The Magazine for ENERGY EFFICIENCY in Compressed Air Systems

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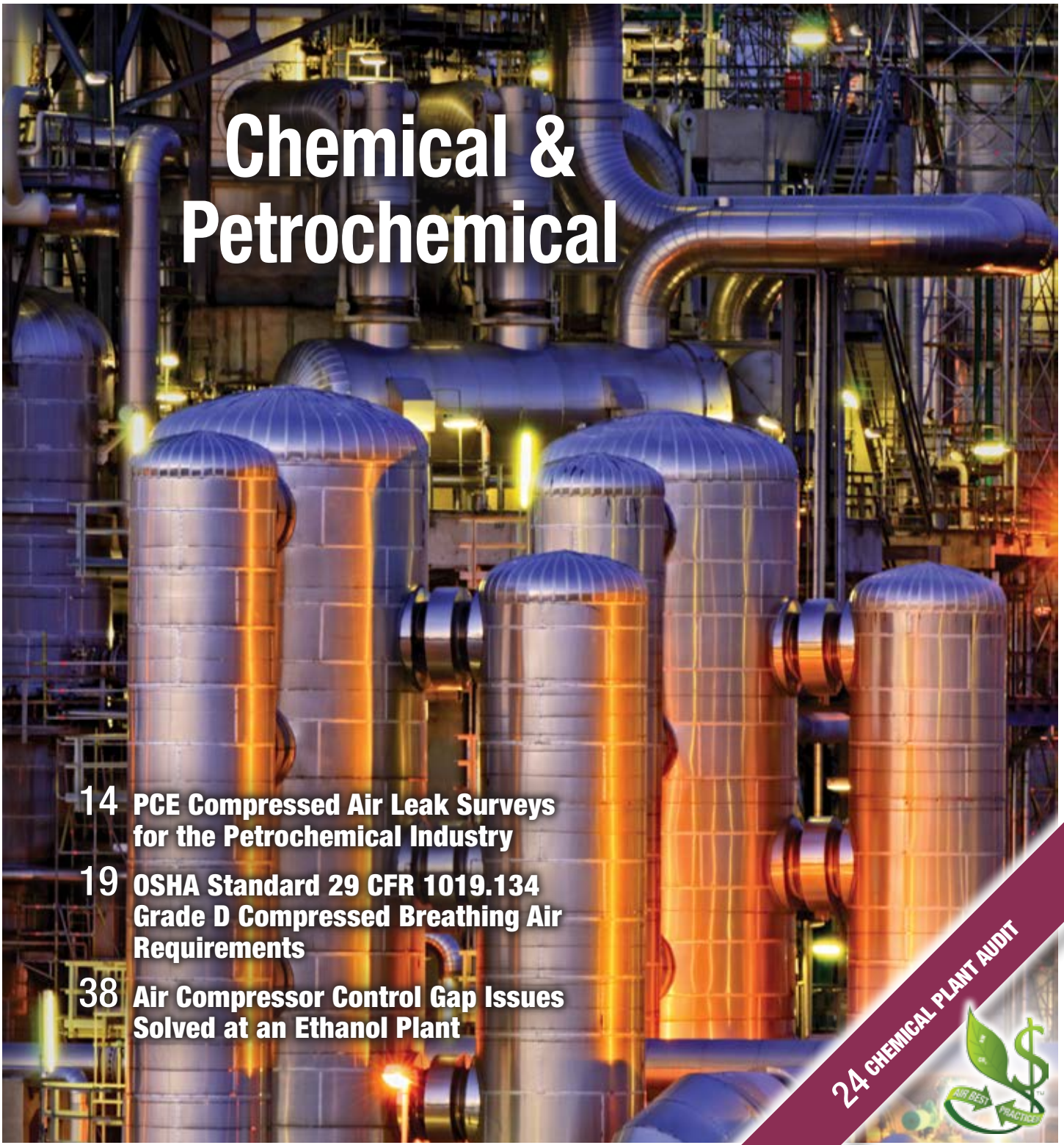

Chemical & Petrochemical

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FROM THE EDITOR | Chemical and Petrochemical Plants

Petro Chemical Energy, Inc. has been providing energy loss surveys to the refining and chemical industries for twenty-five years. They focus on compressed air leak, nitrogen leak, steam leak and steam trap surveys. I think our readers will enjoy hearing from Vice President, James Nipper, and learning what he considers to be "Leak Survey Best Practices" for this market segment.

There are many compressed breathing air applications in chemical plants. Nancy Aulisa, from ENMET, provides an excellent summary of OSHA Standard 29 CFR 1910.134(i)(1) and it's requirement for Grade D breathing air. She also reviews how to comply with the standard covering items like air compressor location selection, common compressed air contaminants (including carbon monoxide), Grade D compressed air filtration systems and carbon monoxide monitoring.

Chemical plants are large complexes with long histories. Don van Ormer, from Air Power USA, provides an audit story of a plant, built in the 1940s and modernized in the 1970s. It has eighteen stationary air compressors, supported by a fleet of rental air compressors, providing compressed air to seven different sections of the complex. His article shows the beginning of their audit where they work to discover the system baseline.

Engineering firms will find Tim Dugan's latest article on commissioning (Part 3) quite useful. His article covers project planning, specification and CX planning, and recommended testing of air compressors and controls before and after the equipment is shipped to the customer.

Last but certainly not least, Ron Marshall provides us with an article about an ethanol plant producing 130 million liters of ethanol per year. The plant power house contains three air-cooled rotary screw air compressors (two are VSDs) and a heated blower style desiccant dryer. His article speaks to air compressor control gap issues they encountered and overcame.

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

ROD SMITH, *Editor*
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INDUSTRY NEWS

Cisco Air Systems Named 2016 Ingersoll Rand Distributor of the Year

Ingersoll Rand Master Distributor, Cisco Air Systems, has won the 2016 Ingersoll Rand Distributor of the Year award for North America. Cisco Air Systems is located in Sacramento, CA. Their primary territory is Northern California & Nevada. This is the 4th time Cisco Air Systems has won the Ingersoll Rand Distributor of the Year award since 2004; 2004, 2008, 2012 & 2016.

Cisco Air Systems President and CEO, Kent Frkovich, said, "The success of Cisco Air Systems over the years is because our employees always strive to provide the best customer service and support. Our customers appreciate the great support. Our customers want to do business with us because of our employees."

Todd Barrett, Brian Kellogg, Kent Frkovich and Keith Berens (left to right) from Cisco Air Systems receive the 2016 Ingersoll Rand Distributor of the Year Award.

Cisco Air Systems has been providing industrial air compressor sales and support since 1973. The company provides sales, service, parts, rentals, turn-key installations, and air/energy audits for the industrial air compressor industry. The company also provides industrial nitrogen generators, fluid pumps, and vacuum pumps.

For more information about Cisco Air Systems please visit www.ciscoair.com

Total Equipment Company Nominated 2017 Northeast Oil and Gas Awards Finalist

Total Equipment Company, a top regional sales and service provider of industrial pumps and air compressors, sitting in the heart of the Marcellus and Utica shale, announced their

nomination as a 2017 Northeast Oil and Gas Awards Finalist.

Total Equipment Company has supplied almost all of the critical process pumps for a joint venture between Antero and Veolia to design, construct, and operate a 60k bbl/day wastewater treatment complex in Doddridge County, West Virginia. The strategy is going to have a tremendously positive impact on the surrounding community by reducing road traffic, noise, wear and tear on the roads, road safety, and drilling/completion costs - resulting in the overall improvement of the quality of life in many of the surrounding neighborhoods.

As a result of the rapid growth of the company, Total Equipment Company has also been able to invest back into the community through two large expansions of their facilities resulting in an increase in their workforce, along with making an investment into the "Coraopolis Train Station Project." The goal of the project is to restore and preserve a National Historic Landmark positioned along the Ohio River Greenway Trail.

Pat Manning, Jason Onyshko, Chuck Gerbe and Eric Solverson, from the Total Equipment Company, receive the Industry Supplier of the Year Award at the Northeast Oil and Gas Awards.

"Total Equipment is excited to be nominated, for the fourth time, as "Industry Supplier of the Year," said Chuck Gerbe, Vice President of Total Equipment Company. "Our success can be attributed to the commitment of all our employees to adapt to the needs of the Oil & Gas market. We appreciate the recognition given for our efforts."

About Total Equipment Company

For 30 years, Total Equipment Company has distributed and serviced fluid and air-handling products for industries in Pennsylvania, West Virginia, and beyond. Total Equipment Company is located at 400 Fifth Ave., Coraopolis, PA. To learn more about their products and services, visit the Total Equipment Company site at www.totalequipment.com or call (412) 269-0999.

INDUSTRY NEWS

First ENERGY STAR Commercial Bakeries Announced by EPA

The U.S. Environmental Protection Agency is pleased to announce the first commercial bread and roll bakeries to earn ENERGY STAR certification for being the most energy-efficient in the United States. Eighteen bakeries from five different companies have earned ENERGY STAR certification offered for the first time to large bread and roll bakeries. The first ENERGY STAR bakeries are:

Automatic Rolls of Baltimore, Baltimore, MD

Bama Frozen Dough, Tulsa, OK

Bama Pie, Tulsa, OK

Bimbo Bakeries Oconomowoc, Milwaukee, WI

Bimbo Bakeries Escondido, San Diego, CA

Bimbo Bakeries Gastonia, Charlotte, NC

Bimbo Bakeries Olean, Olean, NY

Bimbo Bakeries Phoenix, Phoenix, AZ

Bimbo Bakeries Reading, Reading, PA

Bimbo Bakeries San Luis Obispo, San Luis Obispo, CA

Flowers Baton Rouge, Baton Rouge, LA

Flowers El Paso, El Paso, TX

Flowers Lynchburg, Lynchburg, VA

Flowers New Orleans, New Orleans, LA

Flowers Modesto, Modesto, CA

Flowers Norfolk, Norfolk, VA

Flowers Tolleson, Tolleson, AZ

Klosterman Bakery, Morristown, IN

More efficient than average performing bread and roll plants, these bakeries prevented more than 35,294 metric tons (carbon dioxide equivalents) of greenhouse gas emissions and saved more than 686,000 MMBtus (source) in energy - equal to the average annual energy use of more than 3,800 households.

To earn ENERGY STAR certification, these bakeries demonstrated a top level of energy efficiency by scoring a 75 or higher on the **ENERGY STAR Energy Performance Indicator for Commercial Bread & Roll bakeries (EPI).** The EPI is a benchmarking tool that compares an individual bakery's energy performance to the rest of its industry. The EPI is based on industry data and uses sophisticated statistical methods to adjust for differences between plants, including production mix, location, and refrigeration. The EPI compares a plant's annual energy performance and provides a score on a scale of 1 to 100. Plants that score a 75 or higher are in the top quartile of performance and are determined to be the most efficient in their sector. The EPI was developed in partnership with baking companies, the American Baker's Association, and was released by EPA in June 2016.

Any bread and roll bakery that produces more than eight million pounds of raw dough a year is encouraged to benchmark their energy performance using the EPI to see if they qualify for ENERGY STAR certification. Bakers can also use the EPI as an energy management tool to evaluate a plant's thermal, electrical, and total energy usage and set energy goals. The EPI can be downloaded at www.energystar.gov/epis.

ENERGY STAR has released EPIs for multiple industrial plant types, including Cookie and Cracker Bakeries. In 2015, 70 industrial plants earned ENERGY STAR certification. The award must be earned annually, and a Professional Engineer must verify a plant's energy performance. Applications for ENERGY

STAR certification are welcomed at any time of the year.

FAQs

What is ENERGY STAR Certification?

ENERGY STAR certification designates a plant, building, home, or consumer product as being the most energy-efficient within its class. For building and plants, ENERGY STAR certification is awarded annually to existing facilities based on their annual energy use. Any facility or product that earns ENERGY STAR certification must have its energy performance verified before certification is awarded.

How is energy efficiency determined?

For industrial plants, energy efficiency is determined by using a benchmarking tool called an Energy Performance Indicator (EPI). EPIs use sophisticated statistical models derived from bakery industry-wide data to compare a bakery's energy performance to the rest of the industry. The EPI indexes a plant's performance on a scale of 1 to 100, and plants that score a 75 or higher are determined to be the most efficient.

How are EPIs developed?

EPIs are developed through a collaborative process with industry and researchers at Duke University called an ENERGY STAR Industrial Focus. EPIs are based on industry data collected by the US Census or provided by industry participants. Using this data, researchers at Duke University develop a statistical model that enables comparisons between plants. The EPI is tested and reviewed by industry experts and revised as needed. Once EPA and industry participants are satisfied that the EPI accurately benchmarks performance, the EPI is released for industry use and published on the ENERGY STAR web site at www.energystar.gov/epis.

What data was used to develop the Commercial Bread & Roll Bakery EPI?

The Commercial Bread & Roll Bakery EPI is based on industry data representing approximately 80% of total US baking production. Because this data is primarily from large bakeries, the EPI is useful for benchmarking bakeries that produce a minimum of 8 million pounds of raw dough annually.

INDUSTRY NEWS

Why does ENERGY STAR certify industrial plants?

Improving energy efficiency is good for business and the environment. Industrial facilities are the largest users of energy. Improving energy efficiency can help reduce air pollution and greenhouse gas emissions while saving companies money. To motivate companies and facilities to improve their efficiency, EPA offers recognition for best in class performance through ENERGY STAR certification.

Can bakeries that produce cookies use the Commercial Bread & Roll EPI?

ENERGY STAR has released a separate EPI for cookie & cracker bakeries since the baking process is not comparable to bread & roll bakeries on an energy performance basis. Cookie & cracker bakeries can also earn ENERGY STAR certification.

Does ENERGY STAR offer other resources for bakeries?

ENERGY STAR offers a number of resources that bakers can use to improve their energy performance. These include a guidebook on energy-efficient technologies and practices, energy program guidance, employee engagement resources, and a best practice-sharing network. More information can be found at www.energystar.gov/industry. *For more information on ENERGY STAR certification visit www.energystar.gov/plants.*

Festo North America Relocates Corporate Office

Festo, a leading manufacturer of pneumatic and electromechanical systems, components, and controls for process and industrial automation, will move its corporate office from 395 Moreland Road, Hauppauge, NY, to a newer state-of-the-art facility at 1377 Motor Parkway in Hauppauge.

The targeted move-in date is July/August 2017. The new office will be approximately 53,000 square feet in size and is in Suffolk County's "Golden Triangle" with easy access to the Long Island Expressway, Veterans Memorial Highway, and Motor Parkway. Festo North America has been headquartered on Long Island for more than 40 years.

New corporate offices for Festo North America in Long Island

This new location will serve as center of operations for the Festo North American executive management team, as well as marketing, finance, technology, human resources, and other corporate functions. All employees from the current Moreland Road location will relocate to its new location on Motor Parkway.

In 2016, Festo moved its distribution and assembly operations from Hauppauge to a new 230,000 square foot Regional Service Center in Mason, Ohio. The regional center serves customers in the United States, Canada, and Mexico and is comprised of logistics, production, purchasing, and engineering.

About Festo

Festo is a leading manufacturer of pneumatic and electromechanical systems, components, and controls for process and industrial automation. For more than 40 years, Festo Corporation has continuously elevated the state of manufacturing with innovations and optimized motion control solutions that deliver higher performing, more profitable automated manufacturing and processing equipment.

For more information, contact us at www.festo.us or by calling 800-993-3786.

INDUSTRY NEWS

Parker to Acquire Filtration Company CLARCOR

Parker Hannifin Corporation and CLARCOR Inc. announced that the companies have entered into a definitive agreement under which Parker will acquire CLARCOR for approximately $4.3 billion in cash, including the assumption of net debt.

Under the terms of the agreement, Parker will purchase all of the outstanding shares of CLARCOR for $83.00 per share in cash. This represents a premium of approximately 17.8 percent to CLARCOR's closing share price on November 30, 2016 and a premium of approximately 29.2 percent to CLARCOR's volume weighted average share price over 90 days and a premium of approximately 17.1 percent to CLARCOR's all-time and 52-week high. The Board of Directors of each company has unanimously approved the transaction.

CLARCOR, headquartered in Franklin, TN, is a diversified marketer and manufacturer of mobile, industrial and environmental filtration products with annual sales of approximately $1.4 billion and 6,000 employees worldwide. CLARCOR adds a broad array of industrial air and liquid filtration products and technologies to Parker's filtration portfolio.

"This strategic transaction is consistent with our stated objective to invest in businesses that accelerate Parker towards our goal of top quartile financial performance," said Tom Williams, Chairman and Chief Executive Officer of Parker. "The combination of Parker and CLARCOR is highly complementary and offers a great opportunity to combine our strength in international markets and OEMs with CLARCOR's strong U.S. presence and high percentage of recurring sales in the aftermarket."

Williams added, "We also believe our cultures and values are an excellent match. CLARCOR, like Parker, prides itself on a long and successful history that reinforces entrepreneurialism and innovation. We're confident that the goals and measures outlined in the Win Strategy™ will guide a seamless integration and generate significant synergies. This transaction delivers immediate cash value to CLARCOR shareholders and is expected to create sustained value for Parker shareholders. Together, Parker and CLARCOR will advance our commitment to engineer the success of our customers and team members and enhance shareholder value."

"Joining Parker provides a terrific opportunity to accelerate our mission of making our world cleaner and safer while delivering an immediate and substantial cash premium to our shareholders and bolstering the confidence of our customers," said Chris Conway, Chairman, President and Chief Executive Officer of CLARCOR. "We believe Parker is an ideal fit for CLARCOR as it shares both our culture and our passion for developing solutions to our customers' complex filtration challenges. Becoming part of Parker, with its significant systems expertise and stellar reputation for quality and innovation, should only enhance and accelerate our strategic initiatives and technology development efforts, expand our growth plans and provide new opportunities for many of our employees. We are looking forward to working together with the Parker team to ensure a smooth combination of our businesses and operations and bring these goals to fruition."

Compelling Financial and Strategic Benefits

- **Significant Operating Synergies:** Parker expects to realize annual run rate cost synergies of approximately $140 million three years after closing through a variety of initiatives, including the consolidation of the companies' supply chains and a successful implementation of Parker's Win Strategy™ throughout CLARCOR's operations.
- **Accretive to Parker's Cash Flow, EPS and EBITDA Margin:** The transaction is expected to be accretive to Parker's Cash Flow, EPS and EBITDA margins, after adjusting for one-time costs.
- **Significantly Enhances Parker's Filtration Group:** The combination of the companies' complementary filtration offerings strengthens Parker's position in a growing and resilient business.
- **Strong Recurring Revenue Opportunities:** Parker expects to benefit from increased recurring revenue streams as approximately 80 percent of CLARCOR's revenue is generated through aftermarket sales. The addition of CLARCOR is expected to significantly increase recurring revenue in Parker's Filtration Group.
- **Enhances Parker's Product Portfolio with Leading Brands:** With the addition of CLARCOR's leading and respected brands, including CLARCOR, Baldwin, Fuel Manager®, PECOFacet, Airguard, Altair, BHA®, Clearcurrent®, Clark Filter, Hastings, United Air Specialists, Keddeg and Purolator, Parker expects to be better positioned to deliver enhanced and expanded filtration solutions to its customers. In addition, this transaction strengthens Parker's systems capabilities and enhances the rest of Parker's technologies, enabling the company to provide even better motion and control systems solutions to customers.
- **Complementary Products, Markets and Geographic Presence:** Parker expects to be able to leverage both companies' complementary filtration technologies to further accelerate growth.

Organization and Leadership

Upon closing of the transaction, CLARCOR will be combined with Parker's Filtration Group to form a leading and diverse global filtration business. Williams added, "We look forward to working collaboratively with CLARCOR team members to jointly build on CLARCOR's great history. CLARCOR is a premier filtration company due to strong leadership, a great culture that is highly complementary to Parker's, and an impressive breadth of products and technologies with talented team members contributing daily to its success."

About Parker Hannifin

With annual sales of $11 billion in fiscal year 2016, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of mobile, industrial and aerospace markets. The company has operations in 50 countries around the world. Parker has increased its annual dividends paid to shareholders for 60 consecutive fiscal years, among the top five longest-running dividend-increase records in the S&P 500 index.

About CLARCOR

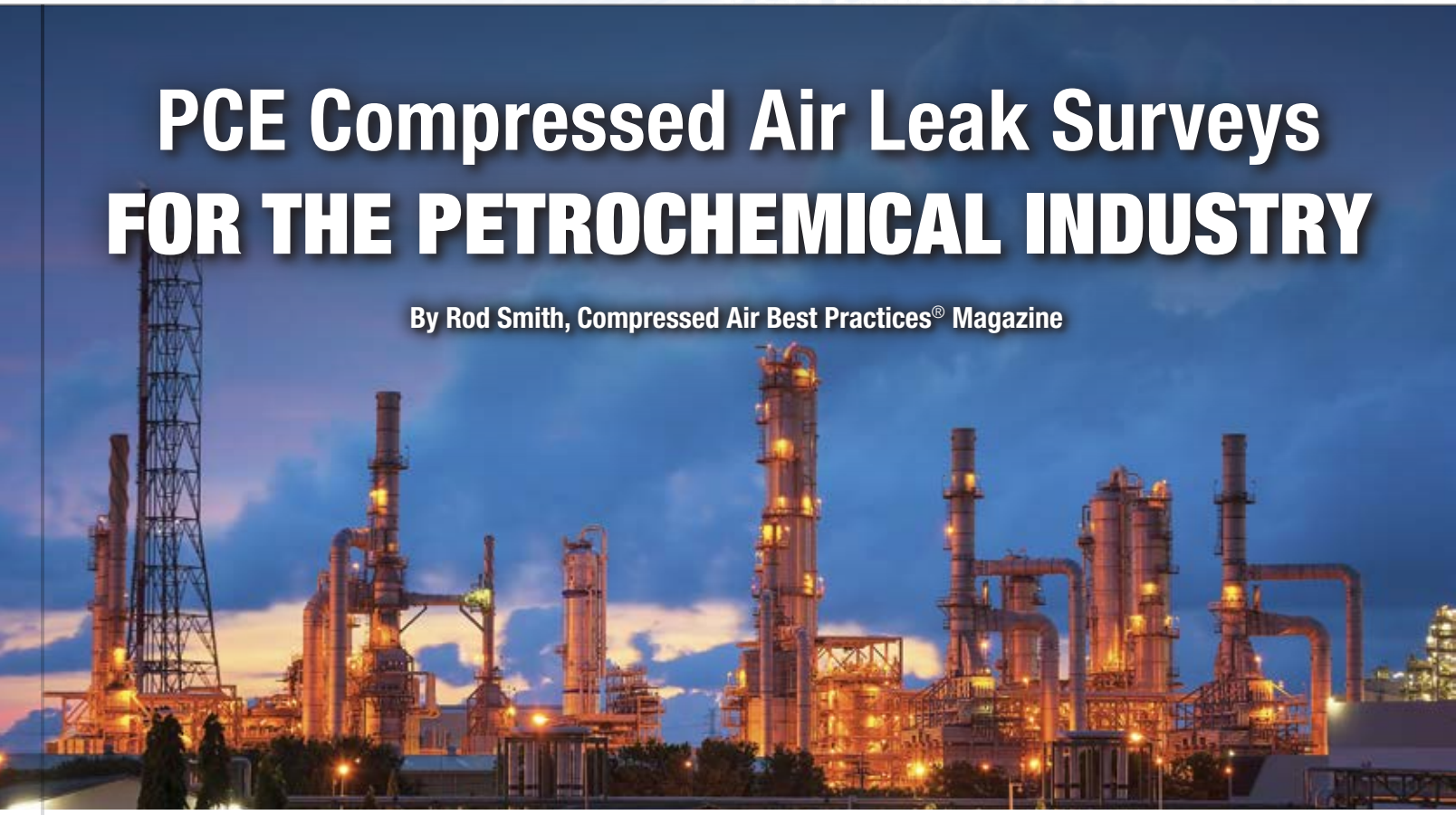
CLARCOR is based in Franklin, Tennessee and is a diversified marketer and manufacturer of mobile, industrial and environmental filtration products sold in domestic and international markets. Common shares of CLARCOR are traded on the New York Stock Exchange under the symbol CLC.

For more information about Parker Hannifin, visit www.parker.com.

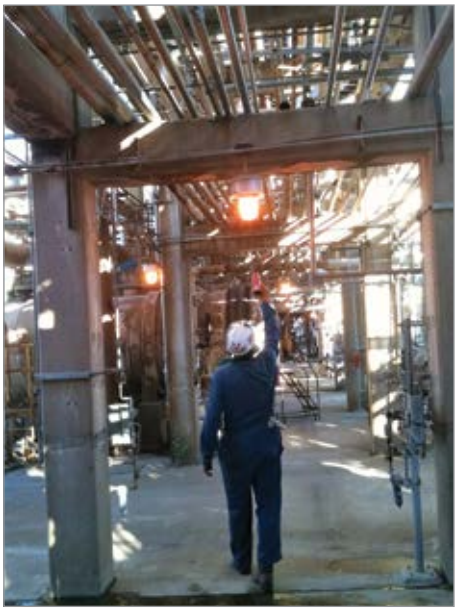
For more information on CLARCOR, visit www.clarcor.com.

PCE Compressed Air Leak Surveys FOR THE PETROCHEMICAL INDUSTRY

By Rod Smith, Compressed Air Best Practices® Magazine



➤ Compressed Air Best Practices® Magazine interviewed Mr. James Nipper, Vice President, of Petro Chemical Energy, Inc.



Compressed air leak surveys in the petrochemical industry differ from surveys in "quiet" manufacturing or commercial industries.

CABP: Good morning, can your briefly describe Petro Chemical Energy, Inc.?

Good morning. Petro Chemical Energy, Inc. (PCE) specializes in energy loss surveys for the refining and chemical industries. We've been providing Compressed Air Leak Surveys, Nitrogen Leak Surveys, Steam Leak Surveys and Steam Trap Surveys – for over twenty five (25) years. We operate totally independent of all equipment manufacturers to ensure our clients receive a complete and unbiased report of the leaks in their facility. PCE has conducted compressed air leak surveys for hundreds of customers at thousands of sites. Undetected, compressed air and gas leaks rob efficiency in manufacturing and processing industries. As a result, businesses lose millions of dollars annually in energy costs and lost production time.

If you don't know what you are looking for (or what to listen for) - you can miss leaks and get hurt in the process.

CABP: While you also serve manufacturing plants, PCE's specialty is the petrochemical industry-correct?

Absolutely. Petro Chemical Energy is the preferred vendor for Exxon, BASF, Dow and many others- when it comes to compressed air and gas leak surveys. In this article, we will discuss some of our case studies along with our experience in conducting air leak surveys in the petrochemical industry.

PCE measures leak loss by orifice size, plume length, and line pressure. We can find leaks in areas that would be unnoticed and undetected by the human ear.

Compressed air leak surveys in the petrochemical industry differ from air leak surveys in "quiet" manufacturing or commercial industries. There are always loud noises, along with many safety items, that our technicians in the field must deal with every day. You may have multiple steam leaks around a compressed air leak that you have to deal with. If you don't know what you are looking for (or what to listen for) - you can miss leaks and get hurt in the process.

CABP: Where do you find the majority of compressed air leaks in a petrochemical facility?

The majority of all compressed air leaks, in a petrochemical facility, are located in the process areas in the units where all the action is going on. There are also leaks in pipe racks between the units, just not as many. Most of the time the leaks are located at the packings, valves, holes in pipes, unions, regulators, valves left open and air traps blowing through or bypassed.

PCE measures leak loss by orifice size, plume length, and line pressure. We can find leaks in areas that would be unnoticed and undetected by the human ear. We tag the leaks, document the location and size of each one in a spreadsheet, give an estimate of annual CFM and dollar loss, and provide our recommendations for repair and improvements.

The challenges of working in the petrochemical industry are getting the leaks fixed. It can be a

PCE COMPRESSED AIR LEAK SURVEYS FOR THE PETROCHEMICAL INDUSTRY

challenge to find an operator able to go around with us the whole time we are in the plant - fixing the leaks they can while we are there. Another big problem is that energy leaks at plants change on a yearly basis, sometimes even quicker. That's why it's good to keep in contact with the corporate energy contacts to find out who the new plant contacts are.

CABP: What kind of leak detection equipment does PCE use?

Our highly trained and professional staff utilizes state-of-the-art ultrasonic leak detection equipment to find compressed air and gas leaks, steam leaks and faulty steam traps. Leaks are caused by dozens, perhaps hundreds, of hard to pinpoint outflows which can be produced by vibrations and a corrosive atmosphere.

A Best Practice is to have an operator or local contractor (like a pipefitter) go around with us and repair the leaks during the survey. We have found they can fix, an average of 30% of the leaks we identify!

Another advantage of having a plant wide ultrasonic air leak survey conducted is that when covering the plant, the ultrasonics pick up all compressed gases. We find the leak and then identify what the leak is. Most of the time it is compressed air but we also find nitrogen, hydrogen, natural gas and any other gas that is compressed in the plant. Finding the hydrocarbon leaks helps the environment and helps from a safety aspect also.

CABP: What are some "Best Practices" for compressed air leak surveys you recommend?

Some of the Best Practices we recommend are to make sure plants do leak surveys on an annual (or better bi-annual) basis. If you only do the survey once every four years you are going to have the same, if not more, leaks on each survey. What you want to do is see your leaks trend down each year, keeping them to a minimum. You are always going to have leaks. You just want the lowest number of leaks possible at your plant.

Another Best Practice is to have your employee or local contractor (like a pipefitter or operator) go around with us and repair the leaks during the survey. We have found they can fix, right on the spot, an average of 30% of the leaks we identify! This pays for the survey and the pipefitter before we even finish the survey - saving the customer money and compressed air immediately. This creates the fastest pay back of any energy project out there.

PCE identified 1,726 leaks resulting in the plant losing 13,424 CFM of compressed air to leakage.

CABP: Can you provide us some examples of the results of your leak surveys?

Sure-we have quite a few! PCE performed a plant-wide compressed air & gas leak survey for a refinery in Houston, Texas. We

"Some of the Best Practices we recommend are to make sure plants do leak surveys on an annual (or better bi-annual) basis. If you only do the survey once every four years you are going to have the same, if not more, leaks on each survey."

— James Nipper, Vice President, Petro Chemical Energy Inc.

identified 1,726 leaks resulting in the plant losing 13,424 CFM of air to leakage. After the customer repaired about 70% of the leaks, they were able to shut down three 3000 CFM air compressors. This saved the customer millions of dollars annually.

PCE performed another compressed air leak survey for a petrochemical plant in Louisville, Kentucky. It was a small petrochemical plant that wanted to eliminate excess air usage. The customer was able to repair approximately 30% of the leaks we identified during the survey - resulting in a $15 to $1 payback before we left the plant. We recommended that the customer implement a yearly compressed air leak survey into its preventive maintenance program to keep their excess air usage down.

In June of 2016, we conducted another compressed air leak survey for a petrochemical plant in Texas. We identified 563 leaks leaking 2,416 CFM. We called the customer back in October and asked him how the repairs were going. He said they had fixed about 70% of what we had found and they were able to shut down a 1500 CFM air compressor! This saved the company over $400,000 annually. The customer stated they were putting our survey on a PM (preventive maintenance) program every year - not only because of the results but also because they don't want to get back in the shape they were in before our survey.

Here's one last example. We conducted a compressed air leak survey for a customer at a small Midwestern petrochemical facility. The customer stated their air pressure had been dropping and they needed more air to run the

PCE COMPRESSED AIR LEAK SURVEYS FOR THE PETROCHEMICAL INDUSTRY

plant. They were looking at buying another air compressor to help the pressure increase. Before they purchased the compressor, they had us out to do a survey. We found 152 leaks leaking 577 CFM of air. They fixed 88 leaks leaking 254 CFM during the survey. The customer informed us their air pressure increased by 20 PSI before we left the plant, saving them from buying a new compressor!

CABP: Does PCE have multi-site contracts with individual clients?

Yes. This is our bread and butter. Here's an example of work we've done at six (6) locations for a petrochemical corporate account. PCE performed multiple compressed air leak surveys at these different sites and has seen an average $50,000 NET per week in annual savings for the sites we have conducted surveys for - when all leaks that could be repaired were repaired during the surveys.

- In five weeks at the Location 1 site, we identified $625,907 worth of leaks of which $279,891 were associated with leaks that could easily be repaired.
- At Location 2, we performed a partial plant survey for five weeks and identified $777,189 worth of leaks with $224,891 easily repaired.
- At Location 3, we performed a partial plant survey and identified $119,196 worth of leaks in one week and the Company A employee fixed $50,791.

COMPANY A SITES

LOCATION	TOTAL LOSSES CFM	TOTAL SAVINGS
Location 4	728	$259,896
Location 2	2,177	$777,189
Location 1	3,277	$625,907
Location 3	516	$119,196
Location 5	989	$274,942
Location 6	2,128	$138,320

CABP: How do you structure the agreement?

PCE recommends that each Company A site conduct a plant-wide compressed air and gas leak survey annually and that they provide a Company A employee to repair the easily repairable leaks identified during the performance of the survey. Immediately repairing leaks such as valve packing, tubing fittings, open valves, unions, etc., make this a Best Practice in all Company A facilities.

During the survey, therefore, PCE will identify and document all compressed air and gas leaks and the Company A employee will repair any leaks that he/she can. On average, a petrochemical plant is losing 30% of the compressed air they produce and of that 30%, around 30% of the leaks can be repaired during the survey. This means you should be able to recoup an average of 10% of compressed air produced right away.

CABP: That's very impressive – and profitable for the petrochemicals.

You bet. As you can see from the case studies above it is best to try and fix as many leaks as you can during the survey. It can and will result in saving your plant money, energy and unwanted down time. When customers have fixed the leaks during the surveys we have never seen a survey that was not paid for before we left the site.

CABP: Thank you for your insights. BP

For more information contact: James Nipper, Vice President, Petro Chemical Energy, email: james@petrochemicalenergy.com, or visit www.petrochemicalenergy.com

To read similar articles on ***Compressed Air Leak Surveys*** visit www.airbestpractices.com/system-assessments/leaks

OSHA Standard 29 CFR 1019.134 Grade D Compressed Breathing Air Requirements

By Nancy Aulisa, , Marketing Communications Manager, ENMET

Compressed air, commonly called Industry's fourth utility, is the most common utility used in a typical industrial facility. Compressed air is used in more than 70 percent of all manufacturing activities including supplying breathing air to personnel using supplied air respirators. Hazardous breathing conditions exist in many routine industrial operations, such as chemical manufacturing, hospitals, abrasive blasting, paint spraying, industrial cleaning, and arc welding. In these and other operations that introduce contaminants into the workplace, supplied-air respirators, air filtration systems and carbon monoxide monitors are frequently used for worker protection.

OSHA Standard 29 CFR 1910.134(i)(1)

These "breathing air" systems are designed to meet Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.134(i)(1) which states: "Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:

- Oxygen content (v/v) of 19.5% - 23.5%;
- Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
- Carbon monoxide (CO) content of 10 parts per million (ppm) or less;
- Carbon dioxide (CO_2) content of 1,000 ppm or less; and
- Lack of noticeable odor"

"Compressed air is used in more than 70 percent of all manufacturing activities including supplying breathing air to personnel using supplied air respirators."

— Nancy Aulisa, Marketing Communications Manager, ENMET

OSHA STANDARD 29 CFR 1019.134 GRADE D COMPRESSED BREATHING AIR REQUIREMENTS

AFS-50 Air Filtration System with a CO-GUARD Carbon Monoxide monitor and alarm system in a steel enclosure.

Air Compressor Location Selection

Oil-lubricated air compressors are a common source of supplied breathing air. These compressors are placed in a wide range of ambient air conditions. Common contaminants in the ambient air of typical work areas may contain carbon monoxide, water vapor, oil and dirt. An important consideration, when providing safe compressed breathing air, is the location of the air compressor. OSHA 1910.134(i)(5) states, "the employer shall ensure that compressors used to supply breathing air to respirators are constructed and situated so as to prevent entry of contaminated air into the air-supply system."

The air compressors in a large industrial facility are often located in a dedicated room or separate building from where the actual supplied-air respirators are being used. It is important to locate the compressor away from hazardous areas where the air intake could be easily contaminated, such as in truck/vehicle loading areas where carbon monoxide is likely to accumulate or areas where chemicals and solvents are used or stored, or where heaters or combustion equipment are used.

Four Common Compressed Air Contaminants

There are four main types of compressed air contaminants of concern in a compressed breathing air system.

1. **Carbon Monoxide -** Carbon monoxide (CO) is a common toxic contaminant in compressed air. It enters the breathing air system through the air intake, or is produced by overheating of piston type air compressors. The air intake must be placed away from engine exhaust or other sources of carbon monoxide. CO poisoning can cause headache, shortness of breath, dizziness, nausea or vomiting, confusion and loss of consciousness.

2. **Water/Water Vapor -** Air contains moisture, which is drawn into the air compressor and enters the air stream as a vapor. As compressed air flows

An ENMET AFS-50 Air Filtration System

through the system, it cools, causing the vapor to condense in the facepiece or helmet. Moisture combines with oil and solid contaminants to form sludge, which can clog or damage system components. Water also causes rust in pipelines, and can freeze in cold weather to block air flow.

3. **Oil/Oil Mist -** Oil is a major contaminant in systems using lubricated air compressors. In reciprocating compressors, lubricating oil applied to cylinders causes small droplets by the shearing action of the piston to enter the air system as a mist. Oil mist can cause breathing discomfort, nausea, pneumonia, and create unpleasant taste and odors.

4. **Solids -** Solids generally enter the system through the air intake. However, some materials may be introduced by the air compressor itself. In non-lubricated compressors, teflon, carbon and other materials are used as lubricants. Frictional wear can cause particles from these materials to enter the air stream.

Grade D Compressed Air Filtration System

A compressed air filtration system that removes oil, water, solid particles and odors from supplied breathing air is an important component in supplying Grade D breathing air and ensuring the safety of personnel using compressed air. ENMET's AFS-50 air filtration system incorporates a unique three-stage filtration concept which utilizes a prefilter, high-efficiency coalescer filter and charcoal adsorber element. The compressed air passes through the prefilter/coalescer, a two-stage filtering device, which removes oil, water, and solid particles from the compressed air. The prefilter extends the life of the coalescer and adsorber filter elements. The coalescer is a high-efficiency filter that removes oil mist and fine (sub-micron) particles. Once the compressed air is filtered through the prefilter/coalescer it then passes through the adsorber filter which removes unpleasant odor and taste. The AFS-50 manifold has a maximum capacity of 50 CFM and is equipped with four outlet ports each supplied with a quick-disconnect. The system provides uniform air distribution to four supplied-air respirators and a fifth quick disconnect can be used for connecting a carbon monoxide monitor or an additional respirator.

ENMET compressed airline monitors ProAir 2200 and CO-GUARD (left to right)

OSHA STANDARD 29 CFR 1019.134 GRADE D COMPRESSED BREATHING AIR REQUIREMENTS

Carbon Monoxide Monitoring

Carbon monoxide monitors specifically designed to monitor CO levels in compressed air are available for meeting OSHA requirements for Grade D breathing air. ENMET's CO-GUARD is a compact, easy to install and operate compressed airline carbon monoxide monitor that meets OSHA monitoring requirements. The instrument is designed for trouble-free operation, utilizing a carbon monoxide sensor with a life expectancy of up to three years. The system is supplied factory pre-calibrated and users have the capability to change alarm points, program relays for auxiliary warning equipment and perform calibrations in the field. It is simple to replace the sensor and recalibrate the instrument in the field.

A custom designed AFS-100 air filtration system with a ProAir 2200 carbon monoxide monitor.

Complying with OSHA 29 CFR 1910.134 Requirements for Grade D Breathing Air

A system that includes both air filtration and CO monitoring is the best solution to safeguard against exposing workers to contaminants in supplied breathing air. An air filtration panel and carbon monoxide compressed airline monitor combination system is designed to comply with OSHA 29 CFR 1910.134 requirements for Grade D breathing air. Typically, these types of systems are mounted directly on the wall or a mounting plate. In certain applications, customers require more protection for instruments that will be installed in poor ambient air conditions such as environments that may contain large amounts of dust, sand blasting material, particulates, hazardous liquids, gas vapors, overspray and corrosive materials.

Systems can be custom designed to protect the filtration and monitoring equipment by mounting them in stainless steel, aluminum or fiberglass enclosures. These enclosures deflect and protect the breathing air filtering and monitoring equipment from hazardous environments, providing continuous long life

operation. The enclosure can include a lock, keeping unauthorized personnel from tampering with the devices. Connection ports are plumbed on the outside of the enclosure for easy access. Some CO monitors include service relays that can be programmed to activate auxiliary equipment, such as a strobe light and horn attached to the outside of the enclosure. These provide audible and visual alarms to alert users in the work area when a hazardous breathing air condition exists.

Employers are responsible for providing and maintaining safe breathing air equipment for their workers required to use supplied air respiratory equipment. An air filtration system and carbon monoxide monitor, designed for compressed air, helps employers maintain OSHA required Grade D breathing air.

About ENMET

ENMET offers a complete line of compressed airline monitors for monitoring carbon monoxide, oxygen, carbon dioxide, dew point and total hydrocarbon for complying with OSHA 29 CFR 1019.134 for Grade D breathing air requirements. Learn more at www.enmet.com BP

For more information contact Nancy Aulisa, Marketing Communications Manager, ENMET, tel: 734-761-1270 x223, email: naulisa@enmet.com

To read similar articles on ***Compressed Air Standards*** visit www.airbestpractices.com/standards

Making Sense of Compressed Air AT A HUGE CHEMICAL PLANT

By Don van Ormer, Air Power USA

A chemical plant spends an estimated $587,000 annually on electrical energy to operate their compressed air system. In addition, the plant has an expenditure on rental air compressors of equal or greater size - but this will not be covered in this article. The plant was built in the 1940s and modernized in the 1970s. The plant generates its own power and serves many processes. The average cost per kWh is $0.0359.

TABLE 1: SUMMARY OF ANNUAL ELECTRICAL ENERGY COST FOR COMPRESSED AIR

LOCATION	ACFM	COST PER YEAR
Powerhouse	2799	$173.910/yr
Caustic and Sparging	258 + 145 = 403	28,304 + 11,007 = $39,311/yr
Pels	1155	$66,671/yr
Paint	83	$19,812/yr
Cal Hypo	763	$47,298/yr
East Chlorine	622	$37,738/yr
West Chlorine and Sparging	2412 + 222 = 2634	159,443 + 14,309 = $173,752
MCB	150	$28,303/yr
Plant Total	**7987 acfm**	**$586,795 /yr**
Probable Peak	**9500 acfm**	

"Better maintenance practices focusing on condensate drains and compressed air leaks can make a difference at this plant. The systems are currently a patchwork of seven compressed air systems."

— Don van Ormer, Air Power USA

TABLE 2: KEY AIR SYSTEM CHARACTERISTICS – CURRENT SYSTEM							
MEASURE	**POWER HOUSE**	**CAUSTIC**	**PELS**	**PAINT**	**CAL-HYPO**	**EAST CHLORINE**	**WEST CHLORINE**
Average System Flow (acfm)	2799 acfm	258 acfm	1155 acfm	83 acfm	763 acfm	622 acfm	2,412 acfm
Avg Compressor Discharge Pressure (psig)	105 psig	105 psig	105 psig	105 psig	105 psig	105 psig	105 psig
Average System Pressure (psig)	100 psig	100 psig	100 psig	100 psig	100 psig	100 psig	100 psig
Input Electric Power (kW)	553 kW	90 kW	212 kW	63 kW	134.5 kW	120 kW	507 kW
Operating Hours of Air System (hours/year)	8,760 hrs	8,760 hrs	8,760 hrs	8,760 hrs	8,760 hrs	8,760 hrs	8,760 hrs
Specific Power (acfm/kW)	5.06 cfm/kW	2.87 cfm/kW	5.45 cfm/kW	1.32 cfm/kW	5.67 cfm/kW	5.18 cfm/kW	4.76 cfm/kW
Electric Cost for Air /Unit of Flow ($ acfm/yr)	$62.13 /acfm yr	$109.71 /acfm yr	$57.72 /acfm yr	$238.20 cfm/yr	$55.44 /acfm yr	$60.67 /acfm yr	$66.10 /acfm yr
Electric Cost for Air /Unit of Pressure ($ psig/yr)	$696 /psig/yr	$113.21 /psig/yr	$266.68 /psig/yr	$79.24 /psig/yr	$169.19 /psig/yr	$150.95 /psig/yr	$637.77 /psig/yr
Ann'l Elec Cost for Compressed Air ($ yr)	$173,910 /year	$28,304 /year	$66,671 /year	$19,812 /year	$47,298 /year	$37,738 /year	$159,443 /year
Total	$533,176 (above) + $28,303 (MCB) + $11,007 (Caustic sparging) + $14,309 (West Chlorine sparging) = $586,795						

*Based upon on a blended electric rate of $0.0359 per kWh and 8,760 hours/year.

MAKING SENSE OF COMPRESSED AIR AT A HUGE CHEMICAL PLANT

TABLE 3: CONDENSATE DRAIN SURVEY

NO	LOCATION	DESCRIPTION	EST SIZE	EST CFM	COMMENTS
1	East Chlorine	Inter-cooler	Large	10	IR 150 hp
2	East Chlorine	After-cooler	Large	10	IR 150 hp
3	West Chlorine	Inter-cooler	Large	10	IR HH250
4	West Chlorine	After-cooler (air)	Large	10	IR HH250
5	West Chlorine	After-cooler (water)	XL	30	IR HH250 aux after-cooler
6	West Chlorine	Non-lube Mod filter	Large	10	* Near Kobelco (Drain-All)
7	West Chlorine	Wet tank	Large	10	* Near Kobelco (Drain-All)
8	West Chlorine	Wet tank	Large	10	* behind air dryers (Drain-All)
9	Caustic	After-cooler	Large	10	Kobelco instrument air
10	Caustic	Inter-cooler	Medium	5	Kobelco instrument air
11	Caustic	Tank drain	Medium	7	* bypassed Drain-all
12	Powerhouse	After-cooler	Large	10	Gardner Denver
13	Cal Hypo	250 dryer	Medium	7	Small filter drain
14	Cal Hypo	250 dryer	XL	25	1" drain line cracked open
15	Cal Hypo	Inter-cooler	Large	10	#1 ZR 90
16	Cal Hypo	After-cooler	Large	10	#1 ZR 90
17	Cal Hypo	Inter-cooler	Large	10	#2 ZR 90
18	Cal Hypo	After-cooler	Large	10	#2 ZR 90
19	MCB	Open line valve	XL	20	Plant air feed line near air dryer
20	Paint Air / Pels	3 cracked filter drains	XL	35	Breathing air carbon filters; Note: cause short life
21	Cal Hypo	Tank drain		10	
22	Powerhouse	Zurn dryer pre-filter		20	
23	Powerhouse	Zurn dryer after-filter		10	
24	East Chlorine	NLM filter drain		20	Bypass
25	East Chlorine	High pressure air end		25	Side
26	Organics / Pels	Head system		5	Cracked drain head before riser

There are basically seven different operating compressed air systems running from a combination of central compressed air supply and decentralized systems.

- Powerhouse Air
- East Chlorine
- West Chlorine
- Pels
- Caustic
- Cal Hypo
- Paint

There are three types of main compressed air systems in this sprawling facility. Most systems operate between 90-100 psi in the headers.

- Plant Air – normally not dried
- Instrument Air – normally dried to a -40˚F pressure dew point
- Dry Air – normally dried to a -80˚F pressure dew point (this is the air that goes to the chlorine processes)

"Repairing these drains will save 349 cfm of compressed air. This equates to an annual energy cost savings of $17,502. The cost to repair the drains was estimated to be $8,000."

— Don van Ormer, Air Power USA

The system assessment data logged and did a comprehensive analysis of every single lubricated and non-lubricated air compressor (18 units). We recommended a completely new supply side strategy involving the creation of one main compressed air system. This system would be powered by either one large oil-free centrifugal air compressor or by four oil-free rotary screw air compressors - both sending air to a Heat of Compression compressed air dryer.

Due to article space limitations, this article will focus on a few of the demand reduction projects recommended.

Demand Reduction Project #1: Condensate Drain Survey

The system assessment identified a total number of twenty-six (26) condensate drains, which were either cracked or simply not functioning and leaking compressed air. Most of the drains were "no air loss" drains" but simply needed maintenance attention – to be cleaned and repaired. Many of these drains are in the Plant Air System and are bypassed, but still running due to the high condensate load in the system. Once the Plant Air System is dried, the system will not generate condensate and these drains can be eliminated.

Repairing these drains will save 349 cfm of compressed air. This equates to an annual energy cost savings of $17,502. The cost to repair the drains was estimated to be $8,000.

Demand Reduction Project #2: Compressed Air Leak Survey

A partial survey of compressed air leaks was conducted at the plant and 115 leaks were identified, quantified, tagged, and logged. Potential savings totaled 609 cfm for the 115 leaks that were identified.

We recommend an ultrasonic leak locator be used to identify and quantify the compressed air leaks. We use either a VXP AccuTrak manufactured by Superior Signal or a UE Systems Ultraprobe.

Shutting off or valving off the air supply to these leaks when the area is idle would save significant energy use from leaks. Reducing the overall system pressure would also reduce the impact of the leaks, when air to the machine cannot be shut off.

Repairing the leaks can save additional energy. The savings estimates associated with a leak management program are based on the unloading controls of the compressors being able to effectively translate less air flow demand into lower cost.

Repairing these leaks will save 609 cfm of compressed air. This equates to an annual energy cost savings of $30, 541. The cost to repair the leaks was estimated to be $11,600.

Demand Reduction Project #3: Misapplied High-Pressure Air

High-pressure air being used for very low-pressure applications is not an efficient use of energy. A close review of the plant's system discovered aeration and open-blow applications using 100 psig compressed air. This project replaces compressed air with blower-produced air at 8 psi.

MAKING SENSE OF COMPRESSED AIR AT A HUGE CHEMICAL PLANT

TABLE 4: COMPRESSED AIR LEAK SURVEY-PARTIAL LIST

NO	LOCATION	DESCRIPTION	EST SIZE	EST CFM	COMMENTS
14	Cal Hypo	Inside palletizer	large	10	
15	Cal Hypo	Flow meter	small	2	
16	Cal Hypo	Webber	medium	5	Multiple leaks
17	Inorganics	Leak up above	large	10	Middle of tank
18	Caustic	Filter	medium	5	90-etb-6
19	Caustic	Filter by office	medium	4	2nd floor
20	Caustic	Control valve	small	3	Beam k1
21	Caustic	Up above	medium	5	To right side of office
22	Caustic	Regulator	small	2	Control valve tcv-90-365
23	Caustic	Hose fitting	medium	5	2nd floor
24	Caustic	Leak in line	large	10	2nd floor
25	Power House	Kemp dryer	large	20	Left tower bottom fitting
26	Cal Hypo	Condensate drain	large	10	Atlas Copco ZR 90
27	Cal Hypo	1" valve leak	medium	5	#2 receiver
28	Cal Hypo	Valve open	medium	5	Past air receiver
29	Caustic	Ammonia pre-heater	small	2	90d4-069-0232
30	Caustic	I 32 degree heater	medium	5	90d4-069-0234
31	Caustic	Along wall	large	10	Behind caustic tank 9002-06-0005
32	Caustic	ABB control valve	medium	5	On #7 bird motor
33	Caustic	Over head	large	10	Near marks office
34	Caustic	Control valve	small	2	Tank 9002-104-0005
35	Caustic	Rose mount Valve	small	2	Column B2
36	Caustic	Valve	medium	5	Behind tank 902-107-0298
37	Caustic	ABB controller	medium	5	Behind column B4
38	Caustic	Control valve	small	3	Lower level beam A5
39	Caustic	Surface condenser	large	10	9002-069-0726
40	Caustic	CA-52 valve	small	3	Column A2
41	Caustic	By panel 90-23	large	10	1st floor end wall P2
42	Caustic	Outside	small	3	A2 46 pole
43	Pels tower	Filter	small	2	Level 3
44	Pels tower	Gate valve	small	2	Pels process rack sump
45	Pels	Regulator	small	2	3rd level by eyewash station
46	Pels	Union in pipe	small	2	By high voltage room
47	West Chlorine	Open valve	large	8	Tank 0343
48	East Chlorine	Leak up above	large	8	Drop on I-64
49	East Chlorine	#1 scrubber cooler	large	8	Leak is up above tag
50	Pels	Vacuum break	medium	4	Top floor below molten salt
51	Pels	Nylon tube fittings	small	2	Top of dissolving tank
52	Pels	Across from elevator	small	2	On column
53	West Chlorine	Fitting	medium	5	
54	West chlorine	Regulator	medium	5	2nd floor Maint. Area
55	West Chlorine	ABB actuator	small	3	
56	West Chlorine	ABB valve	small	3	Under building in tunnel
57	West Chlorine	3" gate valve	large	8	White building

TABLE 5: ELECTRIC COST AT VARIOUS PRESSURES

PRESSURE	APPROXIMATE HORSEPOWER INPUT	ESTIMATED ELECTRICAL COST
100 psig	220 hp	$77,295
50 psig	133 hp	$46,735
15 psig	92 hp	$32,355
7 psig	33 hp	$11,555

Using low-pressure blowers instead of 100 psig compressed air will save 619 cfm of compressed air. This equates to an annual energy cost savings of $31,043. The cost to purchase and install the blowers is estimated at $55,000.

Conclusion

Better maintenance practices focusing on condensate drains and compressed air leaks can make a difference at this plant. The systems are currently a patchwork of seven compressed air systems. We have attempted to show how one can begin a huge project like this by simply trying to understand what is happening in the different areas of a huge campus. The second step can be to get some "easy wins" by working on compressed air leaks and misapplications. 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 System Commissioning Part 3: TESTING

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

➤ Introduction:

If you've been in the compressed air business long enough, you've heard the following contradictory statements about the same project – usually given after start-up and a difficult customer call:

> Service manager: "I sent Joe out there, and he started up the system. Everything was running perfectly when he left! I can deploy another technician (a different one – Joe is out) right away. If you have a technical question, ask the engineering department."

Engineering: "All our XYZ systems were designed as ordered. I have never heard of that problem before! If the customer needs to be taken care of, talk to the sales manager."

> Sales manager: "Talk to the service manager!"

I have been involved in many of these "do-loops" in my OEM experience as Engineering Manager, and have always seen them as fruitless to solve the real problem. Most often, the root problem lies within the specification and start-up/testing phases.

> "Testing has to be done at several stages and locations, due to the cobbled-together nature of a compressed air system."
>
> — Tim Dugan, P.E. President, Compression Engineering Corporation

What is the "testing" that needs to be done on site? It is part of "commissioning", abbreviated as "CX". Don't cobble-together a system and expect the start-up technician to work miracles. Execute commissioning in steps, flushing out the bugs as you go.

Background

In Part 1, I made the case that full system commissioning is needed whenever a compressed air system is significantly modified. And I suggested the following definition of commissioning:

"Compressed air system commissioning is the process for measuring, testing, adjusting, and documenting that the performance of an entire compressed air system achieves the target system efficiencies (scfm/kW as a whole and for each piece of equipment) in all load regimes and potential failure modes."

In Part 2, I talked about measurement, how it can be done cost-effectively, and some ways to use the data.

This article will talk about testing. I will assume a "typical" system, a screw air compressor mix with regenerative dryers.

Planning

No project can be planned perfectly, but you will surely have a chaotic project if you don't have a plan! Particularly in the testing arena. Testing has to be done at several stages and locations, due to the cobbled-together nature of a compressed air system. The following overall plan is recommended:

- Before Equipment is Purchased
    1. Develop Overall Specification for System and Equipment
    2. Develop Commissioning Plan for System
- Before Equipment is Shipped
    1. Test Equipment at OEM
    2. Test Interfaces Between Subsystems at OEM
- After Equipment is Installed, but Before System Commissioning
    1. Existing air compressor controls modifications
    2. "Start-up" - Major Equipment Mechanical and Electrical Testing
    3. Pre-commissioning Check-out
- Site Testing:
    1. Test System as a Whole, Off-line
    2. Test System as a Whole, On-line

Before Equipment is Purchased – Specification and CX Planning

A new air compressor and dryer added to a system changes the entire system. See Part 1 for more discussion. Adding several pieces affects the entire system, so a new system specification needs to be developed. This is rarely done by the equipment supplier, and is often not done by customers, even sophisticated ones who document their utility systems fastidiously. A "system specification" really needs to be re-drafted by a compressed air systems engineer who understands all aspects of the systems, mechanical and electrical, and who either performed the audit that preceded the project or is working from it and knows how to read it. Many things can be said about specification development that are outside the scope of this article. The items that

COMPRESSED AIR SYSTEM COMMISSIONING PART 3: TESTING

TABLE 1. CONTROL STRATEGIES

		300HP VFD, 2-STAGE DRY SCREW	300HP FIXED SPEED 2S DRY SCREW	300HP FIXED SPEED 2S DRY SCREW	FLOW RANGES		SHIFT STRATEGIES	
COMPRESSOR NO.		1	2	3	FROM	TO	SHIFT UP	SHIFT DOWN
MAX FLOW/COMPRESSOR		1300	1300	1300				
MIN FLOW/COMPRESSOR		500	0	0				
STRATEGY	1	T			0	1300	P=90 PSIG	
	2	T	B		1300	2600	P=90 PSIG	FLOW<1300
	3	T	B	B	2600	3900	P=90 PSIG	FLOW<2600

T = "TRIM", B = "BASE"

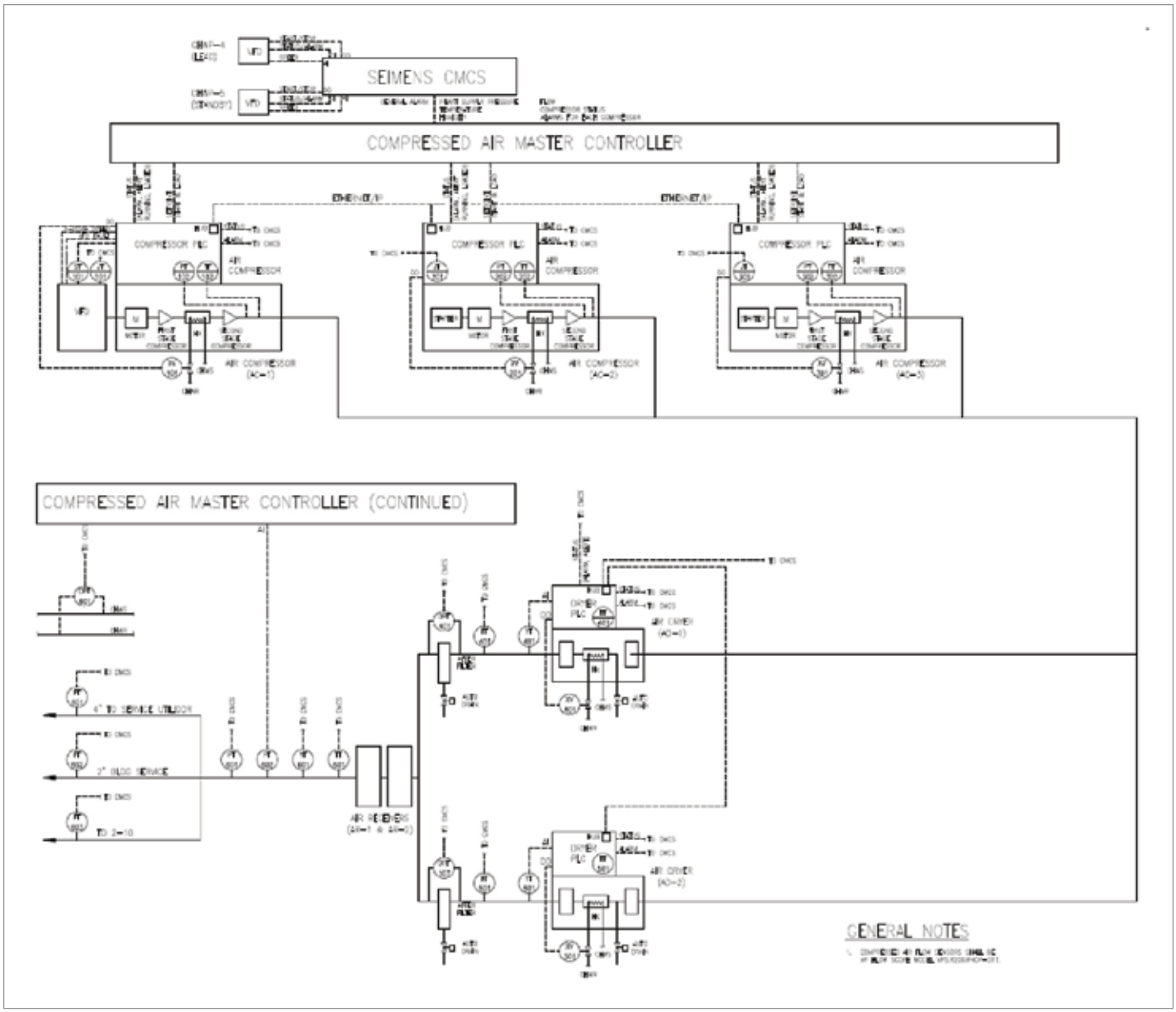

Figure 1. Sample P&ID, Well-integrated Compressed Air System

are of concern mostly have to do with controls. How they are intended to function, and how they realistically should work in the customer's actual system. A sample project is described below:

- Three Air Compressors and Two Dryers: Heat-of-Compression Type
  - One VFD-driven, 480V, 300 hp compressor, running in "trim" position at all loads, low and high. Full speed capacity of 1250 to 1350 acfm.
  - Two fixed speed 300 hp compressors, 1250 to 1350 acfm, 4160V, only running one fully-loaded when ISAL demand exists, one off in standby.
  - If at all possible, use mechanically identical compressors for VFD and fixed-speed units.
  - Insulated piping.
  - Two heat-of compression (HOC) regenerative dryers, rated at approx. 2500 scfm each. Dryer includes aftercooler and air-less drain.
  - Pre and after filters, low pressure drop.
  - Two dry-side 3,000 gal air receivers.
  - Master controller.

Three documents need to be developed to lay the foundation for commissioning planning.

1. Full system process and instrumentation diagram (P&ID). This shows all relevant mechanical and instrumentation items, and their interconnection. See Figure 2 for an example P&ID.
2. Flow profile of system. This should come from an audit or the customer's data-collection system, if they have comprehensive

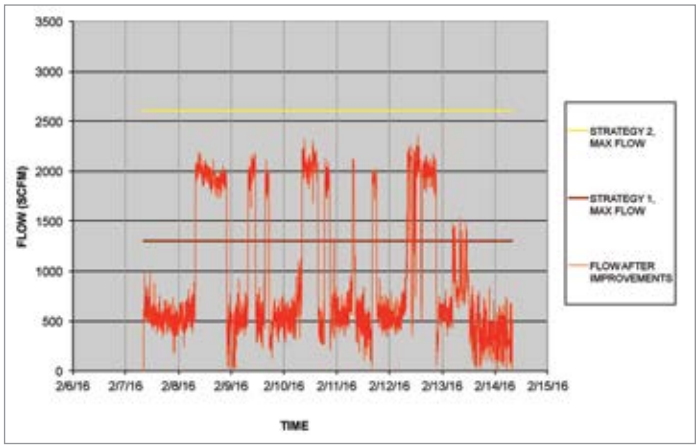

Figure 2. Flow Profile

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COMPRESSED AIR SYSTEM COMMISSIONING PART 3: TESTING

flow meters installed and logging. Typically they don't. Draw lines across the flow profile, showing where expected combinations of compressors ("strategies") are maxed out. See Figure 2. This shows that the flow is "binary", shifting from low to high, and back again, with some "noise" in between.

3. Control algorithm. This is the intended combination of air compressors in each flow range, and the method to shift in between. See Table 1.

System Commissioning Planning

System CX is the measurement, testing and adjustment of the *entire system,* not just the air compressor or dryer that was added. Systems are interactive. When planning this example system, which includes oil-free compressors, heat-of-compression dryers, and a master control system, the following interactive issues must be addressed:

1. Heat available from compressors to regenerate dryers.
2. High heat and moisture load variance on the dryers.
3. Sequencing and control with a large change in flow and one VFD trim compressor.

This article can be used as a sample commissioning plan. Change the diagrams and specific descriptions, and you're 80% there.

Testing Before Equipment is Shipped

In our experience, industrial customers tend to over-simplify air compressors as "appliances", and don't apply the same rigor to testing as they do to a custom, mission-critical production system. Largely because the compressors tend to be bought reactively, not proactively. Industrial plant readers, if all you did was adapt and simplify the process they already use for engineered systems, you would arrive at the conclusion that a lot can go wrong between design and start-up of a compressed air system project. You would determine that it's cheaper and easier to catch something before it ships than after. The following is recommended:

1. Get a copy of each OEM's standard test protocol, with a typical test sheet for another unit similar to the one being purchased. See Figure 3 for an example.
2. Evaluate the test sheet for critical items, particularly the ones that are unique to the system as identified above and in CX planning. Add those steps in an addendum test requirement document. Having an air compressor expert engineer involved at this phase is helpful.
3. Include this test plan addendum it in the purchase contract.
4. Consider the value of having a witness test. This might be justified, particularly when there are several critical items that need to be tested that are not in the standard test plan. Remember that people all get stuck in their little box, and don't communicate well with other boxes, particularly at equipment OEMs! What you say you want and what they actually do are two different things. They might not understand your intent. For instance, there are two critical items in the system described in Figure 1 that justify a witness test by the customer or compressed air systems engineer representing them:

   Compressor/dryer mechanical interaction. The dryer needs to

COMPRESSED AIR SYSTEM COMMISSIONING PART 3: TESTING

use compressor heat to dry, and available temperature and load on the compressor are hard to predict. A factory test that couples a dryer and compressor, simulating min and max load, is recommended. In the example project, the distributor of the compressor and dryer are the same entity, so this testing is not difficult.

Compressor controller and sequencer interface. They come from different vendors, but the master controller can easily be shipped to the compressor distributor for interface testing. The master controller can communicate with the compressor controller and change set points, start and load the compressor, at a variety of scenarios. Problems can be remedied/repaired at that time.

The typical air compressor test data sheet shown in Figure 3 has a variety of missing pieces in it that would make factory testing more valuable for this project:

Item	Notes	Guidelines	60 Hz @ max pres.	60 Hz @ op. pres.	Units
1ST Stage Suction Pressure - PE1	Unloaded	(23.8 - 25.6)		24.2	In-Hg
1ST Stage Discharge Air Pressure - PE2	Unloaded	(5 - 15)		12.6	In-Hg
Note: Unloaded at Max PSI same as at Test	Loaded	25 - 38	31.7	31.5	PSIG
2ND Stage Discharge Air Pressure - PE3	Loaded	40 - 150	113.7	98.1	PSIG
Oil Pressure - PE4	Loaded	28 - 35	30.3	30.5	PSIG
Inlet Air Temperature - TE1	Loaded	40 - 104	76	76	°F
1ST Stage Discharge Air Temperature - TE2	Loaded	250 - 390	338	338	°F
2ND Stage Suction Air Temperature - TE3	Loaded	110 - 130	99	101	°F
2ND Stage Discharge Air Temperature - TE4	Loaded	280 - 425	320	297	°F
Compressor Outlet Air Temperature - TE5	Loaded	H2O In + 10-15	N/A	N/A	°F
Oil Temperature - TE6	Loaded	85 - 125	112	112	°F
Running Hours	At end of test			4.5	Hours
Loaded Hours	At end of test			4.1	Hours
Load/Unload Cycles	At end of test			26	Count
High Air Pressure Switch Setting				155	PSIG
Ambient Conditions					
Temperature				70	°F
Relative Humidity				76	%
Barometric pressure				29.1	In-Hg
Cooling Air Inlet Temperature	Air Cooled			N/A	°F
Service Water Inlet Temperature	Water Cooled			79	°F
Service Water Outlet temperature	Water Cooled			94	°F

Electrical Readings (Take readings at Full Load and Highest Operating Pressure)

AC Supply Voltage :	L1 - L2 : 478.8 Volts	AC Supply Frequency : 60 Hz						
	L2 - L3 : 482.3 Volts	DC Power Supply Voltage :			Output : 24.5 Volts			
	L1 - L3 : 478.1 Volts				Input : 126.4 Volts			
Motor Amps	At Max PSI	Test Data		At Max PSI	Test Data		At Max PSI	Test Data
Pump Motor M1	T1 :	2.81	T2 :		3.00	T3 :		2.85
Fan Motor M2	T1 :	1.52	T2 :		1.58	T3 :		1.56
Compressor Motor M3	T1 : 405.4	376.2	T2 : 405.4		376.2	T3 : 405.4		376.2
Compressor Motor M4	T4 :		T5 :			T6 :		

☐ Freeze Protection — Control Switch Set: ____ °F — AMPS

Other Readings

Item	Test Data	At Max PSI	Units

☑ Test Cart 1 (Yellow)
☐ Test Cart 2 (Orange)
☐ Additional Test Instrument:
☐ Additional Test Instrument:

Calibration documents located in QA Office

Figure 3. Sample Factory Equipment Test Data Sheet

- What are the set points at site? Is it being tested at those set points?
- What are the min and max outlet temperatures required for reliable operation and good dryer performance? If the temperatures are not in the range, what are the acceptable methods to adjust it (intercooler water adjustment, for instance)?
- Where are the communications testing requirements?

After Equipment is Installed, but Before System Commissioning

Existing Air Compressor Control Modifications

In the example project, all the air compressors are new. Most projects are not replacing all compressors. If one or more of the fixed-speed compressors were existing units, the master controls become more involved, and a few more steps are needed. Each compressor needs to have the following fundamental inputs and outputs to be automated:

- Local remote switch
- Remote start/stop
- Remote load/unload
- Feedback for running, alarm and standby
- Remote set point (see below)

These can either be hard-wired, if controls are older electro-pneumatic type, or through a communications interface like Modbus, if of a more recent vintage. The remote set point would not be possible with an electro-pneumatic controller.

These modifications need to happen prior to full system commissioning, and tested. The automation company who is doing the master

controller should supervise or directly do this work. They should develop an electrical schematic of the modifications needed to the compressors, and test all interfaces. Close a relay contact and see that the compressor starts, for instance.

Start-up – Major Equipment Mechanical and Electrical

"Start-up" is a phrase that is sometimes used in place of "commissioning". It isn't system commissioning. It precedes it. The start-up of each piece of major equipment is the supplier's testing and documentation that each major piece of equipment is ready to run at the site, with the utilities and configuration they are in, and at the set points required. It is done according to the plan agreed on. The equipment supplier will send out their skilled technician and go through all their standard check-outs, electrical and mechanical. It should be done several weeks before system commissioning, and the equipment run in "local" controls to flush out any issues that need to be corrected before the full system is commissioned.

Pre-Commissioning Check-out

If the pieces are all checked out properly at the factory (compressors, dryer, and sequencer in this example project), very little pre-commissioning site checks are left. Mainly controls and instrumentation that are not part of the packaged equipment, and modifications to equipment.

The following can be checked by the site construction manager or engineer in charge of the project:

- Electrical connections and wiring are all in place for controls and instrumentation. The system P&ID should be adequately detailed to see where control wiring is needed, but a system electrical schematic might be needed also. Then all conduit and wires are pulled and terminations made before the system commissioning starts. Power can be validated for all components as well.
- Piping changes are done correctly. Piping sizes, valves, drains, etc should be checked out.
- In the case where some existing compressors are automated, the interface wiring/network connections are run and wires terminated properly.

Make a punch list of items that need to be addressed/repaired before full system commissioning and correct the items prior to site testing of the full system.

Site Testing

Once this is all done, site testing should be pretty straightforward. The issues that take time to correct are mostly flushed out. Now the system testing can focus on validating that the entire system operates as the customer will use it in their real operation.

Off-Line Testing

More details will be in a future article, but the basics are as follows:

- Have adequate rental compressor & dryer capacity available, or an old compressor room still available for supplying the plant during testing.
- Install temporary piping to isolate all the new tested equipment from the system, ideally with an air receiver.
- Install 2 or 3 manual bleed valves, size to create the anticipated flow range needed by the plant (see Figure 2).
- Test the combined system at the 2 or 3 flow ranges that are typical, and at the transitions between them. Tune compressor controls for optimal operation, managing energy to the lowest possible level, while maintaining pressure and dew point within specification.
- Get customer participation. This is where they get to "drive the simulator", and learn much about the entire system.

On-line Testing:

Finally, you are ready to go "live". This is really a validation test where the vendor/contractor team validates that the system operates for the customer, witnessed by the customer. If possible, both facility and process managers are involved, and the system operation against the typical loads are seen while all parties view the central monitoring system. In some cases, the customer needs to turn on and off production lines to validate that the peak and valley are handled well, and process control needs to be on the radio. This requires some coordination planning.

Conclusion

Don't hope for the best without a plan. Plan and execute system commissioning in steps, starting with specification development and commissioning planning. Require testing at the OEM as part of your purchase contracts. Perform site modifications and checks, prior to full system commissioning. Finally, perform full system commissioning off-line, and then live. You will then have a system that operates smoothly and reliably for its life. BP

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

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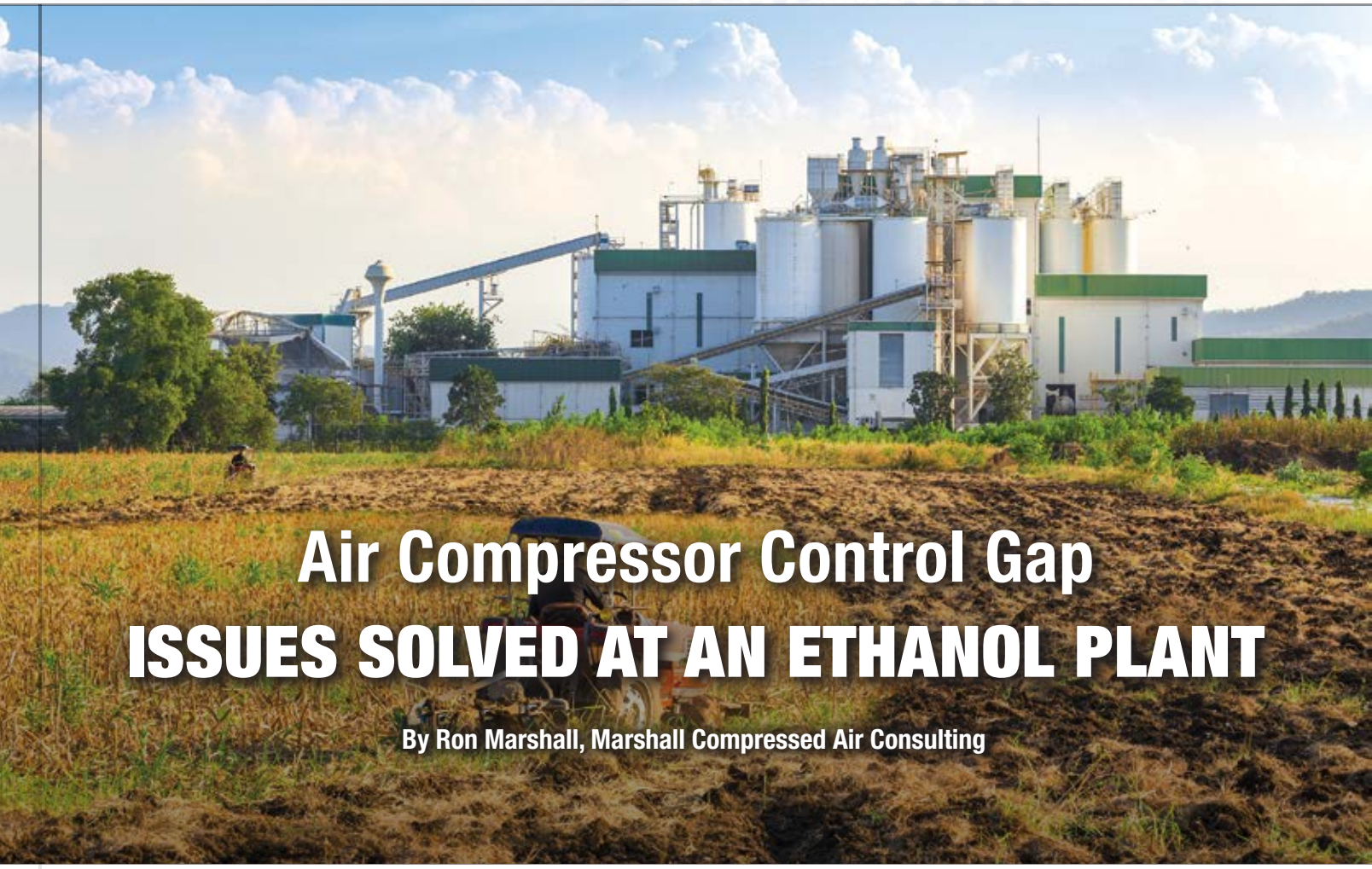

Air Compressor Control Gap ISSUES SOLVED AT AN ETHANOL PLANT

By Ron Marshall, Marshall Compressed Air Consulting

A newly constructed ethanol plant experienced control gap issues shortly after commissioning. This article discusses the cause of the issue and how the problem was solved.

Background

The ethanol plant is located in Canada and has an input of about 350,000 tons of grain resulting in an output of 130 million liters of ethanol. Within the plant power house is a compressed air system using three air cooled lubricated screw air compressors, two of which are VSD controlled, and a heated blower style desiccant dryer. A pressure/flow controller is used to keep the plant pressure at a constant 88 psi. The air compressors are controlled using a sophisticated central

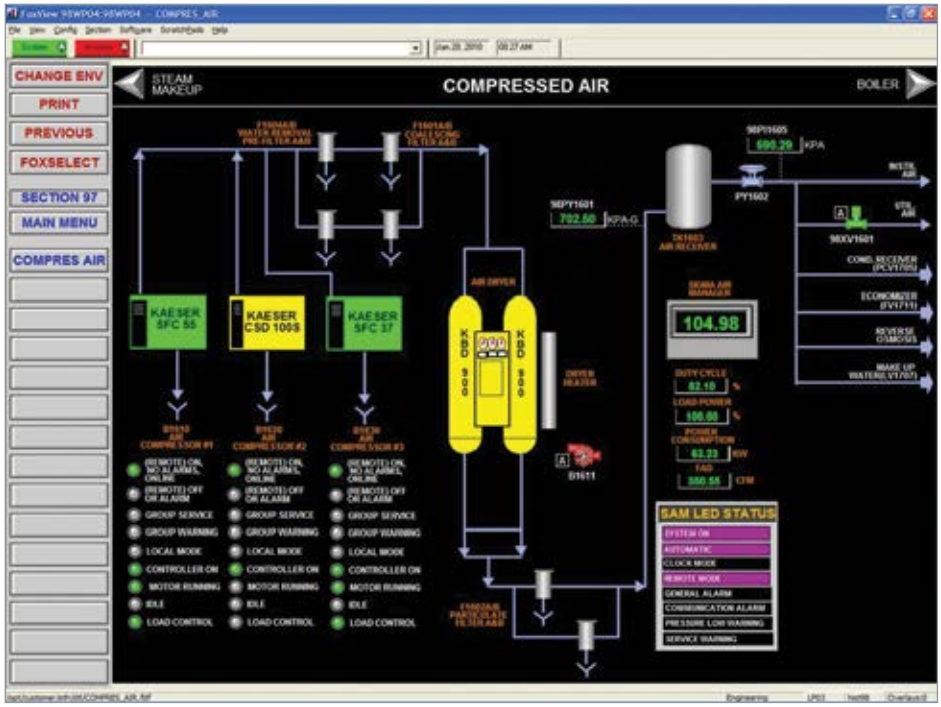

Figure 1: A central control system provides optimal control and data for monitoring.

Figure 2: Air is injected into the fermentation process for mixing. This causes a step change in flow.

controller that operates the combination of air compressors for the best efficiency and provides a data interface so the compressed air equipment can be monitored centrally from the plant SCADA system.

Load Profile

The plant load profile is fairly flat, with most of the compressed air being consumed by general process operations the majority of the time with the occasional peak. The ethanol is produced in batches. During part of the fermentation process, a flow of compressed air is injected into the bottom of the fermentation vessel (Figure 2) to mix the liquid for better consistency. This flow occurs for 12 to 14 hours at a time. On top of this flow is a requirement for the air dryer cooling purge. After every air dryer regeneration cycle, a flow of compressed air is used to cool the heated desiccant so it is ready for the next drying cycle. These two additional loads cause a more or less consistent three-stepped flow characteristic.

Design Process

In the design stage, the engineering consultants, engaged to plan out and specify the compressed air system, counted on the step change of the compressed air flow to help them reduce the costs of the original design. The plan was to use VSD control to keep the system efficiency high, but there was an additional concern about the additional cost of the unit. Variable speed compressors have a cost premium compared to fixed speed units. To try to reduce costs to stay within budget, the engineering team sized the air compressors based on a particular estimated load profile where a fixed speed compressor would run during high flow agitation periods, with VSD trimming during vessel agitation. The other times, during the low load step, the VSD would run alone. This allowed the consultants to specify a smaller, less expensive 75 hp VSD to work with a 100 hp fixed speed unit.

During the design review stage, it was pointed out to the design team by external reviewers that use of a smaller VSD than the base unit

AIR COMPRESSOR CONTROL GAP ISSUES SOLVED AT AN ETHANOL PLANT

results in a condition called "control gap". When control gap problems occur, at flows between the capacity of the larger base compressor and the smaller VSD compressor, the two units will fight for control, causing undesirable and inefficient operation. The team was confident, however, that their calculations were accurate, and because the process flow was more or less constant and repeatable, a flow within the control gap would never occur.

The team made some good decisions on other aspects of the project:

- A central controller was specified to better control the air compressors
- A heated blower style dryer (Figure 3) was purchased with dew point control to reduce regeneration energy consumption
- Efficient filtering was specified to reduce pressure loss
- Airless drains were included to reduce compressed air waste
- A flow pressure/flow controller was installed to reduce plant pressure and limit artificial demand flow
- Air compressor room piping was sized to limit pressure loss, with consideration for additional future loads
- Large receiver capacity was installed to better stabilize pressure control and guard against large transient air demands

Figure 3: The blower style dryer saves 71 percent due to cool dry conditions and the dew point control.

Problems after Commissioning

As the reader could likely predict, the design calculations were off slightly. Murphy's Law came into the picture. The compressed air system ran adequately for the first month or so of operation, as per Figure 4, where the 100 hp air compressor ran at full load and the VSD compressor at near minimum speed. This kept the base compressor at its most efficient point, but was a cause for concern for the long-term health of the VSD compressor. Operation at or near minimum speed is the least efficient point of the VSD flow vs. power characteristic (see Figure 6), and further to this, often at low flows inadequate heat is generated within the compressor to drive off moisture that

"The selection of a good control strategy or central system is important to the efficiency and pressure stability. A system that is smart enough to keep the installed compressors operating at their best efficiency point saves energy."

— Ron Marshall, Marshall Compressed Air Consulting

condenses into the compressor lubricant. This can cause water damage of compressor internals and bearing failure. For this reason manufacturers recommend not to run VSD compressors at or below minimum speed for long periods of time.

As can be seen in Figure 4 the effects of the control gap started to become apparent. Near the last third of the graph some periods of time can be seen where the air compressors are fighting for control, with the VSD speeding up and slowing down, but at the same time the fixed speed base compressor inefficiently loading and unloading at a high frequency. There are some periods of low load where the VSD finally takes control and is the lone compressor running, this is the only period of good efficiency within the sample.

As commissioning progressed, the production staff found that additional unanticipated compressed air uses needed to be added to the production process. This increased the load to a point where the flow was almost always within the control gap, more than 90 percent of the time as shown in Figure 5.

Solution

To solve the control gap issue, more variable capacity needed to be added so that this variable capacity was larger than the 100 hp base unit. A smaller fixed speed unit could have been added, but the site operators decided to install an additional 50 hp VSD compressor. This brought in the total variable capacity up to 125 hp, a size that ensures minimal VSD operation at below minimum speed, which is recommended by the compressor manufacturer. Fortunately, the central compressor controller has a built in algorithm that always seeks to keep the running VSD compressors between 30 and 80 percent of their capacity, which is the sweet spot of most VSD efficiency curves.

This change was not without problems, however. Sometimes, when a VSD compressor is placed on a central controller that takes its pressure sensing point downstream of a desiccant dryer, a delay is introduced to the control loop. This can make the VSD PID control loop unstable, causing the compressor to hunt up to maximum speed,

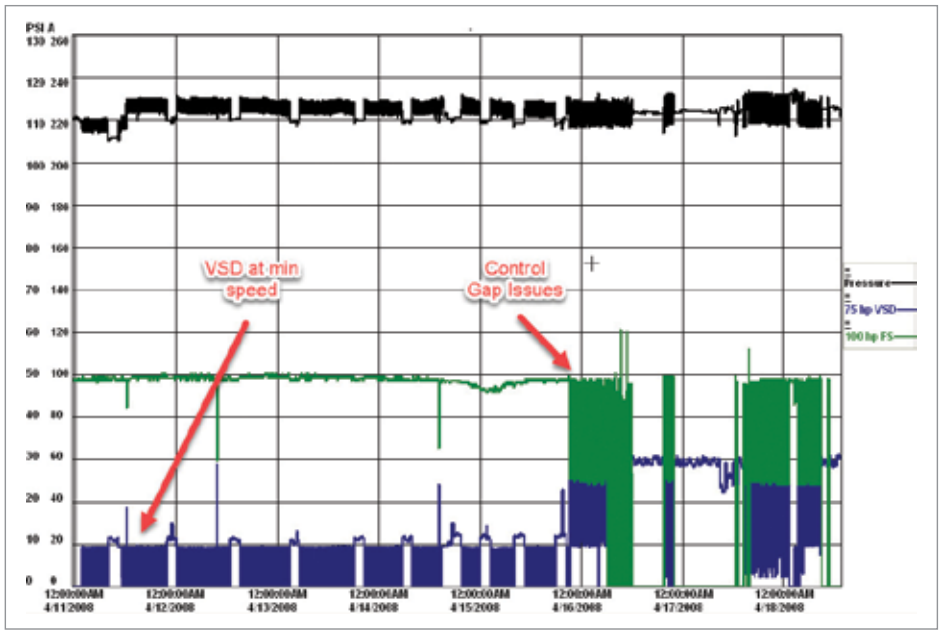

Figure 4: Compressed air profile during commissioning showed less than optimum compressor operation.

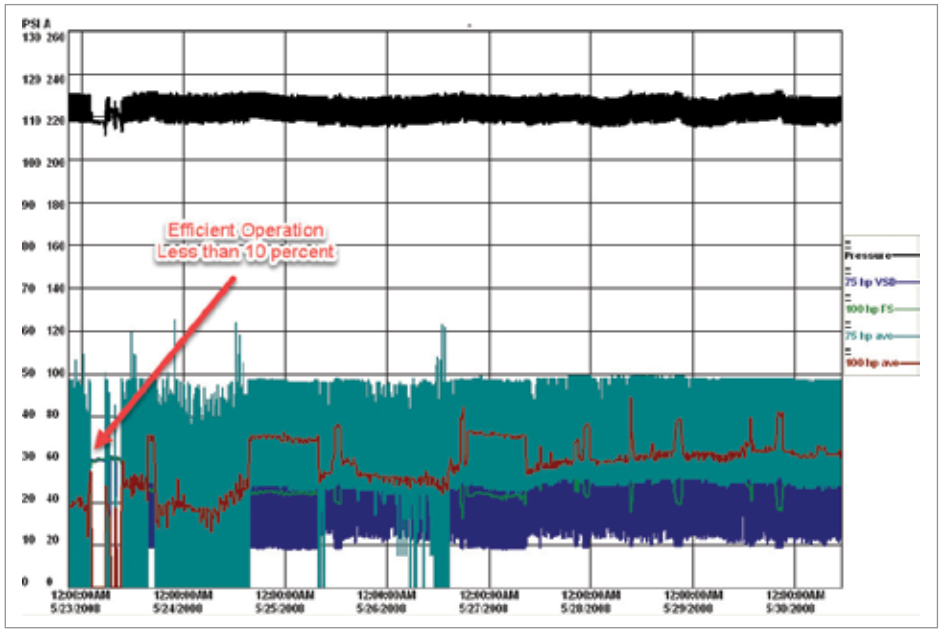

Figure 5: Load additions eventually pushed the system into the control gap most of the time. The compressors are fighting for control.

AIR COMPRESSOR CONTROL GAP ISSUES SOLVED AT AN ETHANOL PLANT

then down to minimum speed with a sine wave characteristic. This type of operation can be seen on the first part of Figure 7. The manufacturer was consulted and instructions were given on how to tune the compressor control to make it less sensitive. This fixed the issue and the two VSD compressors started operating normally.

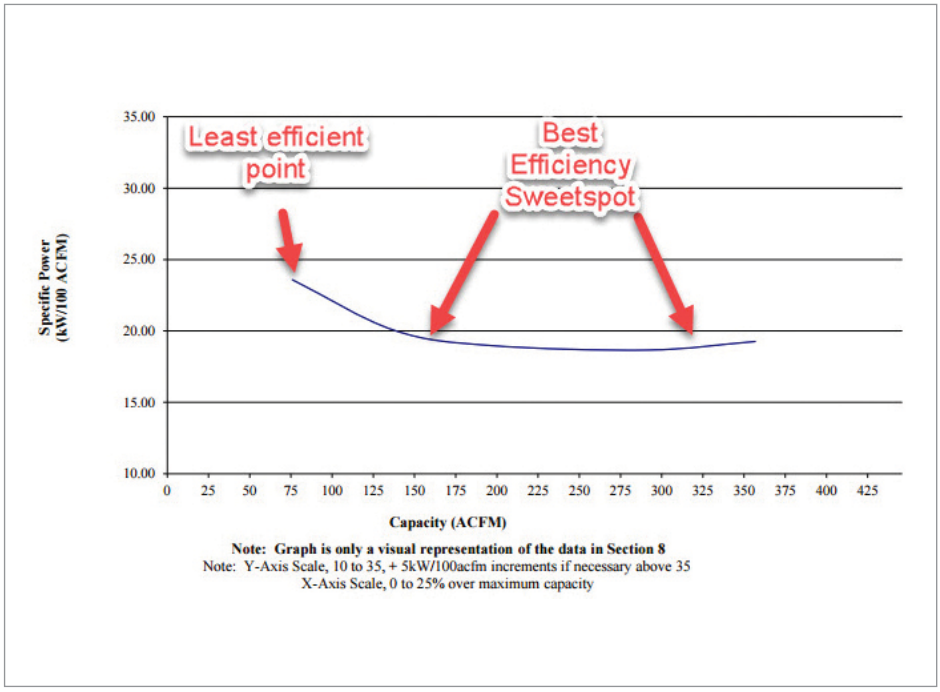

Figure 6: Best VSD efficiency is midrange. The central controller keeps the VSD compressors in this range. Source: Kaeser Compressors

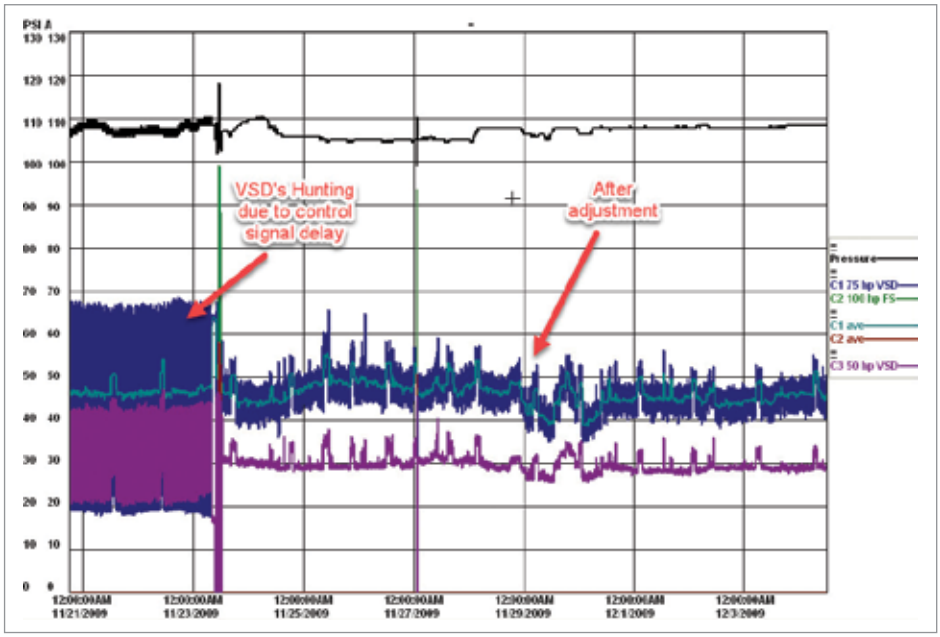

Figure 7: When the new compressor was installed problems with the control required tuning of the PID control parameters.

Conclusion

Good intentions to reduce costs in the purchase of new equipment can sometimes cause efficiency issues if the compressor sizing selection causes a control gap. The best bet to avoid control gap is to size the VSD capacity so that the variable part of the VSD capacity (capacity between minimum speed and full speed) is equal to or larger than the largest base compressor. If this is the case, it is possible to control the system efficiently from zero to full capacity with no inefficiency gaps in between.

The selection of a good control strategy or central system is important to the efficiency and pressure stability. A system that is smart enough to keep the installed compressors operating at their best efficiency point saves energy. The selection of other components like efficient filters, dryers, piping and drains makes the system even more efficient.

One important point about this system is that it was measured for verification after the installation took place. Many system operators assume that their system will operate efficiently, as designed and specified, and often no verification of the system is done. But, as we could see, some unexpected changes to the system caused poor system operation, something that would likely not have been noticed had measurements not been done.

And in case you are wondering, the plant is currently looking into more efficient low-pressure sources of compressed air for agitation. BP

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

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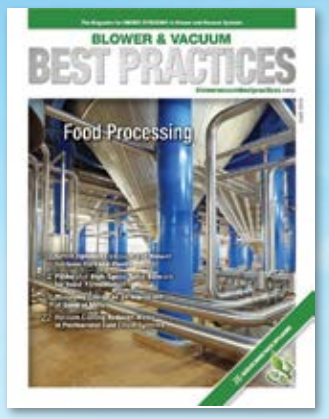

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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

FS-Curtis Introduces New ECO Series Class 0 Oil Free Air Compressors

FS-Curtis, a leading manufacturer of reciprocating and rotary air compressors since 1854, is proud to introduce the new ECO Series Oil Free Air Compressors.

The new FS-Curtis ECO Series Oil Free Air Compressor.

FS-Curtis Eco Scroll oil-free air compressors are ISO 8573-1 CLASS 0 certified compressors which are energy efficient, easy to operate and maintain, quiet and save space in your facility. A failure of components in an oil-injected compressor can result in oil contamination which will cause expensive damage to downstream products and processes. Because the ECO series requires no oil, it delivers Class 0 clean and efficient compressed air, meaning that there is no risk of oil contamination or the expenses associated with it.

The Eco-Series has many advantages to assist with the new ecological and technological challenges faced by countless businesses that require compressed air. Some of these advantages are highlighted below:

Ecologically Conscious

- Environmentally friendly Class-0 clean and efficient air
- No oil contamination, designed to meet ISO8573-1
- Approved and certified by TÜV Rheinland® (Germany)
- Small footprint, modular design

dbA Shield Noise Reduction

- Extremely quiet operation (as low as 56 dbA)
- Very low vibration level (5 mm/s or less)
- To be installed where quiet setting is important

Quality Components

- Higher reliability - Fewer moving parts
- Exclusive Eco-Series scroll airend
- High Efficiency TEFC motor
- Maintenance friendly

Compressed air requirements have changed drastically as industries push to become ecologically friendly. The Eco Series can help customers in a multitude of different industries meet these changing regulations/requirements:

Life Sciences

- Medical (breathing air source [ONLY when used with approved clean-up equipment], operating surgical tools)
- Dental (air tools that come in direct contact with the patient)
- Pharmaceutical (fermentation, conveying, mixing, control, powdering, dehydration and vaporization)
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TECHNOLOGY PICKS

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- Fermentation, Conveying, Dehydration,
- Packaging, bottling, cleaning, filling and capping
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Electronics

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- N2 replacement with CDA (clean dry air)

Air Separation

- Oxygen and nitrogen generation

Automotive Painting (Point of use)

- High quality painting, alleviates costly repairs due to oil carry over

About FS-Curtis

Since 1854, FS-Curtis has been designing and manufacturing solutions for industry. The FS-Curtis Air Compressors brand continues to be the symbol of quality and excellence in the design and manufacture of air compressors. Dedicated to customers and loyal distributors, our brand names are synonymous with Legendary Reliability since 1854. FS-Curtis is proud to be ISO 9001:2008 and ISO 14001:2004 certified.

If you would like more information about this product, please visit www.fscurtis.com or contact Darryl Frierson at tel: 314.383.1300 or email: info@fscurtis.com

Kaeser Launches Redesigned SFC 75-132S VFD Screw Compressors

Kaeser has redesigned their SFC 75-132S variable frequency drive rotary screw air compressors. These new models are up to 25% more efficient than the competition.

Thanks to a new airend designed specifically for these models, the control range has increased up to 11% for added application versatility. These new models feature the latest in Siemens drive technology for the best in reliable and efficient drive control. Additionally, built-in heat recovery options multiply energy savings potential.

Kaeser has redesigned their SFC 75-132S VFD rotary screw air compressors.

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

Series features include an enhanced cooling design, eco-friendly filter element, integral moisture separator with drain, and an Electronic Thermal Management system. Units also come standard with Sigma Control 2™. This intelligent controller offers unsurpassed compressor control and monitoring with enhanced communications capabilities for seamless integration into plant control/monitoring systems and the Industrial Internet of Things (IIoT).

About Kaeser

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

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

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Michell's Sensor Exchange Program Wins Power Station Order

The sensor exchange program, which Michell offers to its dew-point transmitter customers, helped win a major order for dew-point transmitters from a power station in Africa.

The operators wanted to reduce the costs and maintenance time for their hydrogen-cooled electricity generators. One of their major costs was in the maintenance of their moisture sensors which had to be returned to the manufacturer for recalibration and refurbishment. As this could take up to 3 months, a stock of spare sensors was needed to ensure the process could be kept running continuously. The high cost of the necessary stock of backup moisture transmitters greatly increased their overhead.

The Michell Easidew PRO I.S. Dew Point Transmitter

They selected Michell's Easidew PRO I.S. dew point transmitters, as an alternative to their usual supplier. As well as its fast response and wide measurement range, the transmitter is part of Michell's sensor exchange program. This program is a cost effective way to keep processes running while ensuring the measurement integrity of the moisture transmitters – and there is no need for the additional expense of carrying extra stock of sensors.

The sensor exchange program is available for the full range of Michell's Easidew Dew-Point Transmitters, as well as the Pura Trace Moisture Transmitters. Customers who sign up to the program benefit from what is essentially a life time warranty for their transmitters.

The Easidew PRO I.S. dew-point transmitter has a measurement range from -100 to +20°C dew point, with an accuracy of ±1°C. It is also certified for installation in hazardous areas around the world, including ATEX, IECEx and CSA approvals.

About Michell Instruments

Michell Instruments Group is a worldwide leader in the field of moisture and humidity measurement solutions. With four decades experience, Michell designs and manufactures a wide range of sensors, instruments and customized systems capable of measuring

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For more information visit http://www.michell.com/us

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About Ashcroft

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IAC Air Compression and Power Systems is looking for an experienced, motivated and self driven Area Sales Manager for the Indianapolis, Indiana area representing all of our product lines and services. Industrial market sales experience is required, compressed air experience is recommended. IAC is proud to have a team of individuals focused on taking care of our customers by doing the right thing, every time.

We offer an attractive compensation plan, matching 401(k), heath benefits, paid vacation and much more. Apply to find out how you can make your next stage of your career better.

Candidates needing relocation are welcome to apply.

Please email resume to Steve Briscoe, VP Business Development. sbriscoe@iacserv.com

Learn more about us at www.iacserv.com

MULTIPLE SALES AND SERVICE POSITIONS IN CHICAGO

While innovation is our lifeblood at Kaeser Compressors, delivering superior customer service is at the heart of everything we do.

For our Chicago location, we are currently looking to add dedicated, motivated, and hardworking:

- Territory Managers
- Service Technicians
- Sales Manager
- Service Manager

Discover more about Kaeser and our open positions at us.kaeser.com/careers.

KAESER COMPRESSORS

THE MARKETPLACE

TECHNOLOGY

IT'S NOT ONLY THE PRODUCTS, BUT PEOPLE AT DV SYSTEMS THAT MAKE THE DIFFERENCE FOR MY BUSINESS.

DENNIS BERMANI, OAK STREET CLASSICS, MOORESVILLE, NC

AIR COMPRESSORS 5 TO 200 HP

JOIN US, BECOME A DISTRIBUTOR

With over 125 years of manufacturing excellence it's not only our products that are built to last, we strive to build lasting relationships. Contact us to learn more.

dvcompressors.com **1-877-687-1982**

DV Systems Ltd. 128-B Talbert Rd., Mooresville, NC 28117

BUILT BETTER

Clean Sweep!

Air system study yields multiple benefits to bottom line

Problem:

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

Solution:

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

Result:

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

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

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