrigerated air dryer diagram, most are similar. Without going into details about dryers, the reader should know a typical dryer inlet design condition is 100 psig, 100 ˚F and 100% RH. See Table 1 for water removed in a 1,000 scfm system, first in the compressor after-cooler, then in a properly functioning dryer. Note the dramatic increase in dryer heat load with increasing ambient temperature.

Evaporator

The first critical component limited by the intake compressed air temperature is the evaporator. The evaporator is the fundamental heat exchanger doing the work to take moisture out of the air. When operating properly, it cools down the compressed air to just above the dew point, about 38 ˚F – 40 ˚F, to condense moisture. The refrigeration loop is a limiting factor as well. It is designed for a particular heat load and ambient temperature (if air-cooled). It has a simplistic evaporator/condensing pressure difference control through an expansion valve. See Figure 5, item #8. If the evaporator is fouled from dirty compressed air, its performance will also suffer. The temperature can quickly climb to above 60 ˚F at the separator, thus only providing a mediocre dew point and water condensation in the plant.

Expansion Valve

This valve is adjusted once. It controls the refrigeration pressure difference between the evaporator and the condenser. Note in Figure 6, the horizontal lines don't differ much with a given dryer. However, there's no allowance in conventional compressed air dryers for heat loads above what is designed. The pressure differential will stay fairly constant, and both the evaporator and condenser pressures (and temperatures) will just rise together as the heat load increases. The evaporator temperature will not be low enough to condense sufficient moisture from the air, and dew-point will suffer.

Automatic Drain

Just like in a compressor, the auto drain functioning is critical for the proper operation of a refrigerated air dryer. It drops out the mass of water it condenses. If the drain doesn't open, liquid water will be evaporated in the re-heater, and passed downstream. All the work to reduce temperature in order to take out the moisture will be invalidated. Dew point will be equal to about the ambient temperature, and condensation will occur in the plant system.

TABLE 1. WATER LOAD AND REMOVAL IN AFTER-COOLER AND DRYER

COMPRESSOR INLET				COMPRESSOR AFTER-COOLER				DRYER				
COMPRESSOR INLET & AMBIENT TEMP, DEG F	SATURATION VAPOR PRESSURE, PSIA	COMPRESSOR INLET % WATER VAPOR (BY MASS)	WATER INTO COMPRESSOR INLET, LB/MIN	COMPRESSOR OUTLET / DRYER INLET TEMPERATURE, DEG F	COMPRESSOR OUTLET SATURATION PRESSURE, PSIA	COMPRESSOR OUTLET % WATER VAPOR	CONDENSATE DRAIN WATER REMOVED, LB/MIN	DRYER OUTLET DEW POINT, DEG F	DRYER OUTLET SATURATION PRESSURE, PSIA	% WATER VAPOR (BY MASS)	WATER CONDENSED IN DRYER, LBM/MIN	HEAT LOAD, BTU/HR
40	0.122	0.26%	0.19	55	0.221	0.12%	0.10	40	0.127	0.07%	0.04	2,444
50	0.178	0.38%	0.28	65	0.306	0.17%	0.16	40	0.127	0.07%	0.07	4,648
60	0.256	0.54%	0.41	75	0.424	0.23%	0.23	40	0.127	0.07%	0.12	7,702
70	0.363	0.77%	0.58	85	0.588	0.32%	0.34	40	0.127	0.07%	0.19	11,941
80	0.507	1.07%	0.81	95	0.810	0.44%	0.48	40	0.127	0.07%	0.28	17,700
90	0.698	1.48%	1.11	105	1.103	0.60%	0.66	40	0.127	0.07%	0.40	25,315
100	0.949	2.01%	1.51	115	1.481	0.80%	0.91	40	0.127	0.07%	0.55	35,120
110	1.281	2.71%	2.04	125	1.957	1.06%	1.24	40	0.127	0.07%	0.75	47,450
120	1.706	3.61%	2.71	135	2.543	1.38%	1.68	40	0.127	0.07%	0.98	62,640
130	2.235	4.73%	3.56	145	3.252	1.76%	2.23	40	0.127	0.07%	1.27	81,025

COMPRESSED AIR DRYER FUNDAMENTALS – THE LAST 25 YARDS

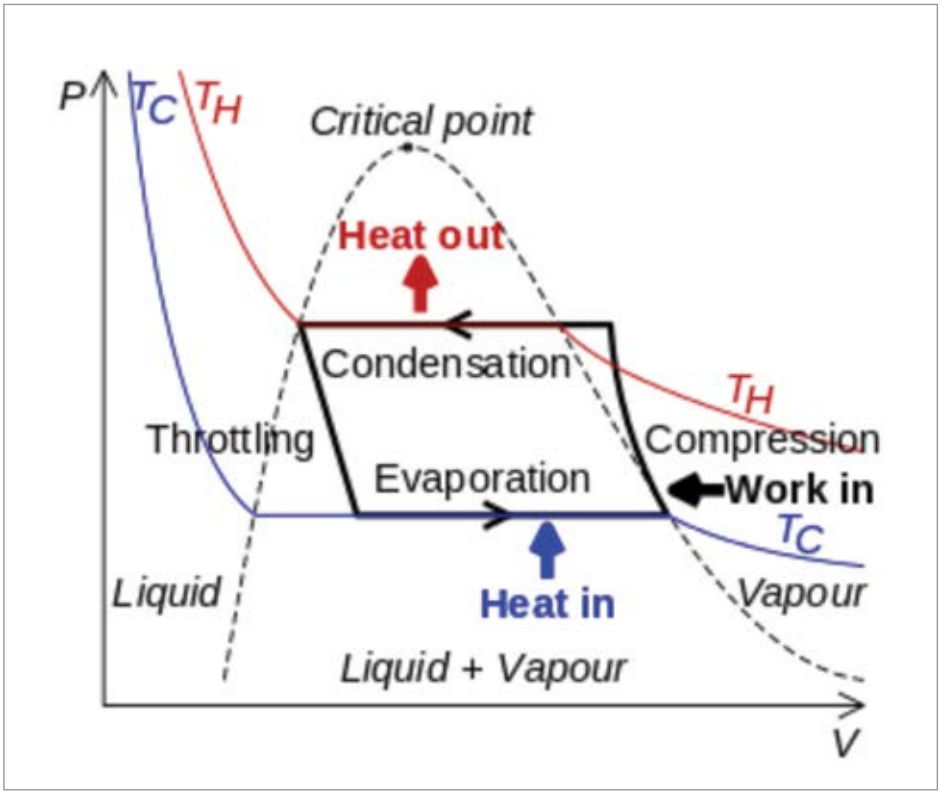

Figure 6. Refrigerated Air Dryer Thermodynamic Diagram

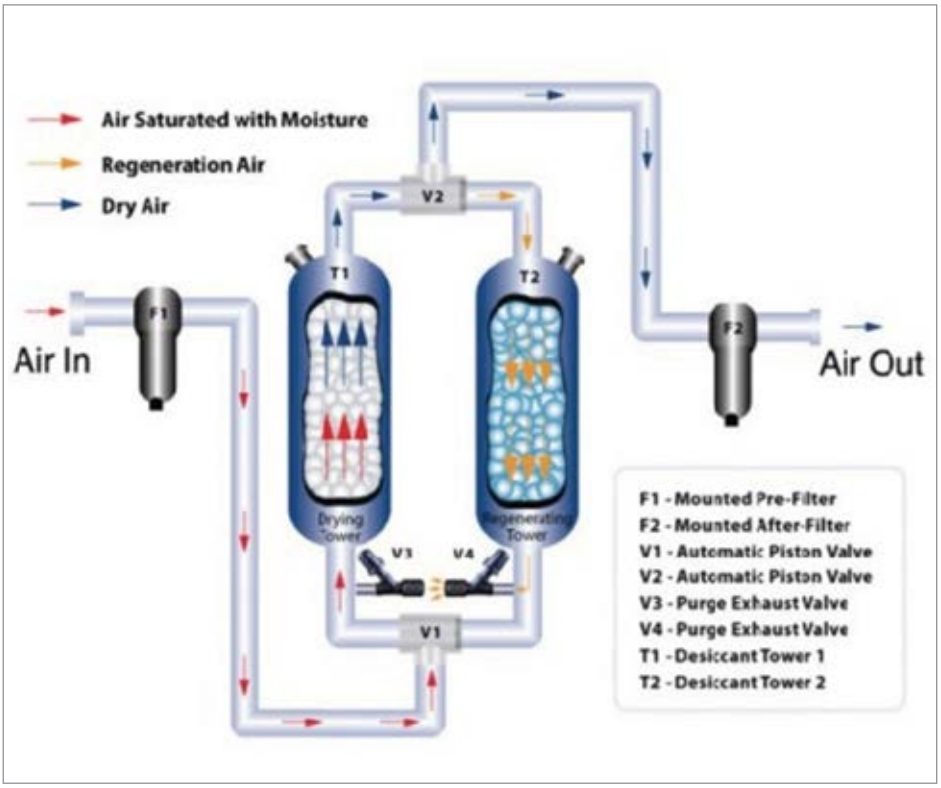

Figure 7. Typical Regenerative Air Dryer Diagram

Condenser

If the ambient temperature is too high, the condenser temperature (and pressure) rises, effectively raising the evaporator temperature and pressure along with it. This has the same effect on the compressed air cooling and condensing as the hot intake air does. Higher evaporator temperatures reduce dryer performance.

Regenerative Dryer Package Issues

Refer to Figure 7 for a typical regenerative air dryer diagram, most are similar. The four most common types on the market, based on the type of regeneration method, are as follows:

1. Heatless Regenerative (shown in Fig 7): Use about 15% of dry "purge" air to regenerate offline tower, about 10 minute total cycle, -40 ˚F dewpoint. They use approximately 15% energy to dry.

2. Heated Regenerative: Use about 7.5% of dry "purge" air, heated, about 8 hour total cycle, -40 ˚F dewpoint. They also use about 15% total energy, shared between purge and heater.

3. Blower Purge Regenerative: Use external ambient air, through blower, and heated, for regeneration, about 8 hour total cycle, -40 ˚F dewpoint. They use about 5% – 10% energy.

4. Heat-of-Compression Regenerative: Use hot compressor outlet air for regeneration, cycle varies on design, -40 ˚F to 0 ˚F dewpoint. They use no energy, unless cool-down purge or trim heaters are used. There are multiple designs. Some are twin-tower, like the rest. Some are rotating drum type. They can only work with oil-free screw and centrifugal compressors.

Valves

Dry switching valves are a maintenance concern with regenerative dryers. If they don't seat and leak, compressed air can feed back to

the regenerating tower and purge. Cool-down purge valves on blower purge dryers are rather large, and they can be stuck open as well. Finally, purge control valves can fail shut, and not dump pressure in a tower intended to regenerate. All of these failures can, and do, cause higher energy and/or poor dew point. Note, once dew point is compromised in a regenerative dryer, the bed is saturated. This can take a long time to dry out, and sometimes never can. After valve repairs causing a dryer to go wet, a new load of desiccant is often needed.

Heaters

Heaters and contactors frequently fail on heated and blower purge dryers. This not only degrades dew-point, but saturates the dryer as well.

Controls

Regenerative dryer controls are dependent on pressure sensors, temperature sensors, relays, dew-point transmitter, etc. A common issue with these controls is component failure. When one component fails, the overall controls don't work correctly. This can cause high energy usage, or poor dew point and bed saturation. I have seen a failed dew point transmitter fault a 6,000 scfm blower purge dryer into full cool-down purge, plus blower and full heater, costing over $50,000/yr. just to run the dryer.

Conclusions

Compressed air dryers need to get the ball handed to them on the 25 yard-line by a compressor providing low enough temperature, and high enough pressure for the dryer to take it to the design dew point. If not, the dryer is not able to work properly. Once the dryer gets the right moisture level, it needs to operate properly. Heat exchangers, drains, switching valves, etc., all have to work with the proper control sequence to provide reliable dew point to the plant.

Recommendations

1. Install an indicating and trending temperature transmitter at the inlet of the dryer, and use it to indicate when the compressor after-cooler needs cleaning.
2. Install an indicating and trending dew point meter after the dryer(s). Watch the trend, and note if dew point suffers in particular circumstances, like peak load or hot ambient.
3. Keep air-cooled refrigerated air dryer condensers clean, and ensure the warm air is not recirculating in from the compressor or another heat source.
4. Duct the coolest and cleanest air available to an air-cooled refrigerated air dryer.
5. Make sure the automatic drain on the refrigerated air dryer is functioning properly. If it is poor quality, replace it with a solid air-less drain.
6. Check all dryer component and control functionality on the recommended interval.
7. Perform all routine maintenance on the recommended interval. BP

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

To read more articles on ***Compressed Air Purification Technology,*** please visit www.airbestpractices.com/technology/air-treatment

SHOW REPORT: 2017 WEEC Chiller & Compressed Air Control Technology

By Rod Smith, Compressed Air Best Practices® Magazine

The 2017 World Energy Engineering Congress (WEEC) was held September 27-29 at the Georgia World Congress Center in Atlanta, Georgia. According to the producer, the Association of Energy Engineers (AEE), the WEEC is the largest energy conference and technology expo held in the U.S. specifically for business, industrial and institutional energy users. Widely known for its recognized energy certification programs, including the Certified Energy Manager CEM® program, the AEE has led the development of the fields of energy engineering and energy management since its' founding in 1977.

We thank the Michelin energy management leaders, Olivier Selosse and Thomas Sullivan (our Editorial Board Member) for all their support (left to right)!

The Association of Energy Engineers (AEE) has a membership base of over 17,500 professionals in 98 countries and has 96 locally-run chapters. Both Chiller & Cooling Best Practices and Compressed Air Best Practices® Magazines are honored to have a long collaboration with the AEE and were pleased to chair two sessions, be in the literature bins and to have a booth at the 2017 WEEC!

"Best Practice" Conference Session for Compressed Air and Chiller & Cooling Systems

The WEEC deploys 14 simultaneous conference tracks – impressive! I have had the great opportunity to Chair a 2-hour session for compressed air for many years – and we've just done our second straight year with a second session on chiller and cooling systems. Our sessions are quite well attended, averaging 70 to 90 people, which is a testament to the speakers we invite to present. I'd like to thank our speakers for making the time and for presenting.

Compressed Air Best Practices® Magazine hosted a WEEC Conference Session on September 28th titled "Best Practices in Compressed Air." The session presenters this year and their topics were:

1. "Reducing Site Cost through Ultrasonic Air Leak Surveys and Repairs," James Nipper, Vice President, Petro Chemical Energy
2. "Why do Compressed Air Systems Need Drying?" Frank Moskowitz, Service Manager AIRScan, Atlas Copco Compressors
3. "Anatomy of a Compressed Air Project," Paul Edwards, President, Compressed Air Consultants
4. "Applying Root Cause Analysis to Compressed Air," Neil Mehltretter, Systems Engineer, Kaeser Compressors

Chiller & Cooling Best Practices® Magazine hosted a WEEC Conference Session on September 29th titled "Best Practices in Chiller & Cooling Systems." The session presenters this year and their topics were:

1. "How to tell if your Chiller Plant is Optimized?" Brett Rasmussen, P.E., Senior Energy Engineer, Nissan North America
2. "District Chilled Water Optimization at an Academic Medical Center," Kevin Kanoff, C.E.M., Campus Energy Engineer, Milton S. Hershey Medical Center
3. "Water & Energy Efficient Operation of Open & Closed Loop Cooling Towers," Matthew Shank, Industrial Process Application Manager, Evapco
4. "Energy-Efficient Operations of Cooling Towers," Mark Pfeifer, Technical Services Manager, SPX Cooling Technologies

ENERGY STAR® Industrial Sector Partnerships

The ENERGY STAR for Industry program, run by Walt Tunnessen and Elizabeth Dutrow, is an amazing program within the U.S. Environmental Protection Agency (EPA). Readers of our publications know we are always profiling ENERGY STAR Industrial Energy Management Partner of the Year award winners. For companies simply wanting to certify their own plant, they have an interesting energy management tool they call the ENERGY STAR Challenge for Industry. There are over 900 sites using it in North America. In order to participate, a site expresses its goal to achieve an energy intensity reduction of 10 percent in five years or less. A plant baseline is developed and registered with ENERGY STAR. They then have to track their progress and report when they achieve the goal.

At the WEEC this year, ENERGY STAR National Program Manager Walt Tunnessen chaired an excellent session titled, "Striking Gold! Tales from the Treasure Hunt." Treasure Hunts are a low/no-cost two-day events held at factories to discover energy savings (treasure)! They are distinguished and defined by having very fast ROI's. ENERGY STAR provides excellent training and assistance so plants can learn to hold Treasure Hunts. This session had Energy Managers from Intertape Polymer Corporation, Bristol Myers Squibb, Olin Brass and General Motors Company providing tales from their adventures.

Brett Rasmussen, P.E., Senior Energy Engineer, Nissan North America, presented; "How to tell if your Chiller Plant is Optimized?"

Kevin Kanoff, C.E.M., Campus Energy Engineer, Milton S. Hershey Medical Center, presented; "District Chilled Water Optimization at an Academic Medical Center."

Frank Moskowitz, Service Manager AIRScan, Atlas Copco Compressors, presented; "Why do Compressed Air Systems Need Drying?"

2017 WEEC: CHILLER & COMPRESSED AIR CONTROL TECHNOLOGY

Nitin G. Shanbhag, Volkan Ayhan and Christina Bailey (left to right) at the Mikropor America booth.

Ahmad Mustafa, Paul Edwards (Compressed Air Consultants), Chris Wagner, Chris Wells and Jeff Kahn (left to right) at the CAM Technologies booth

Mike Gembala, Lou York, Ron Mazur, Dean Smith and Alton Stokes (left to right) at the Case Controls and iZ Systems booth

Compressed Air System Optimization and the Internet of Things

One obstacle to air compressor efficiency is what's called "artificial demand." Compressed air pressure drop, in the system, causes air compressors to work at higher pressures (and higher kW) than necessary. Pressure drop is often caused by poorly designed, or maintained, compressed air purification products.

Focusing on minimizing pressure drop, Mikropor America had several interesting innovations to their compressed air purification products, described to me by Mikropor America President, Nitin Shanbhag, "We have oversized the 1 micron pre- and 0.01 ppm post-filters integrated into our MK Series digital cycling refrigerated dryers." Combined with a 3 in 1 heat exchanger, oversizing the filters allows Mikropor to publish an extremely low < 3 psi pressure drop for the whole package. What's equally impressive, to cynical 'ol me, is these dryers are performance tested (for dew point and pressure drop) under the CAGI Performance Verification testing program. I also liked the fact that units larger than 175 scfm and larger have standard high pressure and suction pressure gauges (old school service-friendly!).

Airleader and CS Instruments had booths side-by-side displaying their compressed air management and measurement technologies. General Manager and Lead Auditor Jan Hoetzel has really come a long way bringing these German technologies to the U.S. market. They are uniquely positioned to provide end users with both air compressor automation products (and knowledge how to use them) plus the instruments required to measure what's going on. The instruments include flow, dew point, data loggers, pressure, amps, and leak detection. I was able to personally visit an Airleader client recently in Chicago (article coming soon!). The President was delighted to show me, on his desktop computer, the energy consumption of his compressed air this year by month! The Airleader software was running the air compressors, incorporating data from specific instruments and giving him a running tracker of specific power (kW per 100 scfm) as his key performance metric. Aside from liking the software, they had already realized six figure $ energy savings and received a $177,000 incentive check from ComEd Chicago! Great stuff.

VP Instruments had a booth displaying their compressed air flow measurement technology – plus they always bring the best cookies/cakes from Holland! Menno Verbeek commented, "Our recent seminars on compressed air measurement have been well attended as we continue to educate on how to properly deploy flow meters in compressed air systems." We reviewed their new and improved VPFlowScope DP flow meter, designed for "real world" hot and saturated compressed air

conditions. "We have the only insertion flow meter designed to handle moisture," said Verbeek. "We've improved the internal filtration designed to keep the moisture out." I'm personally a big believer in compressed air flow measurement – but users need to understand compressed air is a tricky fluid to measure and how to do it properly. Another note of importance is the VP Sensor Cartridge has made flow metering something maintenance can handle like filtration. One can simply change the sensor cartridge – rather than send the whole unit out for calibration.

Case Controls, a leading air compressor automation company focused on centrifugal air compressors, was acquired over the past year by Blake & Pendleton. Blake & Pendleton is one of the larger compressed air system sales and service providers in all of North America, enjoying significant market shares in the Southeast. Congratulations go to their management leadership (Allen King and Mike Gembala) for B&P's steady multi-decade growth - doing things the right way. By acquiring Case Controls, it now complements another subsidiary B&P subsidiary, iZ Systems, which is a leading compressor automation company whose focus has been primarily on rotary screw air compressors. The combined firms had a booth, for the first time, where their combined compressor automation products were on display.

CAM Technologies had a booth where they presented their CAMLink™ Online compressed air visibility and energy optimization system. The system provides system data collection, alarm monitoring and preventative maintenance indicators via email or text. It can be integrated with the CAMLink™ advanced service program as well.

President Chris Wagner explained, "CAMLink Online helps reveal patterns of energy waste that build up between audits and are unseen during walkthroughs." Wagner continued, "The system has government-level firewalls to ensure security while providing access flexibility to connect from any desktop, laptop, tablet or smart phone."

The Hitachi Air Technologies group continues to focus on oil-free air compressors, offering both oil-less scroll compressors and oil-free rotary screw compressors. The oil-less stand-alone scroll air compressor range goes up to 16.5 kW. Their rotary screw compressors include two-stage fixed speed units with capacities up to 240 kW and two-stage VSD units with capacities up to 240 kW.

EnergAir had a booth displaying their compressed air and vacuum Metacentre™ system control products. This "intuitive visual software" helps customers visualize what is happening in their compressed air system. General Manager Nicolas De Deken emphasized the growing demand for visualization, monitoring and automatic controlling of air compressors. Some plants have been receiving the same advice for

Alan Brossault (Compressor Management), Josh Wamser (Air Support iO), Jesus Molina (Thor Industrial), Steve Briscoe (IAC Air Compression) and Jan Hoetzel made the Airleader booth their headquarters (left to right)!

Menno Verbeek and Chuck Mays (left to right) at the VP Instruments booth

Van Tran and Nicolas De Deken (left to right) at the EnergAir booth

2017 WEEC: CHILLER & COMPRESSED AIR CONTROL TECHNOLOGY

years, from their air compressor vendor, but until they see it from a computer software system – they don't take action. Mr. De Deken provided us a good example in our recently published "Great Plains and Air Capital Equipment Monitor Great Savings" article.

Chiller and Cooling System Optimization

Chillers represent one of the largest energy consumers in a plant. The percentage of the total plant power they consume will vary, like compressed air, from plant to plant and by type of industry. Here are some quick and random notes I took from conference lectures of interest (at least to me!):

- A typical demand breakdown for a pharmaceutical plant is HVAC (65%), Equipment (25%) and Lighting (10%). Chilled water optimization is the project driver for HVAC (Allergan Pharmaceuticals)

Derrick Taylor (PneuTech), Andrea Nodari and Mattia Busi (left to right) at the Teseo booth.

Josefine Hoetzel, Robert Howard and James Nipper (Petro Chemical Energy) at the CS Instruments booth (left to right).

- Kimberly Clark's 100 plants have a $700 million annual energy spend. Started energy management journey in 1995. Goal to continue improving their Energy Intensity (kW per unit manufactured) is another 30 percent by 2022. Water intensity by 20 percent. Corporate $5 million Energy Fund to help plants.
- General Motors has 170 manufacturing locations in 30 countries. Build 10 million vehicles per year and have a $1 billion energy spend. Current Energy and Water Intensity reduction goals (MWh or cubic meters per vehicle) are of 20 and 15 percent respectively. Have established Key Performance Indicators for chiller, air compressor and boiler efficiency. Corporate $20 million Energy Fund to help plants.

We are thrilled to welcome Nissan North America's Brett Rasmussen to our Editorial Board! As mentioned, Brett made a chiller presentation with these highlights:

- Nissan's Canton (Mississippi) plant produces 1,400 cars per day in a 1 mile long facility with 4.5 million square feet
- Operate the largest chiller plant in Mississippi of 25,500 Tons using Trane chillers-each using 1.3 MW. Operate a 3,500 cfm compressed air system.
- Each cooling tower supports two chillers. Optimized towers with projects on cooling tower fans, using cooling tower water directly (bypassing chillers) in winter, optimize water temperatures going to chillers
- For chillers, the key performance metric is kW/ton. Installed chiller automation system –significantly reducing kW/ton metric while monitoring and assuring delivery of required water temperatures to process (45.9 F) and HVAC (45.6 F).
- Primary and secondary pump optimization. Successful projects to eliminate use of primary pumps and to stagger start-times of secondary pumps.

Trane was a Diamond Sponsor and Smardt chillers had their usual impressive booth at the show. These firms really "get it" and have deployed a vast array of chillers and other chiller automation technologies to optimize systems. These are still early days in getting cooling towers, chillers, and pumps to work together as one system! BP

The 2018 WEEC will be held at the Charlotte Convention Center, October 17-19, in Charlotte, North Carolina. For more information on the 2018 WEEC, visit www.energycongress.com

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Neos VSD Now Available on Atlas Copco Oil-Free ZR/ZT Compressors

Atlas Copco, a leading provider of sustainable productivity solutions, has expanded its Neos Variable Speed Drive (VSD) technology to include the water- and air-cooled ZR/ZT 75-90 VSD range of oil-free compressors, guaranteeing maximum uptime and productivity.

"The technology was designed in-house and first integrated on the GA series oil-injected screw compressors five years ago. It has demonstrated time-proven reliability in the harshest environments, and we're excited to offer it on the ZR/ZT 75-90 oil-free line of our equipment," said Neil Breedlove, Atlas Copco Compressors LLC's vice president of oil-free compressors. "The in-house design uses few components and is a compact, simple, user-friendly drive, designed specifically to handle the unique torque requirements of the Atlas Copco screw compressor."

The Neos inverter allows for a wider working range in two pressure variants of 8.6 bar and 10.4 bar.

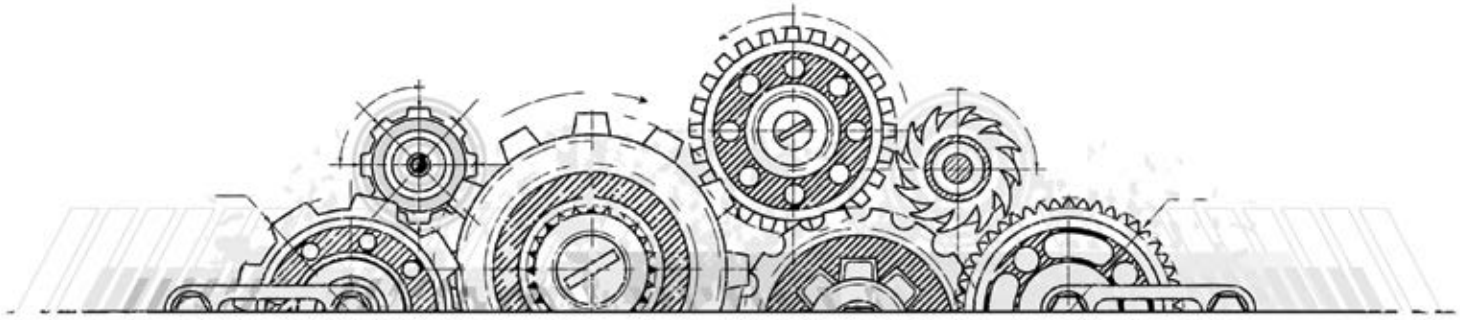
The Neos inverter was created to provide everything a VSD compressor needs, without the unnecessary features. Designed in-house by Atlas Copco, Neos inverters are specifically adapted for Atlas Copco compressors in terms of size, simplicity and reliability. When added to the ZR/ZT 75-90 VSD range, the Neos inverter allows for a wider working range in two pressure variants of 8.6 bar and 10.4 bar. The in-house design guarantees the availability of spare parts and replacements, as well as allows for improved control over the lifecycle of the application.

The Neos inverter has endured extensive testing, guaranteeing high protection and optimized cooling. Its compact, robust aluminum enclosure with IP 5X rating keeps dust away from sensitive electronics for trouble-free operation, even in harsh industrial conditions.

Long-term sustainability was an important factor in creating this technology. With fewer components, the Neos inverter has less of an impact on the environment at the end of its lifecycle. The Neos inverter is a reliable and sustainable solution for both the oil-injected GA VSD screw compressors and the ZR/ZT 75-90 VSD range.

About Atlas Copco

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



TECHNOLOGY PICKS

countries. In 2016, Atlas Copco had revenues of BSEK 101 (BEUR 11) and about 45,000 employees. For more information, visit www.atlascopco.com.

About Atlas Copco's Compressor Technique

Atlas Copco's Compressor Technique business area provides industrial compressors, vacuum solutions, gas and process compressors and expanders, air and gas treatment equipment and air management systems. The business area has a global service network and innovates for sustainable productivity in the manufacturing, oil and gas, and process industries. Principal product development and manufacturing units are located in Belgium, the United States, China, South Korea, Germany, Italy and the United Kingdom.

New Kaeser Smartpipe+ Now Available

Kaeser Compressors is pleased to announce SmartPipe+™ is now available. SmartPipe+ is a versatile, modular aluminum piping system featuring lightweight materials and simple, compression style connections. Available in multiple sizes from 3/4" to 2-1/2", SmartPipe+ is ideal for headers and branch lines all the way down to the point of use.

SmartPipe+ is made from smooth, calibrated aluminum and will not rust. It has a low coefficient of friction, and provides the best possible laminar flow. The full-bore fittings minimize pressure drop, while the leak-free connectors prevent costly compressed air loss. SmartPipe+ can easily be integrated into existing steel, copper, or aluminum systems, and can easily be modified to accommodate changing needs. SmartPipe+ also comes with a 10-year warranty.

SmartPipe+ is available in sizes from ¾" to 2-1/2".

About Kaeser

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

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

BOGE Invests in Industry 4.0 Communication Protocols

BOGE Compressors has made it a development task to pave the way for the fourth industrial revolution in compressed air technology. In the Smart Factory of the future, compressed air technologies automatically communicate with connected peripheral equipment. The foundation for this is laid down in the self-describing communication protocol OPC Unified Architectures. In cooperation with users, the Bielefeld family company is developing standards for intelligent component networking. The goal is to ensure the system adapts itself to the requirements, and operates with maximum energy efficiency. New components should also simply be able to integrate into the system by "Plug-and-Pressure."

"The intelligent networking of compressed air generators and consumers of compressed air opens up a wide range of opportunities to monitor, control and optimize the entire system topology," says Peter Boldt, BOGE's head of development. As one of the first manufacturers of compressed air solutions, BOGE is working on an integrated networking approach, taking the process technologies connected to compressed air into consideration.

In the Smart Factory of the future, compressed air technologies automatically communicate with connected peripheral equipment.

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"The communication protocol from OPC Unified Architectures (OPC UA) is, as an open standard interface for Industry 4.0 applications, one of the most promising solutions in Europe," says Boldt. In contrast to the usual market and manufacturer-specific bus protocols, OPC UA offers the possibility of establishing a vendor-neutral standard. The plant technology automatically undertakes the technical configuration to adjust the defined parameters to the demand-oriented design for the production of compressed air. An easy commissioning of complex compressed air systems and flexible reconfiguration are benefits of the Smart Factory. This is opening up new potential for users and plant designers to save energy.

BOGE has laid the technological foundation for intelligent system networking with the top cluster, "it's OWL," of the German Federal Ministry of Education and Research (BMBF). Since 2016, BOGE developers, together with manufacturers and users of consumables, have been working on the development of a future-oriented networking standard.

About BOGE Compressors

BOGE America is the USA based America's subsidiary of BOGE KOMPRESSOREN Otto Boge GmbH & Co. KG based in Bielefeld, Germany. Whether for centrifugal compressors, screw compressors, high-pressure piston compressors, scroll compressors, controls, air treatment equipment, complete systems or individual devices, BOGE meets the most diverse requirements and highest standards – in a precise and customer oriented manner. BOGE solutions are used by all sectors of industry to supply compressed air for a wide range of manufacturing processes. The USA Operations of BOGE America stocks the various technologies of high-quality compressors and spares for immediate support to needs. Compressed air systems are designed, sold and serviced through a dedicated network of over 50 distributors in North, Central, and South America. The USA Operations is also the "Center of Excellence" for Technical Trainings for our partners to ensure Top Level Support for the consumer. For more information, visit www.boge.com.

New Clean Line Pneumatic ISO Cylinder from Aventics

The new CCL-IC series of compact pneumatic ISO cylinders are the first choice when it comes to limited installation space combined with increased hygiene requirements. Their hygienic design makes them ideal for applications in food and beverage.

The CCL-IC ISO cylinder bore sizes range from 16mm to 100mm.

With nine bore sizes, the CCL-IC series of compact pneumatic ISO cylinder covers the broadest range available on the market for a hygienically designed cylinder. The bore sizes range from 16mm to 100mm, with maximum strokes to 500mm, recorded by an especially sensitive proximity sensor from the ST6 family. The sensor rail is located on the outside at an offset of 90°, relative to the air connections to ensure optimum end position sensing even for short strokes.

The CCL-IC is easy to clean thanks to smooth surfaces, plus lightweight and compact to ISO 21287 standards. The universal mounting concept allows easy installation without additional mounting accessories. The weight-optimized profile tube, head and cap are made of anodized aluminium, with screws and a piston rod made of stainless steel. The scraper material and the lubricants are approved for food industry usage. Hygienic protective caps are supplied for unused mounting holes.

Numerous versions are available for flexibility of use: single and double acting, single or double rod end, and internally or externally thread rod versions. A comprehensive range of accessories complete the installation, and complements many other hygienic Aventics components, such as valves, air preparation and fittings.

About Aventics

Aventics is one of the world's leading manufacturers of pneumatic components, systems, and customer-specific applications. The pneumatic engineering company provides products and services for industrial automation, additionally focusing on the sectors of commercial vehicles, food and beverage, railway technology, life sciences, energy, and marine technology. By integrating electronics, the use of innovative materials and prioritizing trends such as machine safety and the Internet of Things, Aventics is a pioneer in intelligent and easy-to-use solutions.

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

With over 150 years of expertise in pneumatics, Aventics employs around 2,000 associates worldwide. In addition to production sites in Germany (Laatzen), France (Bonneville), Hungary (Eger), USA (Lexington), and China (Changzhou), Aventics is represented in more than 90 countries through direct sales and dealers. The Aventics Group has received multiple certifications, including ISO 9001 and ISO/TS 16949 for quality, ISO 50001 for energy management, and ISO 14001 for environmental management. Further information is available at www.aventics.com/us.

Air Atomizer from Martech

Cleaning, drying, and heating the atomizing air from your existing compressed air source can be accomplished with *The Solution* by Martech Services Company.

According to Tom Wright, Martech Service Company's director of sales and marketing, when placed near the point of use, *The Solution* will work with the existing compressed air source. The four-stage filtration is outfitted with an automatic moisture discharger. Then the clean air is further filtered to remove moisture content for super dry air. A controller, with digital outputs, allows users to set the temperature of the atomizing air up to 165 °F. *The Solution* is shipped complete with a 3/8" ID x 35-foot spray air hose.

"With the advent of waterborne paints becoming mandated by government agencies, the need for this type and quality of atomizing air is crucial," says Wright.

The Solution is a complete compressed air system designed to clean, dry, and heat the atomizing air for today's spray paint requirements.

COMPRESSED AIR BEST PRACTICES®
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TECHNOLOGY PICKS

The Solution is a complete compressed air system designed to clean, dry, and heat the atomizing air for today's spray paint requirements. It is easy to use, simple to install, and affordable to maintain. *The Solution* is the result of years of experience and testing to bring *The Solution* to today's needs for atomizing air, working well with both waterborne and solvent based paint systems.

For more information on The Solution contact Martech Services Company by calling 1-800-831-1525 or visit www.breathingsystems.com

DENT Instruments Launch PowerScout Multi-Circuit Power Submeters

DENT Instruments, a global leader in the design and manufacture of power and energy measurement instruments, announced the introduction of two all-new multi-circuit power submeters: PowerScout 12 HD & PowerScout 48 HD. These two new models, replacing all models of the PowerScout 24, monitor voltage, current, power, energy, and many other electrical parameters on multiple single and/or three-phase systems.

The PowerScout 12 HD and PowerScout 48 HD are equipped with several key features including a USB port for quick setup, and an optional local display for diagnostics and reading real-time values.

The PowerScout 48 HD has two independent voltage inputs, allowing the meter to be used on two 90V-600V services simultaneously.

In addition to Modbus and BACnet communications, standard Serial RS-485 and Ethernet communications are now available in the same unit. Easily toggle between communication methods, protocols, and other parameters in the field using the USB port and ViewPoint HD software. Both meters meet ANSI C-12.20-2010 Class 0.2 revenue grade standards for accuracy.

Unique to the PowerScout 48 HD are two independent

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TECHNOLOGY PICKS

voltage inputs, allowing the meter to be used on two 90V-600V (phase-to-phase) services simultaneously. The PowerScout 48 HD is also available on a new mounting plate to help facilitate easy, safe installation.

As part of the new meter launch, ViewPoint HD software has also been completely redesigned with a fresh, new look and streamlined functionality.

Christopher Dent, DENT Instruments' president said, "The PowerScout 12 HD and PowerScout 48 HD meters are our most flexible, powerful submeters yet. Instead of having one specific meter for a job, these next generation PowerScout meters can adapt to nearly any project requirement. They allow you to mix-and-match a full range of split core or RōCoil (Rogowski) current transformers on 12 or 48 circuit installations. All PowerScout meters are line-powered and can be used on a wide range of voltage services from 90-600VAC."

The PowerScout Series networked power meters are designed to provide timely and accurate consumption data to gain the upper hand on electrical costs in today's escalating energy market. PowerScout meters can capture kWh/kW energy and demand data, as well as virtually all relevant energy parameters for diagnostics and monitoring on three-phase or single-phase circuit installations. The PowerScout's flexibility, size, and ease-of-use make them ideal tools for gathering detailed consumption data in commercial, industrial, government, and retail environments.

About DENT Instruments

DENT Instruments is a leading supplier of an array of precision measurement instrumentation and analytical software in the field of energy management. For more information, visit www.dentinstruments.com.

E+E Elektronik Expands Application Range for EE741 Flow Meter

The thermal flow meter EE741 measures the consumption of compressed air and technical gases. It consists of the transmitter unit and a stainless steel or aluminum gauge mounting block. Up to now the transmitter could be combined with mounting blocks for DN15 (1/2"), DN20 (3/4") and DN25 (1") piping. With the additional gauge mounting blocks, the EE741 can now be also employed in DN32 (1 1/4"), DN40 (1 1/2") and DN50 (2") piping.

Easy Installation and Removal

EE741 now also available for DN32, DN40 and DN50.

The modular design enables precise and reproducible positioning of the transmitter in pipe networks with operating pressure up to 16 bar (232 psi). Once the gauge mounting block is built into the pipeline, the transmitter can be easily installed and removed without disassembling the pipework. This is particularly useful for periodical calibration. The robust stainless-steel sensing head protects the sensing element against mechanical damage during installation or removal.

Highly Accurate Thermal Measuring Principle

The thermal hot-film anemometer principle is largely insensitive to contamination and eliminates the need for additional pressure or temperature compensation. Outstanding measuring accuracy, even in the lower measuring range, is achieved by the application-specific multi-point factory adjustment at 7 bar (102 psi). This allows precise leak detection and the consequent energy savings.

Further Features and Options:

- LC display for comfortable operation
- Configuration via display or USB service interface
- Integrated consumption meter
- Analogue, pulse and switch output
- Modbus RTU and M-Bus interface

For more information, visit www.epluse.com.

THE MARKETPLACE

JOBS

ENERGAIR

REGIONAL SALES MANAGER - EAST

ENERGAIR, a world leader in supplying auditing equipment, and energy efficient master controls and monitoring systems to the compressed air industry, is looking for a Regional Sales Manager for the territory **EAST of the Mississippi river.** The successful candidate will be responsible for achieving regional sales goals through business development with new and existing distributor partners.

The Regional Sales Manager may reside anywhere within the territory and will be expected to travel extensively when not working from his or her home office. Experience in the compressed air industry is preferred.

Interested? Please send your resume with cover letter to nicolas.dedeken@energair.com

COMPRESSED AIR POWER INC. Since 1984
COMPRESSED AIR EQUIPMENT · SALES/SERVICE/RENTALS

SALES DIRECTOR

Compressed Air Power (CAP) is an Air Compressor Distributorship with offices in both Phoenix and Tucson, Arizona. We have a well established industrial customer base in both locations. Founded in 1984, CAP has always been locally owned and operated. We are currently looking for a Sales Director to build our sales team. Benefits include Health Insurance, a company sponsored Health Savings Account and IRA. Salary, commissions and relocation are negotiable for the right person. Check the Phoenix weather in case you enjoy being outdoors.

Sounds interesting? Please send your resume and cover letter to: Tom@capower.com

WEST COAST DISTRIBUTION AREA MANAGER

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

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

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

COMPRESSED AIR EQUIPMENT

SALES REPRESENTATIVE

Compressed Air Equipment Inc., an industrial air compressor sales and service facility in South Jersey, has an immediate opportunity for a full time motivated Sales Representative in the Philadelphia/ South Jersey area market. The qualified candidate would be expected to maintain existing accounts, as well as build and develop new business to reach specific sales goals. Experience in the compressed air industry is required. Applicants must also have proficient computer skills. Qualified applicants should submit resumes to: adam@compressedairequip.com

TECHNOLOGY

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TECHNOLOGY

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BUILT BETTER

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Success Story

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Sweet Savings!

A compressed air audit opens a world of savings opportunities

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

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

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

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

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

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

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