The Magazine for ENERGY EFFICIENCY in Compressed Air Systems

COMPRESSED AIR BEST PRACTICES

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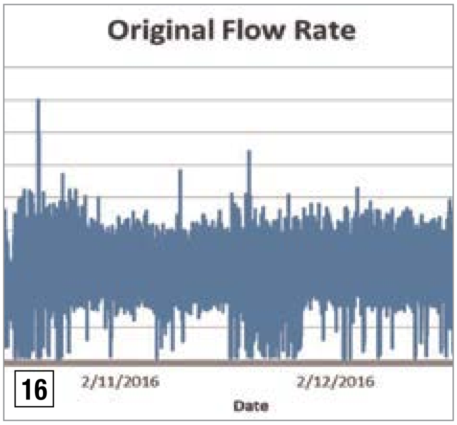
September 2016

System Optimization


Atlas Copco

SUSTAINABLE MANUFACTURING FEATURES



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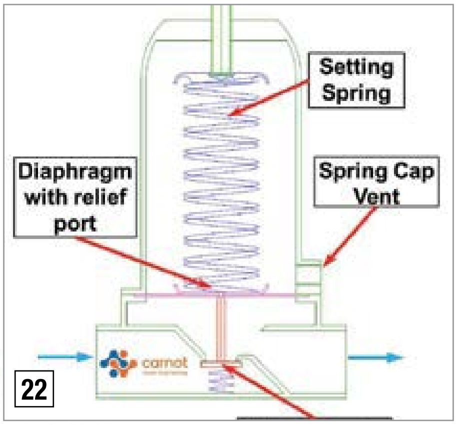

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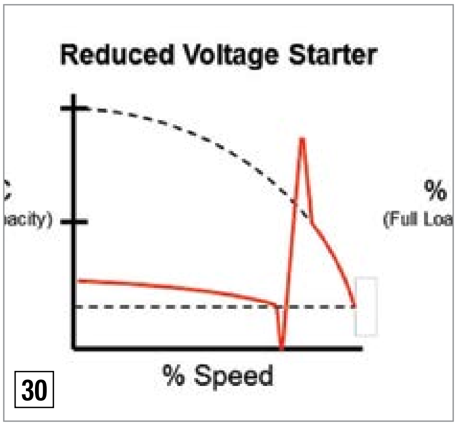

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FROM THE EDITOR | Compressed Air System Optimization

What happens after a compressed air audit? Do the energy savings automatically pour into the bank? Or, is it possible that compressed air leaks and operator bad habits can return? If they do, does anyone notice? Paul Edwards, from Compressed Air Consultants Inc., answers these question, with an important articled titled, "Four Principles for Sustaining Energy Savings."

Utility energy efficiency program personnel play a key role in the creation of energy-efficiency projects. Aside from awarding incentive dollars to projects, the assurances provided by engineers like Jerry Zolkowski, from Consumers Business Energy Efficiency Solutions, give factories the confidence the projected energy savings are real. I hope you enjoy his article on "Calculating Project Savings: Vortex Vacuum Generators and Outside Air Intake (for air compressors)."

In the second installment of a two-part article, Murray Nottle, from The Carnot Group in Australia, writes about the designs of pressure regulators and techniques to overcome pressure "droop". CAGI has excellent educational resources available and provides an example of this with an article titled, "Motor Controls in Centrifugal Air Compressors." Ron Marshall, for the Compressed Air Challenge, also provides an interesting article on the "real world" issues challenging the efficiency of compressed air systems.

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

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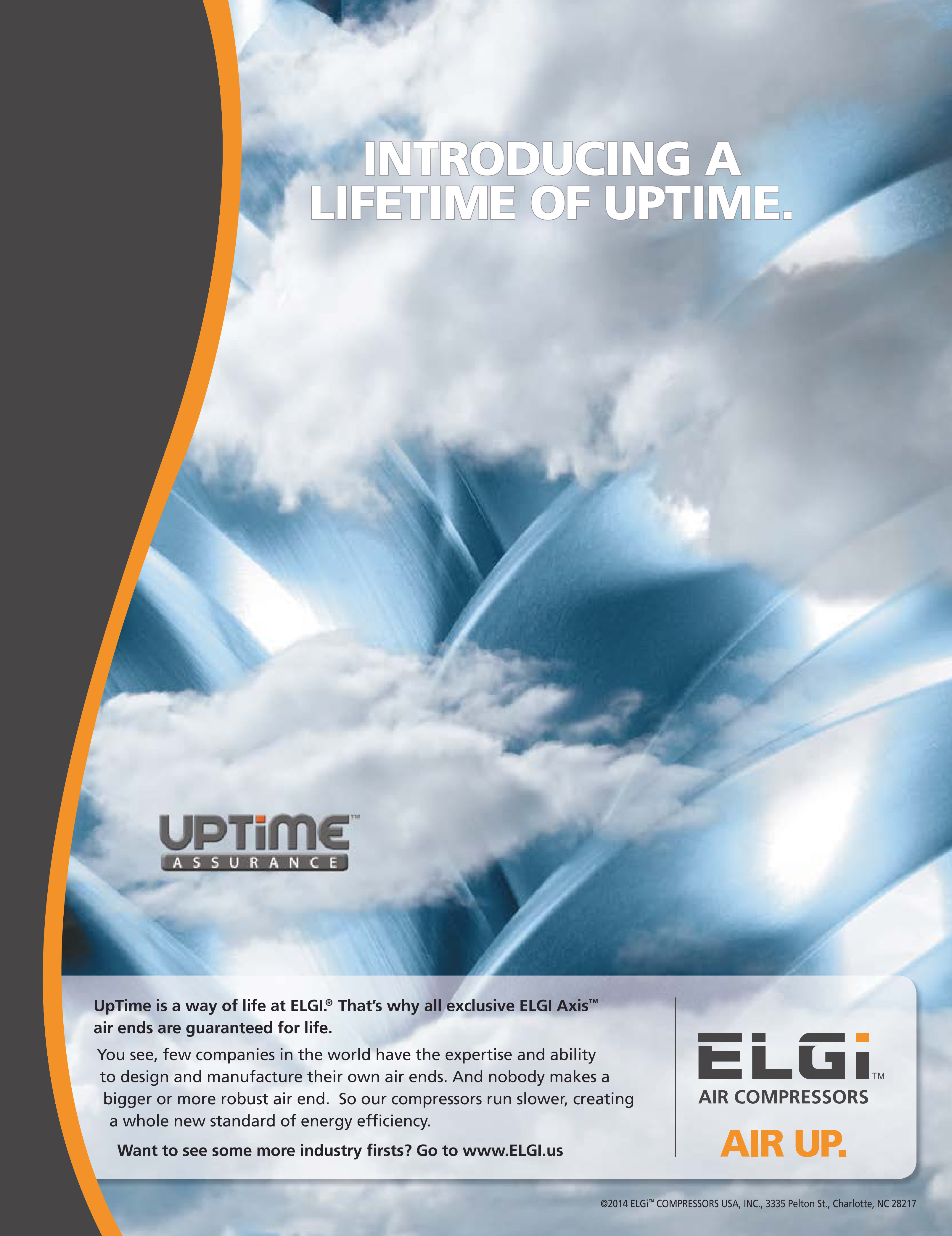
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INDUSTRY NEWS

Victor Arnold Joins Sullair as Vice President, Sales and Marketing, EMEA

Victor Arnold, Vice President, Sales & Marketing, EMEA

Sullair, an industry-leading compressed air solutions provider since 1965, announced the appointment of Victor Arnold as vice president, sales and marketing for EMEA. In this role, Arnold will lead Sullair sales and service teams across Europe, the Middle East and African markets with a focus on continued expansion of product offerings, improved distributor performance and customer enthusiasm.

"As we look to expand our geographic markets, Victor's background and experience will make him an invaluable resource," said Stefan Brosick, vice president, sales and marketing, Americas. "With a number of upcoming product launches, Victor will help Sullair prioritize its efforts, execute our new product introductions, develop our distribution and sales partner network, and understand our distributors' and customers' perspective with increasing clarity."

In early 2016, targeting European customers, Sullair launched the ShopTek™ CE lubricated rotary screw air compressor product family in two power ranges: 4-15 kW and 18.5-37 kW. The 4-15 kW line is offered in fixed speed, while the 18.5-37 kW line is offered in fixed speed or with an optional Variable Speed Drive. In addition to ShopTek CE, Sullair has launched a full range of medium and high-flow portable compressors from 550-1,050 cfm (15.5-29.7 m^3/min), which will be followed shortly by lower flow portable compressors in the 187-375 cfm (5.3 – 10.6 m^3/min) range to complete the offering.

Arnold joins Sullair from Barloworld Global Power, a multi-billion USD revenue multinational Caterpillar distributor, where he previously served as an executive director. He brings more than 25 years of international experience in manufacturing and distribution having worked in five countries in Europe and Africa in sales and marketing, as well as in general management roles.

Arnold, who is fluent in English, Spanish, Portuguese and Afrikaans, has a doctorate in business administration (DBA) from the International School of Management in Paris, France.

About Sullair:

Since 1965, Sullair has been developing and manufacturing air compressors with proven reliability, durability and longevity. Sullair offers complete compressed air solutions for customers ranging from road construction contractors to large manufacturing plants. Beyond air compressors, Sullair provides a full line of aftermarket solutions and air treatment products for optimal air compressor performance. Sullair has manufacturing capabilities in Michigan City, Indiana; Shenzhen and Suzhou, China; and Mahindra World City, India; as well as a JV (IHI-Sullair) based in Suzhou. For more information, visit www.sullair.com.

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About Accudyne:

Accudyne Industries is the parent company of Sullair, and a global provider of precision-engineered, process-critical and technologically advanced flow control systems and industrial compressors that deliver consistently high performance and give confidence to the mission of its customers in the most important industries and harshest environments around the world. Today, Accudyne is powered by ~2,800 employees with 14 manufacturing facilities, supporting a broad range of industries in more than 150 countries. For more information, visit www.accudyneindustries.com.

CalPortland Recognized as a ENERGY STAR® Partner of the Year-Sustained Excellence

CalPortland Company is a major producer of cement, concrete, aggregates, and asphalt in the western United States and Canada. CalPortland's energy program, formed in 2003, continues to expand to cover new areas of the company's operations.

CalPortland is receiving ENERGY STAR® Partner of the Year—Sustained Excellence recognition for advancing and championing energy management within the U.S. cement industry and among industry broadly. Key 2015 accomplishments include:

- Decreasing energy intensity by more than one percent in 2015 while integrating a new cement plant into its portfolio of production facilities. The company has improved energy intensity by 15 percent since 2003 for $85 million in savings.
- Leading the cement industry to conduct a finish mill benchmarking study to improve energy efficiency in these critical cement plant units.
- Completing numerous energy projects such as a cement kiln process improvement that uses microscopy to assist plant operators to improve kiln operation and energy consumption and a quarry fuel improvement that optimized rock transport and improved ore retrieval and blending for better kiln operation.
- Sharing its energy management expertise with prospective ENERGY STAR partners to help these companies build energy management programs.
- Challenging the company's sites to manage energy by taking and completing its corporate-wide energy challenge to save $1 million, achieving ENERGY STAR certification of a cement plant, and taking the ENERGY STAR Challenge for Industry at its aggregate, ready mix concrete, asphalt, and terminal sites.

For more information, visit www.calportland.com or www.energystar.gov

Endress+Hauser Invests in Raman Technology

Endress+Hauser is expanding its manufacturing facility for Raman analyzers. Wholly owned subsidiary Kaiser Optical Systems is investing 8.6 million US dollars

INDUSTRY NEWS

New construction: Endress+Hauser is investing 8.6 million US dollars to expand the manufacturing facility for Raman analyzers in Ann Arbor, Michigan in the US.

to develop the Ann Arbor, Michigan (US) location, which will more than double in size.

"The new facility will be the core of our future Raman-spectroscopic analyzer manufacturing," said Tim Harrison, Managing Director of Kaiser Optical Systems. The instruments, which will be deployed in both process control and laboratory environments, are designed for analyzing the composition and properties of solid, liquid and gaseous substances.

The new two-story facility, which is slated to open in mid-2017, will increase floor space from 3,500 to 8,100 square meters (38,000 to 87,000 square feet). "Our state-of-the-art manufacturing will allow us to produce higher volumes, while maintaining the high

Tim Harrison (right), Managing Director of Kaiser Optical Systems, and George Balogh, long-time head of Endress+Hauser's advanced analyzer business, break ground for the new facility.

quality standards our customers demand," emphasized Tim Harrison. The existing buildings will be renovated after completion of the new plant. Kaiser Optical Systems plans to create up to 50 jobs in Ann Arbor over the next few years.

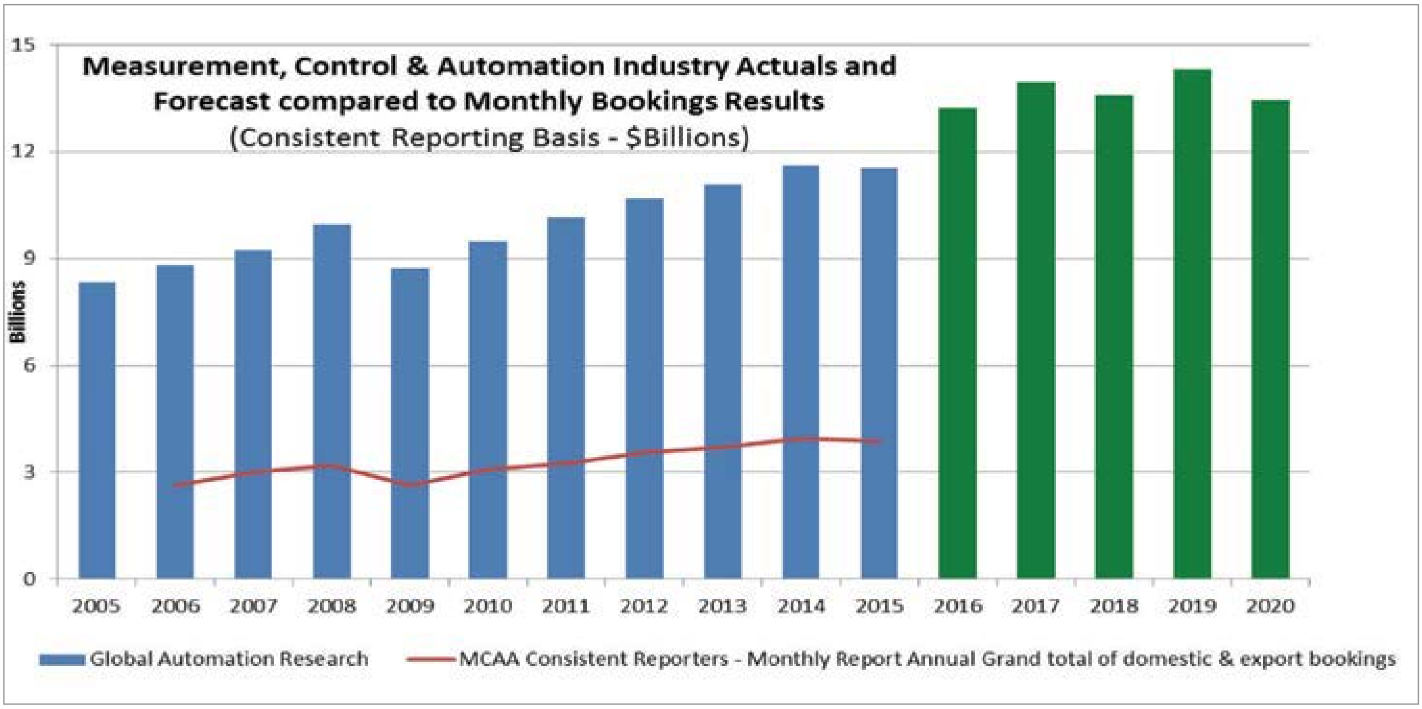
Kaiser Optical Systems Inc. employs some 100 people around the world and has been part of the Endress+Hauser Group since 2013. The company is a leader in the field of Raman spectrographic instrumentation and applied holographic technology. The acquisition of Kaiser Optical Systems underscores Endress+Hauser's strategic goal of employing advanced analytical technologies in process control applications and supporting the customer from laboratory to process.

The Endress+Hauser Group

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering. The Group employs 13,000 personnel across the globe, generating net sales of more than 2.1 billion euros in 2015. With dedicated sales centers and a strong network of partners, Endress+Hauser guarantees competent worldwide support. Our production centers in 12 countries meet customers' needs and requirements quickly and effectively. The Group is managed and coordinated by a holding company in Reinach, Switzerland. As a successful family-owned business, Endress+Hauser is set for continued independence and self-reliance.

For more information, visit www.endress.com.

INDUSTRY NEWS



MCAA Publishes 2015 Bookings Data

2015 bookings in the process measurement and automation industry declined approximately 4.4% members in various bookings reports. This report provides an overview of that data exclusively for members.

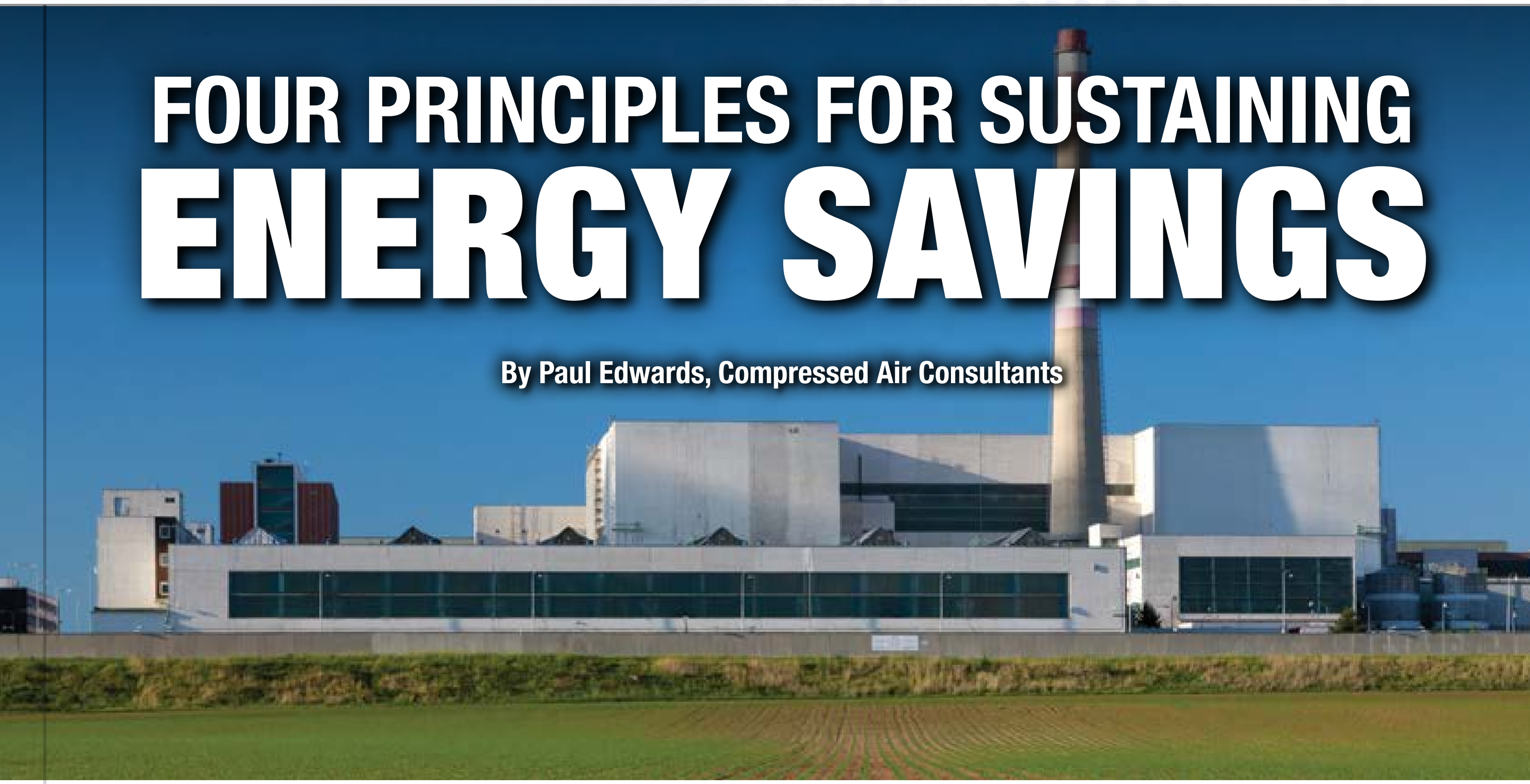
MCAA collects data from its member companies for a variety of reports. On a monthly basis, we collect Domestic and Direct Export bookings information for the US, Canada and Rest of World. Quarterly, the Association collects more detailed information by product category as well as by user industry. Bookings are also collected on a monthly basis from the distribution companies that are Channel Partner members of the Association. Data is reported in confidence and the Association takes great participating, a review of this information may help you understand the potential benefit of these programs.

Looking at data from companies that participated in the bookings reports consistently over the past 10 years, we see that bookings in 2015 took their first downturn after having trended upwards for several years after the "Great Recession" of 2009. In the six years since, bookings are up a total of 46.4%, however 2015 represents a decrease of 2.3% over the 2014 consistent reporter total bookings. To make this comparison, we used only data from companies that reported consistently over the 10-year period. Total actual bookings reported by all members participating in the bookings reports as of December 2015 was $5.8 Billion

In addition to data that is published from the aggregation of member-contributed data, Global Automation Research prepares an annual forecast for MCAA looking out 5 years.

The graph above shows the historical size of the industry as reported by Global Automation Research (blue) and the forecast going to 2020 (green). In RED is the actual reporting from 2006 through 2015 of a group of companies that have consistently reported to MCAA in the Monthly Bookings Reports. In the MCAA Monthly Bookings Report all data is completely historical for 24 months but that would not be representative going back this many years. The actual dollar volume for any one year would be higher than the totals shown here. Because the reporting base changes every year, for this graph, MCAA included only those companies which have reported since 2006 to show the MCAA trend as it stacks up against the actual results for the entire industry.

Visit www.measure.org for more information.



FOUR PRINCIPLES FOR SUSTAINING ENERGY SAVINGS

By Paul Edwards, Compressed Air Consultants

Introduction

When Compressed Air Consultants was starting, in 2003, we were approached by a company experiencing significant problems with their compressed air system. They had compressed air pressure problems causing production interruptions. They had moisture issues causing all kinds of havoc throughout the facility and appeared to be using far too many air compressors for what they wanted to accomplish.

The compressed air audit was performed and the project was implemented. The results were spectacular as the system went from running thirteen (13) air compressors down to seven (7) compressors. At the same time, air pressure was stabilized while air pressure was improved to more than acceptable levels. They did not purchase a single new air compressor, realized an annual energy savings well into six figures and the project delivered a very generous return on investment.

Fast forward to four years later when we called on the client. They were now running on twelve (12) air compressors and were having problems with the compressed air system again. You would think that somewhere along the line, some one would figure out there was a problem. But no one did. No flags were raised, no alarms sounded and no warning lights flashed. Money just poured down the drain.

We talked to several of the individuals who had implemented the project with us - as well as with others who joined the company after the project had been undertaken. They, like us, were disturbed when they saw the before and after snapshots. Everyone had good intentions throughout the audit, the implementation, and the ensuing years. We decided to do a post mortem and came to several interesting conclusions.

Four Principles for Sustaining Energy Savings

The root causes for the problems came down to four basic areas. First, there was a lack of system ownership. Second, there was a lack of understanding of how the system was supposed

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>
> — Paul Edwards, Compressed Air Consultants

to operate in both supply and demand. Third, there was a complete lack of feedback, which would have informed the individuals in the plant that a course correction was needed. Finally, there needs to be a bias towards action when the feedback says you are off course. Due to these root causes, no actions were taken when the compressed air system changed for the worse.

1. System Ownership

The odds of sustaining energy savings increase substantially if someone is in charge of the compressed air system. When responsibility was dispersed throughout the organization, the system began to slip and degrade over time. The lack of an air champion on the supply or the demand meant that operators within the facility could do what they wanted without having some check and balance within the plant.

2. Operator Supply and Demand-Side Knowledge

Operator training is a vital component in sustaining energy savings. In this case, a significant effort was put forth immediately after the audit and after the project implementation so that a dozen individuals understood how the system was supposed to operate. As the positions and job titles changed within the organization, new individuals came in and had zero understanding of how the compressed air system was intended to operate.

For instance, the brain of the system was the control system. When they opened the door to the motor control center where the brain existed, we found that several of the wires from the air compressors to the control panel were cut. Apparently, there was a low-pressure problem at some point and the operators on duty did not understand the control

FOUR PRINCIPLES FOR SUSTAINING ENERGY SAVINGS

system. Since they didn't know how to put the compressors into local control (which was really quite easy to do), they elected to cut all the wiring. The pressure problem went away and no one complained about the air system.

On the demand side, bad practices returned as newer operators weren't given an understanding of the cost of compressed air and the older operators reverted back to the norm. The organization ceased to care about the compressed air system from a cultural standpoint.

To sustain the energy savings of an implemented project, operator training (or reminders) on supply *and* demand needs to occur until the culture of the plant reaches a point where it is self-sustaining. In practice, this often takes years. If the compressed air champion is up to the task, he should lead these annual training sessions.

If the compressed air champion isn't the one to train, then the plant can have their outside compressed air expert take the lead on the program as the cost of training is a fraction of the savings. In this particular plant, annual training would have been less than 0.5% of the lost savings. It should be understood that training on the cost of compressed air and on supply-side and demand-side issues is very necessary.

3. Establish a Feedback Loop to Enable Course Corrections

The third principle is that there needs to be a better feedback loop when the system gets off course. This course correction can come in several forms but the principle comes down to quickly getting information to those that matter, allowing them to act on that information.

Perhaps the most effective way is to track flow and energy and chart that against plant output in terms of product (widgets). Measuring flow will allow the plant to benchmark the amount of air they use, per widget, which in turn gives them feedback on the efficiency of the way the air is being used.

Measuring energy allows the plant to measure the efficiency of how the compressed air is made when it is compared to flow. The SCFM/kW metric tells the plant if the supply side is operating as it should be. Consider what would have happened in this system. As the operators started to use compressed air in more and more wasteful ways, the scfm per widget would increase. If it were graphed, there would have been a clear upward trend.

When the wires were cut from the control system allowing all the air compressors to operate in local control mode (and most were modulating type compressors), the SCFM/kw metric would have seen a huge bump and been obvious to anyone looking at it. These feedback loops would have told the operators in the control room that something was amiss. That would allow them to inform other individuals in the plant to go investigate.

And what if the operators in the control room had little interest in the compressed air system? Well there could be a little feedback loop for them. For larger systems, it is quite easy to log this data and generate reports which can be fed to management. Imagine the amount of time it would take for someone in authority to look at two numbers such as the average SCFM per widget this month and the average kw/scfm. It would take all of 30 seconds. If the change was large enough, then the need for the course correction would be clear. If the control room operators ignored the issue, perhaps the plant manager would give them a course correction.

4. Bias Towards Action When Off Course

The final principle is the requirement to act upon the changes in the compressed air system. The most obvious one is the need for ongoing leak repair. In accordance with the second law of thermodynamics, chaos always increases without some kind of input. That means leaks are going to develop and those that are leaking are going to leak more without some type of energy or effort put into it.

The same holds true with the demand. There will be an increase in waste in systems over time as operators who don't understand, or don't care, do their thing to keep production flowing.

In addition, due to the cost of compressed air, manufacturers of equipment that produce and consume compressed air are continuously developing new, more efficient technologies. Hence, your plant's processes will become less and less optimized as technology changes.

The plant should schedule ongoing reviews, performed by outsiders, of the compressed air system. Sometimes it is just a new set of eyes that see something different that can make all the difference in the world. The compressed air reviews should cover leaks, demand-side and supply-side.

Conclusion

A significant portion of the projects that are implemented revert closer to the norm after a few years because the plant stops doing the things that got the great results in the first place. If the plant really wants to sustain those new-found energy savings, then something different needs to be done. These activities include designating an air champion, training operators on supply and demand, improving the feedback loop that something has gone awry and doing something about those issues once they are known. BP

For more information contact Paul Edwards, Compressed Air Consultants, Inc., tel: 704-376-2600, email: paul.edwards@loweraircost.com, www.loweraircost.com

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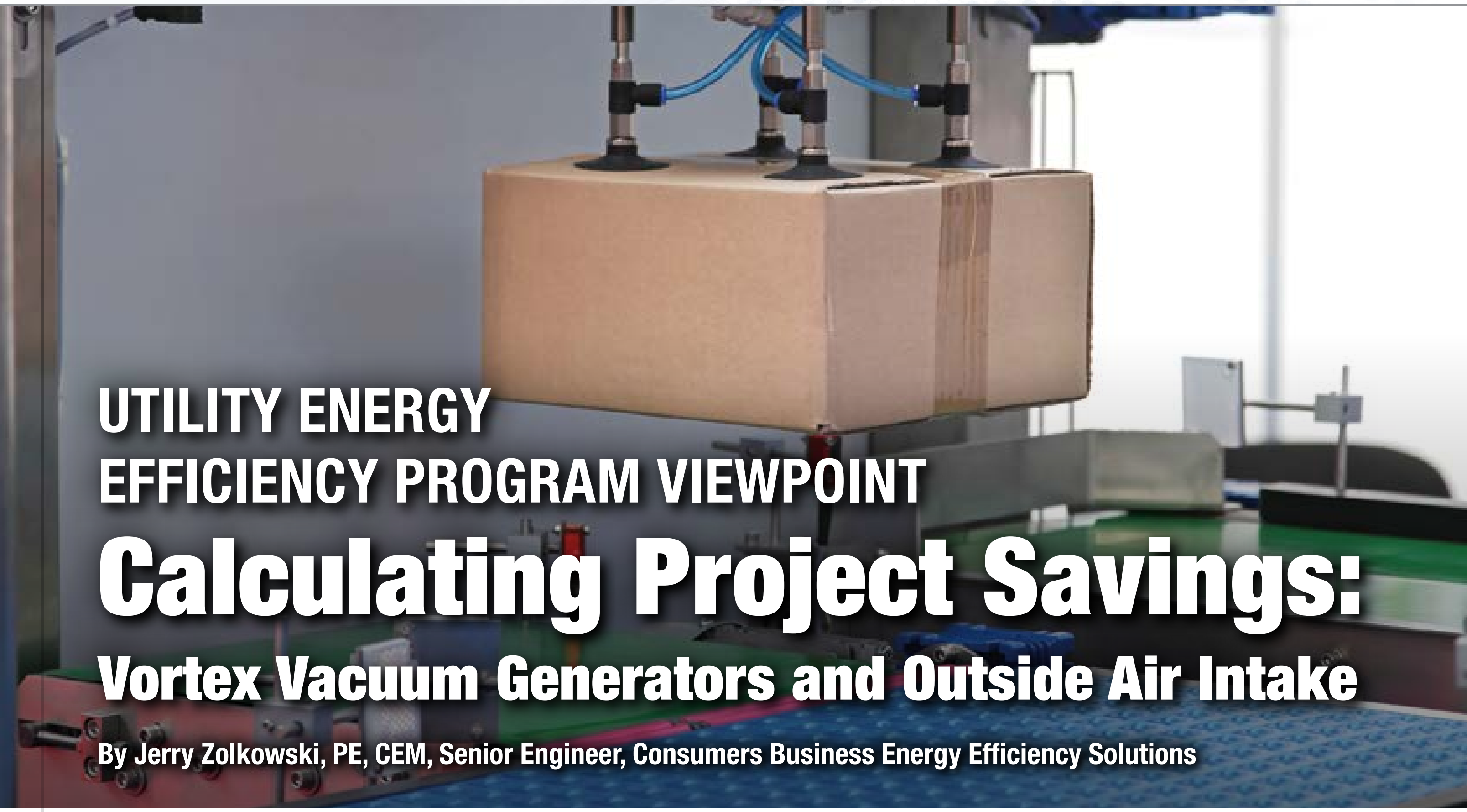

UTILITY ENERGY EFFICIENCY PROGRAM VIEWPOINT

Calculating Project Savings:

Vortex Vacuum Generators and Outside Air Intake

By Jerry Zolkowski, PE, CEM, Senior Engineer, Consumers Business Energy Efficiency Solutions

The intent of this article is to provide readers with simple examples of calculations one can perform to evaluate two sample energy efficiency projects for compressed air systems; pressure sensing vortex vacuum generators and outside air intake (for air compressors).

Project #1: Pressure Sensing Vortex Vacuum Generators

A vortex vacuum generator creates a vacuum by passing compressed air past an orifice. The air rushing past the orifice creates a low pressure which evacuates the vacuum line. A conventional system maintains compressed air flow the entire time suction is needed. A pressure sensing vacuum generator creates a vacuum by the same method, but it is also equipped with a vacuum pressure sensor and a check valve. Upon reaching the desired vacuum pressure, the compressed air flow is stopped. If the pressure sensor indicates that vacuum levels are not maintained, then compressed air flow is resumed. At the end of the cycle the compressed air is stopped and the vacuum line is opened to atmospheric pressure or a small puff of compressed air is used to push the part off.

While creating a vacuum with compressed air is inefficient compared to using vacuum pumps, vortex vacuum generators are ubiquitous for small volume applications. These are commonplace for robotic parts movement and packaging machines using suction cups. Their compact size, high degree of control, and low cost make them an attractive solution for providing the suction needed at the end of robotic arms to move parts, and the modest compressed air demand can generally be accommodated by existing compressed air plants.

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The ability to use compressed air to create this vacuum only when needed based on pressure instead of running constantly while the vacuum is in use represents an energy savings.

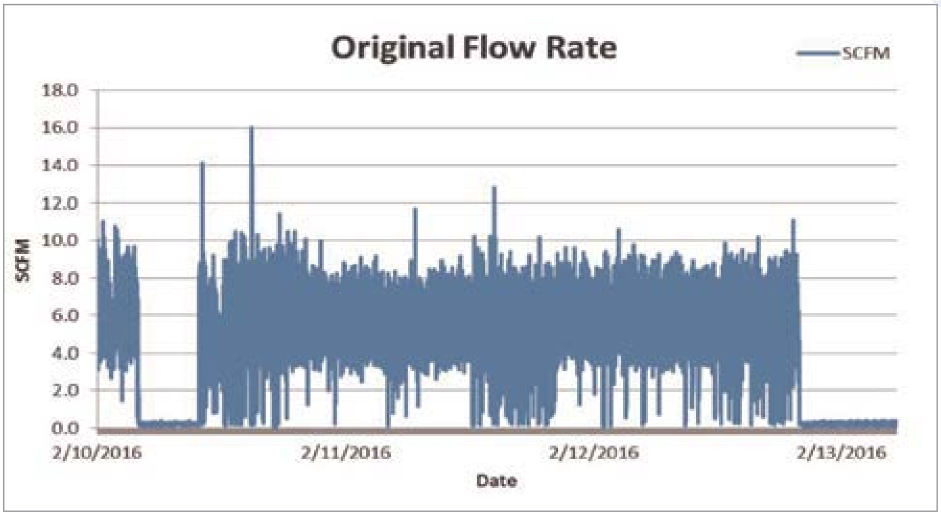
Compressed Air Savings

Manufacturer claims reach up to a 90% reduction in compressed air use[2]. However this is highly dependent on the cycle time and the amount of vacuum loss in the system. The system vacuum loss depends on the porosity of the surface for suction cups and the amount of leakage. When idle and waiting on parts, compressed air flow is shut off. While the manufacturer claims are likely to be correct, it applies to situations where the cycle and hold times are long. In this type of case, maintaining the vacuum would account for a much larger portion of the cycle than initially evacuating the system.

Articles in Compressed Air Best Practices describe one case study on a corrugated cardboard handler where suction cups were used at the end of a robot arm identified 30-50% savings[3]. An automotive case claimed 98% savings[4] for a sheet metal handling application.

The Consumers Energy Business Energy Efficiency Program conducted a study at a plastics parts manufacturer on a single production cell with three vacuum generators. The production cell consisted of an injection molding machine served by robotic removal of parts from the molding machine. An external data logging compressed air flow meter was used to record air flow with the original vacuum generators and the new pressure sensing vacuum generators. The number of production pieces during the monitoring periods was tracked in order to establish compressed air use per piece, and the nominal rate is about 3,000 pieces per day (or two per minute). The original flow recording is shown in the following graph:

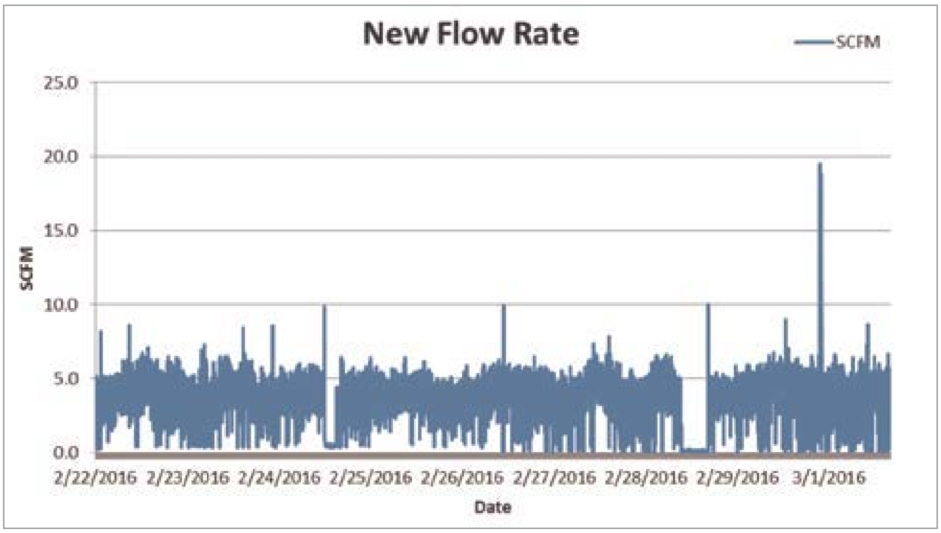
- The production during this period was 9,338 pieces.
- The average compressed air flow rate was 5.55 scfm.
- And the amount of compressed air consumed was 19,257 standard cubic feet.
- Dividing the compressed air use by the production creates a metric of 2.062 ft³/piece.



CALCULATING PROJECT SAVINGS: VORTEX VACUUM GENERATORS AND OUTSIDE

Monitoring was repeated after changing to pressure sensing vacuum pumps. The new flow recording is shown in the graph below:

- The production during this period was 26,683 pieces.
- The average compressed air flow rate was 3.469 scfm.



- And the amount of compressed air consumed was 43,261 standard cubic feet.
- Dividing the compressed air use by the production creates a metric of 1.621 ft^3/piece.

The percentage savings for the metric in this case is given by the following:

$$\%\ Savings = \frac{Original\ metric - New\ metric}{Original\ metric}$$

$$\%\ Savings = \frac{2.062\ \frac{ft^3}{piece} - 1.621\ \frac{ft^3}{piece}}{2.062\ ft^3/piece}$$

$$\%\ Savings = 21.4\%$$

At a production rate of about two pieces per minute, this system would have a brief hold time for the parts which is a case where the pressure sensing technology offers the least advantage, but savings were still demonstrated.

Calculating Percentage Savings

The documented savings vary from 21% to 98% of compressed air use when applied to production systems. This wide variation suggests that users wanting to estimate a payback should first obtain the run time of the vacuum generator. When hold times are brief or there is leakage due to porous surfaces or worn cups, then the savings percentage will be lower.

As an example, assume that 60% savings are obtained during the time the basic vacuum generator is running. Further assume that the generator runs half the time and is idle (off) the other half and there is no air flow. A savings can be predicted based on the rated compressed air consumption of the vacuum generator.

$$percentage\ savings = (60\%\ running\ savings)(50\%\ run\ time)$$

$$percentage\ savings = 30\%\ savings\ of\ rated\ flow$$

AIR INTAKE

Vacuum pumps vary in size, so this is done based on 1 cfm of rated compressed air flow for the vacuum generator. The average cfm savings are thus given by the following:

$$\textit{average cfm savings} = (\%\ \textit{savings})(1\ \textit{cfm})$$

$$\textit{average cfm savings} = (30\%\ \textit{savings})(1\ \textit{cfm})$$

$$\textit{average cfm savings} = 0.30\ \textit{cfm savings per cfm of rated flow}$$

Compressed air generation efficiency is taken to be 0.20 kW/cfm. So the kW savings become the following:

$$\textit{kW savings} = (\textit{compressed air efficiency})(\textit{cfm savings})$$

$$\textit{kW savings} = (0.20\ \textit{kW/cfm})(0.30\ \textit{cfm savings per cfm of rated flow})$$

$$\textit{kW savings} = 0.06\ \textit{kW per cfm of rated flow}$$

For a three shift operation of 6000 hr/yr this becomes 360 kWh per cfm of rated compressed air flow capacity. Typical compressed air flow capacity is 1-10 scfm for each vacuum generator. For a vacuum generator rated to use 3 cfm and an electricity cost of $0.10/kWh, the annual savings would be 1,080 kWh and $108.

The cost of each of the three pressure sensing vacuum generators in the Consumers Energy study was under $300, so these are relatively inexpensive and can offer a reasonable payback. When replacing the conventional vacuum generators, the incremental cost to upgrade to pressure sensing vacuum generators will be even less. While each individual vacuum generator may have a modest amount of compressed air use, this is a compressed air best practice that can have a facility impact when deployed over an entire site with dozens of vacuum generators.

CALCULATING PROJECT SAVINGS: VORTEX VACUUM GENERATORS AND OUTSIDE

OUTDOOR AIR INTAKE ENERGY SAVINGS	
OUTSIDE AIR TEMPERATURE	ENERGY CHANGE FROM BASELINE
35	-8.3%
40	-7.4%
45	-6.5%
50	-5.6%
55	-4.6%
60	-3.7%
65	-2.8%
70	-1.9%
75	-0.9%
80	0.0%
85	0.9%
90	1.9%
95	2.8%
10	03.7%
80 degree F Baseline Temperature	

Project #2:: Outdoor Air Intake Calculations

Many recognize there is a modest efficiency gain by using an outdoor air intake to the air compressor instead of using warm plant air. Sometimes the air compressor inlet air is even taken from hot compressor rooms. One rule-of-thumb is there is a 1% energy savings for every 10˚F drop in inlet temperature[4].

The basic principle for this is cooler air is denser, so the air compressor has to perform less work to reach the desired air pressure. Typically, outdoor air temperatures are lower than plant or air compressor room temperatures, so there is a savings by ducting outside air to the compressor inlet. The amount of compressor work is proportional to the absolute temperature of the intake air. The reduction in work resulting from lowering the intake air temperature is given by the following formula and example:

$$W_{reduction} = (T_{Indoor} - T_{Outdoor}) / T_{Indoor}$$

Where:

$W_{reduction}$ = Work reduction, no units

T_{indoor} = Indoor air temperature at the compressor inlet, 80˚F + 460 = 540˚R

$T_{outdoor}$ =Average outdoor air temperature, 55˚F + 460 = 515˚R

Here it is assumed that the compressor room temperature is 80˚F and the average year-round outside temperature is 55˚F. The temperatures are converted to an absolute temperature in Rankine.

$$W_{reduction} = (540˚R - 515˚R) / 540˚R$$
$$= 0.0463 \text{ or } 4.63\%$$

Applying this to various temperatures from a baseline of 80˚F produces the following table:

The annual savings can then be estimated from an estimate of the air compressor energy use multiplied by the percentage savings. For example a 100 hp VSD air compressor may draw an average of 50 kW for 4000 hours a year thus using 200,000 kWh and costing $20,000/yr in electricity at a price of $0.10/kWh. A 5% savings would be worth about $1,000.

Implementation

As with any project, the cost to implement this has to be reasonable since the savings may be modest. A great many air compressor rooms are located on outside walls or in sheds

AIR INTAKE

which helps keep the duct run short and less costly. A screen to keep out animals and debris may be useful. A few ways that can help keep the installation cost reasonable include the following:

- Include the outside air intake as part of a larger project for new construction or new compressor acquisition.
- Use flex duct between the compressor inlet and the outdoors. The inlet to many compressors is several inches, and flexible ducting may fit and take little labor to install.
- Where a compressor already pulls in outside air for cooling, duct from the intake side of the cooling duct to the compressor inlet. This is a very short run.

Using an outside air intake for the compressor inlet air is a compressed air best practice. It offers modest savings, and where the installation cost is reasonable can provide a good return on investment. BP

For more information contact Jerry Zolkowski, PE, CEM, Senior Engineer, Consumers Business Energy Efficiency Solutions, tel: 517-481-2972, email: Gerard.Zolkowski@dnvgl.com, www.consumersenergy.com

Sources of Information

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Managing Pressure Regulator ARTIFICIAL DEMAND, Part 2

By Murray Nottle, Working Air System Engineer, The Carnot Group

Introduction

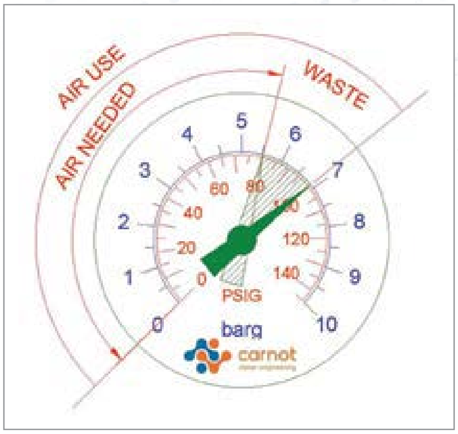
This is the second article on how and why pressure regulators can waste air. The first article raised these points:

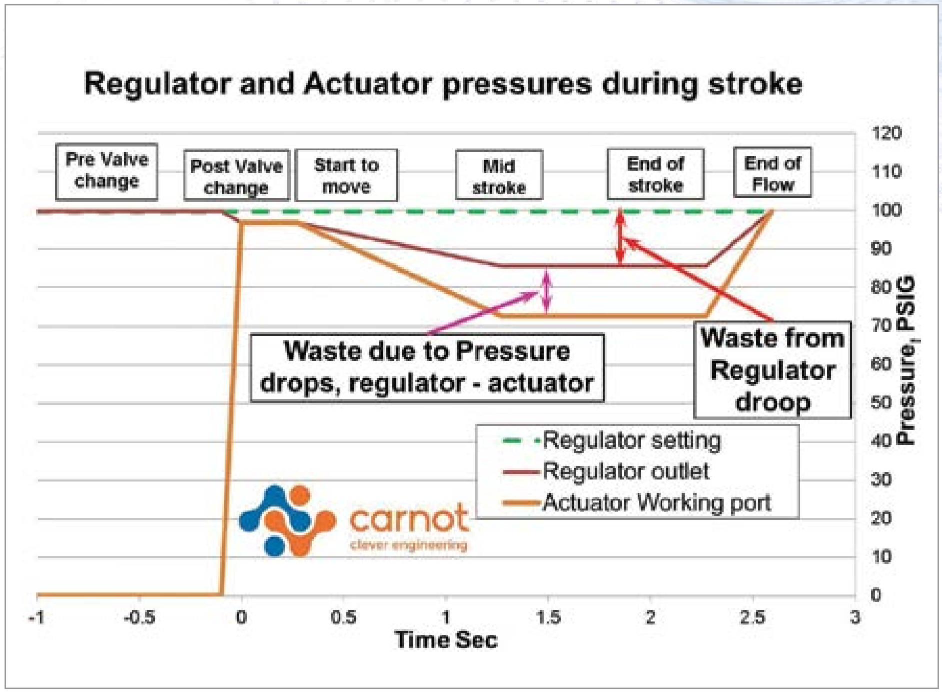
- A pressure gauge is like an air use gauge. A higher air pressure results in higher air use.
- When a machine operates, there will be a minimum regulator outlet pressure during the cycle. This is the minimum "with flow" pressure. Any pressure above this value wastes air by artificial demand.
- The drop in regulator outlet pressure from the "no flow" value to the minimum "with flow" value is called "droop". Droop wastes air.
- Droop is caused by:

1. Mechanical setting spring rate effects.
2. Variation in the "with flow" regulator supply pressure. Usually due to undersized supply piping or dirty filter elements upstream.
3. The regulator being too small.
4. The regulator design.

"By taking care with regulator selection and installation, regulators can save large amounts of air instead of wasting it."

— Murray Nottle, Working Air System Engineer, The Carnot Group





- The regulator valve is like a variable diameter hole. Its size varies with the droop in regulator outlet pressure from "no flow" to "with flow" conditions. As a hole will flow more air with a higher upstream pressure than a lower one so does a regulator valve. So "rated flow" values are often shown based on high supply pressures to exaggerate the regulator performance.

- The valve is opened by a pilot force. A feedback force opposes the pilot force allowing the valve spring to close the valve.

The first 3 causes of droop were explored in the first article. This second article covers regulator design, discusses ways to reduce droop and some special case situations.

Regulator Function

Most regulators are "forward" or "downstream" sensing types. They try to control the downstream pressure. If a "relieving" type they will vent air from the downstream system if the pressure goes above the no flow setting. This is often done by the diaphragm lifting off the top of the valve stem to open a small hole from the diaphragm chamber to the vented spring cap.

MANAGING PRESSURE

The plot of regulator and actuator port pressures shows regulators are not the only cause of droop. It is also caused by pressure drop in all items in a circuit between the regulator outlet and actuator. This includes, piping, lubricators, Direction Control Valves (DCVs), flow controllers and high loss tube fittings (elbows, Tees).

Tubing from a DCV to an actuator increases the wasted volume (and artificial demand) of a circuit so keep it short. Bigger tubes increase wasted volume but reduce pressure drop which also varies with tube length and the actuator size and speed. So picking the optimal tube size is not easy.

An air pilot regulator with high relief flow acts like a 3/2 DCV. If used at the actuator port it removes other sources of artificial demand. There are valves that combine a regulator and 3/2 function. Some are like a regulator, others a spool valve and some as a mix of both.

Such a valve could be controlled by an existing circuit with a small regulator to set the pilot pressure.

Back pressure or pressure relief regulators sense the "backward" or "upstream" pressure and only flow if it is above the set pressure. They are different to a relieving forward regulator. Forward sensing is the most common regulator so this function is not normally stated in the regulator description. As "back pressure", "differential", "proportional" and other regulators are different to a forward sensing type, the function is stated in their descriptions.

REGULATOR ARTIFICIAL DEMAND, PART 2

Regulator Design

For a simple regulator, the pilot force opening the regulator valve is created by a mechanical spring. The opposing feedback force is created by the downstream air pressure working on the underside of a diaphragm. There are different pilot, diaphragm, valve and feedback designs. More complex designs cost more.

The sketches below are some examples of forward sensing regulator designs. The "air pilot, external sensing" is also a differential pressure regulator. The main design differences for back pressure regulators are:

- The valve disc is on the diaphragm side (above) of the seal edge.
- The diaphragm chamber is connected to the regulator inlet not outlet.

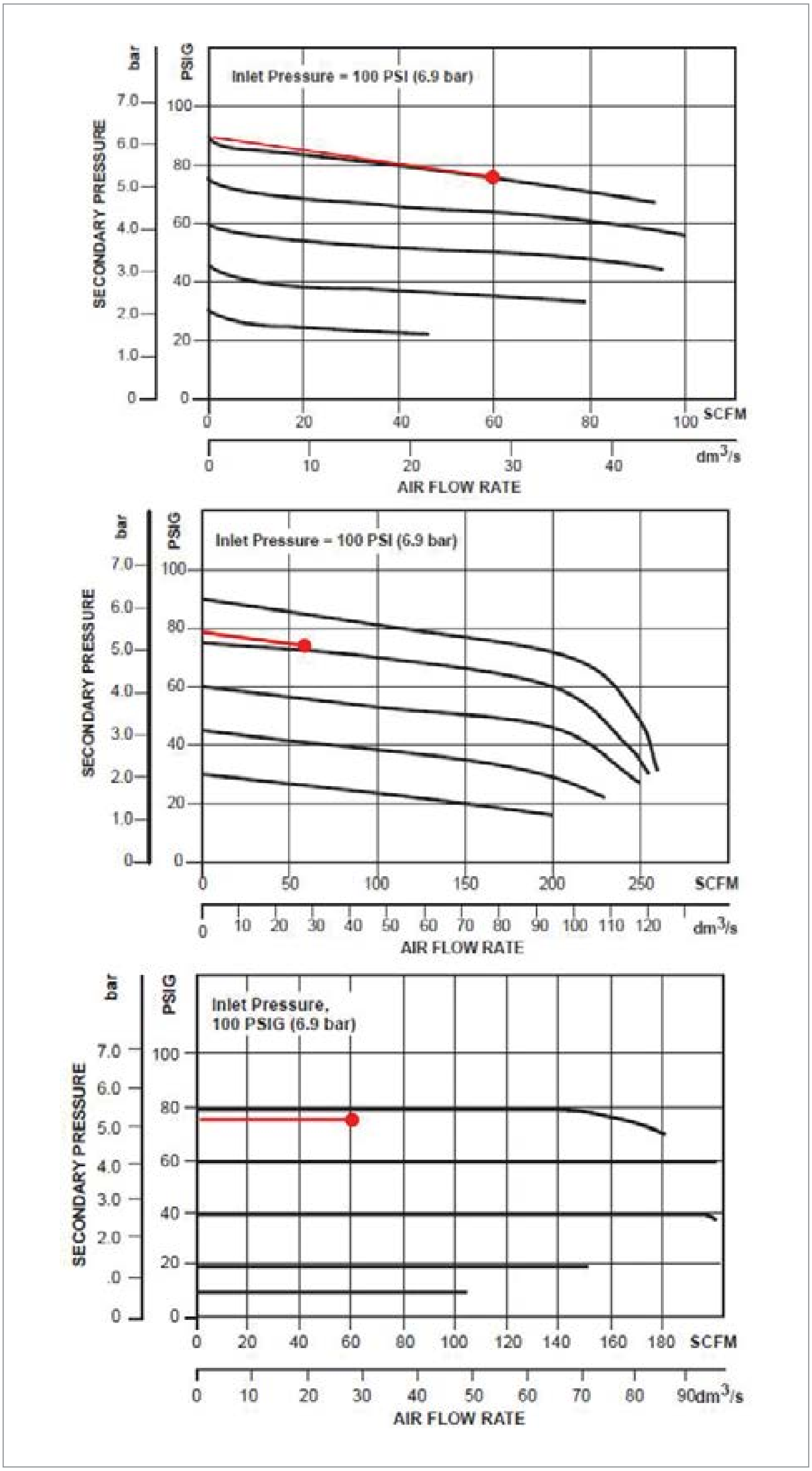
How to Reduce Regulator Droop?

Of the four main causes of regulator droop, three are due to the regulator design, size and

COMMON TERMS RELATED TO REGULATOR DESIGNS

PILOT TYPE	PILOT FORCE CREATED BY:
Spring, mechanical	A mechanical spring.
Air, external pilot	Air pressure on top of the diaphragm.
Spring with pressure loading	A mechanical spring and air pressure on top of the diaphragm
Air, internal pilot.	The regulator has a small spring pilot regulator inside it. The outlet pressure from this regulator works on top of the main regulator diaphragm. Some regulators of this design bleed a small amount of air as part of their operation.
VALVE DESIGN	
Unbalanced	The valve disc has a pressure difference across it. This can cause increasing outlet pressure as the supply pressure falls.
Balanced	The valve disc has a hole in it which equalizes the pressure on both sides. The "non flow" side of the valve disc has a seal system. This can be like a piston with a sealing ring working in a cylinder. The "piston" and valve sealing edge being the same diameter. As the pressure and the area it works on are the same for both sides of the valve disc, the pressure forces on the valve disc are balanced. A balanced valve minimizes supply pressure effects.
DIAPHRAGM CHAMBER DESIGN AND FEEDBACK SOURCE	The feedback pressure on diaphragm should reflect the downstream static pressure. There should be no air speed pressure effects.
Open Chamber	High speed air from the valve sealing edge can strike the diaphragm. This causes a higher feedback force. Increased flow causes a lower outlet pressure i.e. more droop.
Closed Chamber	A closed chamber stops high speed air hitting the diaphragm and so has less droop.
Internal feedback sensing	"Feedback", "aspirator", "sense" and "balance" all refer to providing a feedback pressure to the underside of the diaphragm. Internal sensing uses the pressure inside the regulator. For a closed chamber this needs a hole or tube to connect the regulator outlet port to the diaphragm chamber. A hole can suffer air speed pressure effects so a tube with its opening facing downstream is best.
External/remote feedback/sensing	The diaphragm chamber is sealed to any other pressure in the regulator. A port connects the external pressure signal to the diaphragm chamber. External feedback allows correction for droop in other pneumatics parts downstream and so aids precise pressure control.

MANAGING PRESSURE REGULATOR ARTIFICIAL DEMAND, PART 2



peak flows. "Design" and "size" need regulator replacement. Peak flows can be lowered by:

- Setting the regulator to the lowest outlet pressure for the equipment to work properly.
- For equipment fed by the regulator:
  - Fix air leaks.
  - Fit economiser regulators to actuator return strokes.
  - Use high efficiency nozzles and vacuum venturis.
  - Reduce wasted volume between valves and actuators.
  - Reduce pressure drop between the regulator and the equipment it is supplying.
  - Split the flow and put some of the demand through a second regulator.
  - If there is a high air using device, fit a high relief flow air pilot regulator to it.
  - Using an air tank between the regulator and valve bank.

The fourth cause of regulator droop is from dirty upstream filters (replace them) and undersized piping connected to its inlet and outlet. If upsizing pipes, the new pipe internal diameter should be 3 times the port size of the device supplied by the regulator.

When choosing a new or replacement regulator:

- Use a regulator with a bigger rated flow as it will have less droop. Beware that too big a regulator may be unstable at low flows and cost more than other options.
- Use a low spring rate or air pilot design.

- Use external feedback to correct for downstream pressure drops.

These graphs are for regulators flowing 60 SCFM at an outlet pressure of 76 PSIG.

If this regulator is supplying an actuator:

- The bigger regulator will use 13% less air.
- The air pilot regulator will use 15.6 % less air.

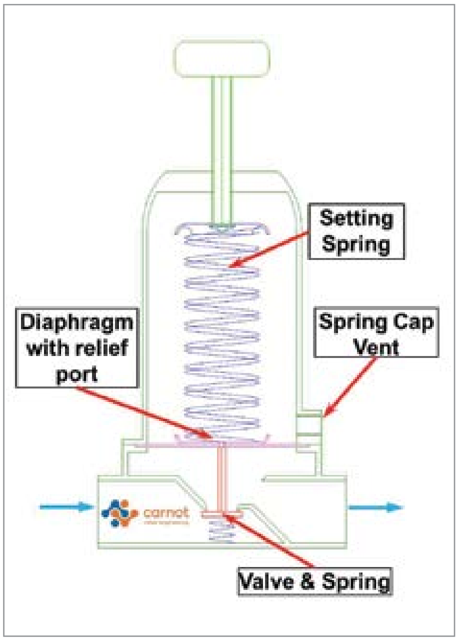
Special Cases

Some special cases need extra thought when choosing a regulator. These include:

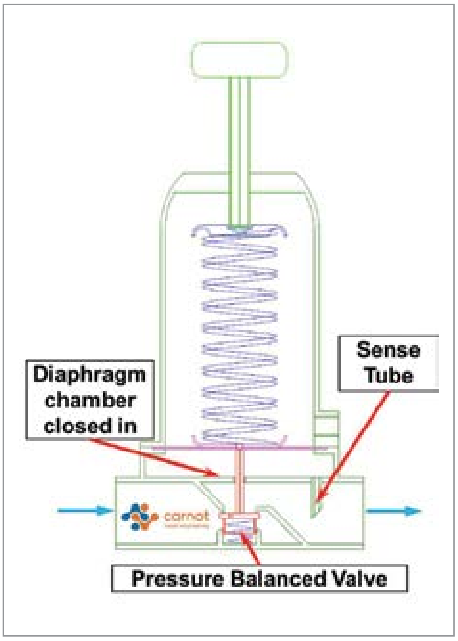
Economiser regulators:

- Are used between a valve and an actuator to reduce the pressure and air used during one of the actuators strokes. For example where the actuator needs to create more force in one direction than the other, it would be used on the lower force direction.
- Must allow reverse air flow. A regulator with
  - A balanced valve doesn't allow reverse flow. A check valve (often built in) with this regulator will allow reverse flow. At the start of reverse flow air passing through the check valve lowers the outlet pressure. The regulator valve then opens allowing easy reverse flow.

	RATED FLOW, SCFM	NO FLOW SETTING PSIG	DROOP %
Top, small spring pilot	97	90	15.6
Center, big spring pilot	170	78	2.6
Bottom, air pilot	180	76	0



Basic design: Spring pilot, relieving. Unbalanced valve, open diaphragm chamber so internal sensing.



Most common design: Spring pilot, relieving. Balanced valve, closed diaphragm chamber. Internal sensing.

MANAGING PRESSURE REGULATOR ARTIFICIAL DEMAND, PART 2

- An unbalanced valve opens naturally at the start of reverse flow due to supply pressure effects on the feedback force. Supply pressure effects can work to reduce droop at end of stroke. So an unbalanced regulator may be better than a balanced one and will likely be cheaper.

- Add to the wasted volume (and artificial demand) of the piping between the valve and the actuator. So using a bigger regulator may not return the expected savings.

Outlet set pressure close to supply pressure.

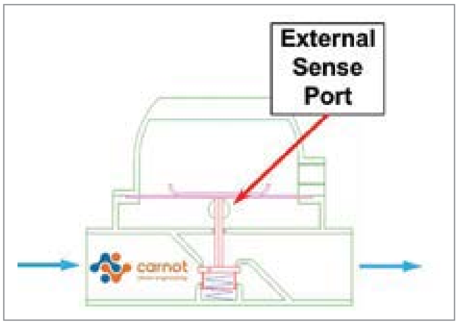
While air pilot regulators give very low droop, the pilot pressure must be sufficient to overcome the force of the valve spring.

This can require:

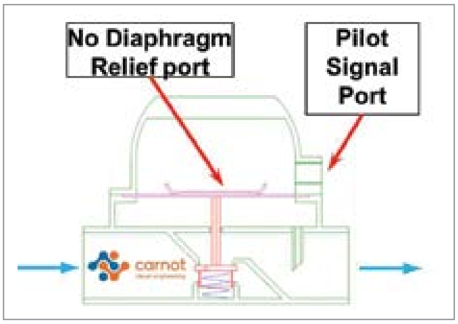
- A minimum pressure difference between the supply and outlet pressures.
- A higher system pressure that increases the air and power use by the wider air system.

Options include using:

- An external air pilot regulator where the supply to the pilot regulator is kept above the supply pressure when the main regulator.
- A pressure loaded spring regulator. Best with an external feedback regulator to supply the loading pressure.
- An oversized spring pilot regulator and reduce the peak flow.



Air pilot, non-relieving. Balanced valve, closed diaphragm chamber, internal sensing.



Air pilot, non-relieving, external sensing. Balanced valve, closed diaphragm chamber.

Conclusion

This article has discussed different aspects of regulator design and how they affect air wasted by droop. Some ways to reduce droop have be shown and some special case situations discussed.

By taking care with regulator selection and installation, regulators can save large amounts of air instead of wasting it. BP

For more information please contact Murray Nottle, The Carnot Group. mnottle@carnot.com.au, www.carnot.com.au

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CAGI DISCUSSION: MOTOR CONTROLS in Centrifugal Air Compressors

By Roderick Smith, Compressed Air Best Practices® Magazine

Compressed Air Best Practices® (CABP) Magazine and the Compressed Air and Gas Institute (CAGI) cooperate to provide readers with educational materials, updates on standards and information on other CAGI initiatives. CABP recently caught up with Rick Stasyshan, Technical Consultant for the Compressed Air and Gas Institute (CAGI) and with Ian MacLeod, from CAGI member-company Ingersoll Rand to discuss the topic of motors on centrifugal air compressors.

The days are long gone when power to a motor was controlled with a knife switch. These were cumbersome and downright dangerous - to man and equipment alike. Every electric motor has some form of controller, responsible for turning over (starting) the motor or motor-controlled equipment. These controllers offer different features and complexity depending on the application. The United States electrical codes require the use of a motor starter meeting NEMA's National Electrical Code as well as all local electrical codes.

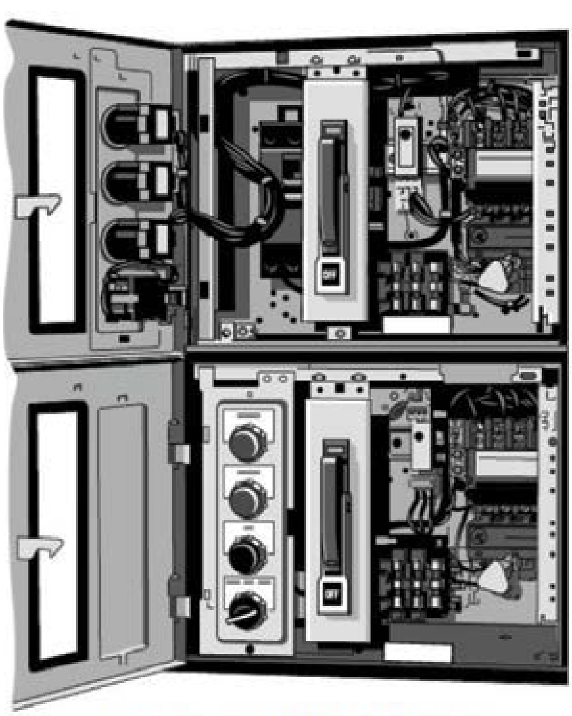
> "The days are long gone when power to a motor was controlled with a knife switch. These were cumbersome and downright dangerous - to man and equipment alike. Every electric motor has some form of controller, responsible for turning over the motor or motor-controlled equipment."
>
> — Roderick Smith, Compressed Air Best Practices® Magazine

CABP: We understand that centrifugal air compressors cover a broad horsepower range. How do the motor control technologies offered differ over this product range?

CAGI: There are indeed several offerings. Today, CAGI's Centrifugal Compressor Section's members offer smaller size centrifugal air compressors that overlap with some of the larger screw compressors. Thus, these small centrifugal air compressors may have a motor starter built into the compressor package like their screw compressor counterparts. This is a common accessory for lower voltage packages of 230, 460, or 575 volts up to about 450 HP. The starter not only controls the power supply to the motor, but protects the motor and wiring system from overloads caused by direct shorts or a faulty motor.

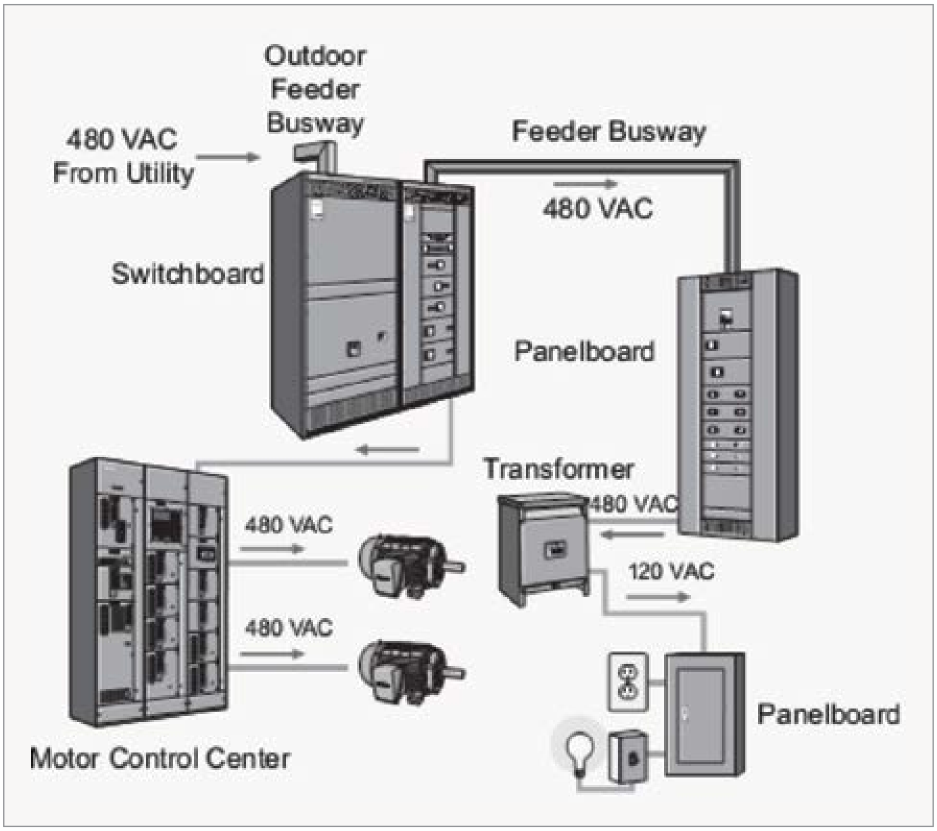
CABP: Can we assume that as the centrifugal air compressor sizes increase, the motor control offerings also differ?

CAGI: They do change. For medium voltage packages of 2300 or 4160 volts, high voltage packages and/or compressors above 450 HP, starters are often provided by the air compressor supplier as a standalone shipped-loose item for field installation or provided by a supplier of the customer. These can be locally installed near the compressor or in the customer's central motor control center (commonly called a MCC).



Combination Motor Control Units

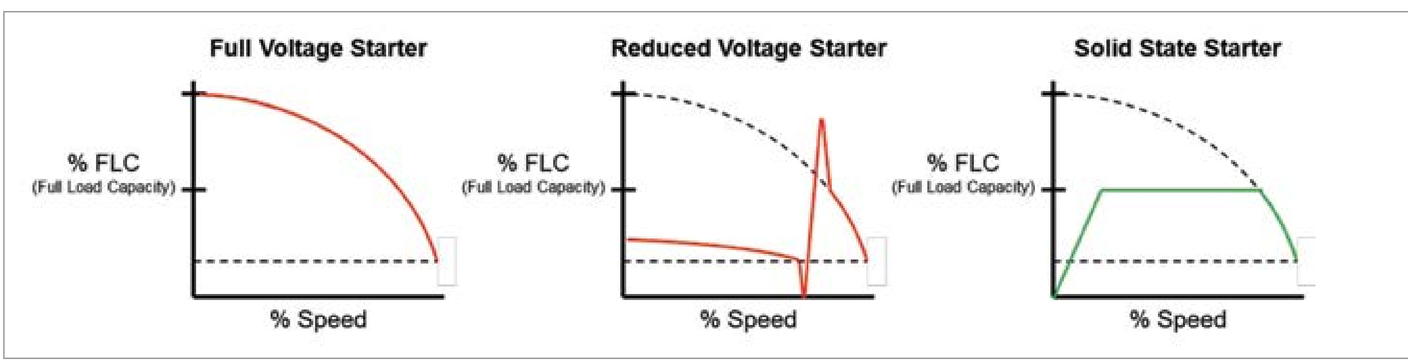
CAGI DISCUSSION: MOTOR CONTROLS IN CENTRIFUGAL AIR COMPRESSORS



An MCC is a floor-mounted assembly including one or more enclosed vertical sections, horizontal and vertical buses for distributing power and principally contains a combination of motor control units. Various certifying organizations have created standards on low, medium and high voltage controllers and motor control centers. A few of these standards include NEMA ICS-18-2001 and UL 845 for low voltage controllers less than 600 volts, as well as UL 347 for medium voltage control centers up to 7,200 volts.

CABP: Can you enlighten our readers on the various technologies available, how they operate and differ?

CAGI: The motor controller dictates how the motor will start and is made up of two key aspects: contactors and overload protection. Contactors control the electric current to the motor, with the core function of repeatedly



"Centrifugal air compressors commonly utilize one of three types of motor controllers, full voltage, reduced voltage and solid state."

— Rick Stasyshan, Technical Consultant, CAGI and Ian MacLeod, Ingersoll Rand establishing and interrupting an electrical power circuit. Overload protection protects the motor from drawing too much current and overheating. Optional features on some motor controllers include temperature monitoring and thermal sensors.

Centrifugal air compressors commonly utilize one of three types of motor controllers, full voltage, reduced voltage and solid state.

Full Voltage Starters: Also known as across the line, full voltage starters are the simplest and oldest method of motor starting. As the name implies, they require full line voltage using up to 6-8 times full load amps during start-up. Starting a motor with full voltage is similar to "dropping the clutch" in your automobile while revving the engine. Application considerations include mechanical stress on the motor and drive components as well as voltage dips. In some situations, starting with full voltage can result in voltage dips not only in the customer's facility but also neighboring users. Full voltage starting can be an economical solution if the system and components are properly designed to accommodate the resultant forces.

Reduced Voltage Starters: The two most common types of reduced voltage starters are wye-delta and autotransformer. Despite the term "reduced voltage starter" the full line voltage is still being applied to the motor leads with reduced voltage occurring because of the electrical characteristic of the wye vs. delta relationship. Both of these electro-mechanical starters transfer a reduced amount of voltage initially and then step up to full voltage. Reduction of the starting voltage results in lower inrush amps and less stress on mechanical components. The star-delta starter requires a specifically designed motor. An autotransformer starter typically has three voltage settings – 50%, 65% or 80% of full voltage.

Solid State Starters: Also known as soft starters, solid state starters gradually apply power to bring the motor up to full speed over a longer period of time – usually in the range of 15 to 30 seconds helping to reduce demand

CAGI DISCUSSION: MOTOR CONTROLS IN CENTRIFUGAL AIR COMPRESSORS

on the power supply. Solid state starters are able to meet the starting requirements of the air compressor while providing a smooth start and minimizing amps. These starters are very flexible and can be adjusted to match the application requirements. Solid state starters are the best choice for centrifugal air compressor motors.

In summary, there are many viable methods to start centrifugal air compressors. It is recommended to consult with the air compressor manufacturer, local utility company and electrical contractor before making any decisions. Choosing the right starter will ensure equipment and electrical system reliability.

CABP: Where can readers learn more about this and other CAGI programs?

CAGI: From Members of the CAGI Centrifugal Compressor Section and from the Compressed Air and Gas Institute.

For more detailed information about centrifugal compressors or answers to any of your compressed air questions, please contact the Compressed Air and Gas Institute or a CAGI Centrifugal Compressor Section. The Compressed Air and Gas Institute is the united voice of the compressed air industry, serving as the unbiased authority on technical, educational, promotional, and other matters that affect compressed air and gas equipment suppliers and their customers. CAGI educational resources include e-learning coursework on the *SmartSite,* selection guides, videos and the *Compressed Air & Gas Handbook.* For more information, visit the CAGI web site at www.cagi.org BP

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COMPRESSED AIR SYSTEM COSTS MEET THE REAL WORLD

By Ron Marshall for the Compressed Air Challenge®

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There is an often-quoted ratio of 7.5 hp input to one horsepower output used to illustrate the inefficiency of the energy transfer in compressed air systems. What this is saying is that you receive the benefit of only 13 percent of the energy you put into your air compressors as mechanical output at the shaft of a typical compressed air powered tool. While this ratio is generally true for compressed air system awareness discussion purposes, you should understand that in the real world compressed air efficiency is usually much lower.

This ratio came about years ago when USDOE compressed air efficiency documents were first being prepared. Experts looked at the energy input required by typical large air compressors and compared this to the mechanical output of standard vanes style air motors. The air compressor specifications that were used assumed that the air compressor consumes about 7.5 hp to produce 30 cfm of air motor consumption. This number was chosen simply because a typical vane style air motor produces about one hp shaft output while consuming roughly 30 cfm at its maximum rpm. If you calculate it out this means the air compressor specific power, defined as the amount of power (kilowatts) a compressor package consumes for every 100 cfm of compressed air it produces, would be about 18.7 kW/100 cfm.

A good way to compare the power input of air compressors is to examine the characteristic specific power numbers. The Compressed Air and Gas Institute (CAGI), an organization that sets testing standards

> "A good way to compare the power input of air compressors is to examine the characteristic specific power numbers. The Compressed Air and Gas Institute (CAGI), an organization that sets testing standards for its members, expresses specific power of air compressors in kW/100 cfm."
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> — Ron Marshall for the Compressed Air Challenge®

for its members, expresses specific power of air compressors in kW/100 cfm. We are fortunate in North America to have an organization like CAGI promoting compressed air efficiency awareness. CAGI has developed a standard for compressed air data sheets that show compressor specific power, and other important information, at rated full load conditions. Each CAGI member organization is required to publish CAGI data sheets for their compressors on their websites. When comparing specific power ratings, the lower the number, the more efficient the compressor.

Real World Problem #1: Typical pressure is higher than model

The model used for the published ratio is based on the assumption of a lossless compressed air system with the compressor discharge pressure at the same pressure as the load, in this case 100 psi. The model assumes the compressor is fully loaded at its most efficient point. There are no leaks in the system and no pressure differentials. Unfortunately these conditions are impossible in a real life situation.

If you browse various published CAGI data sheets you will see the first real world issue. Many air compressors actually have a specific power that is higher than 18.7kW/100 cfm. Those that meet or beat this number are large units that operate with water cooling and run at 100 psi. But a real world system has pressure differentials. The air dryer and the filters that condition the air, and the pipes, hoses and connectors that transmit the compressed air to the end use point all act as a restriction to flow. This means to have 100 psi at the air motor a compressor discharge pressure must typically be set 10 to 20 psi higher to overcome the losses. For every 2 psi increase in discharge pressure, the compressor will consume about one percent more power for the same output flow. This real world condition would increase compressor specific power by 5 to 10 percent depending on how much the pressure is increased.

Real World Problem #2: Compressors are often partly loaded with inadequate storage

The CAGI sheets published for fixed speed lubricant injected rotary screw compressors, the most common compressor used in the industrial market, always show the specific power of the compressor at full load. In

COMPRESSED AIR SYSTEM COSTS MEET THE REAL WORLD

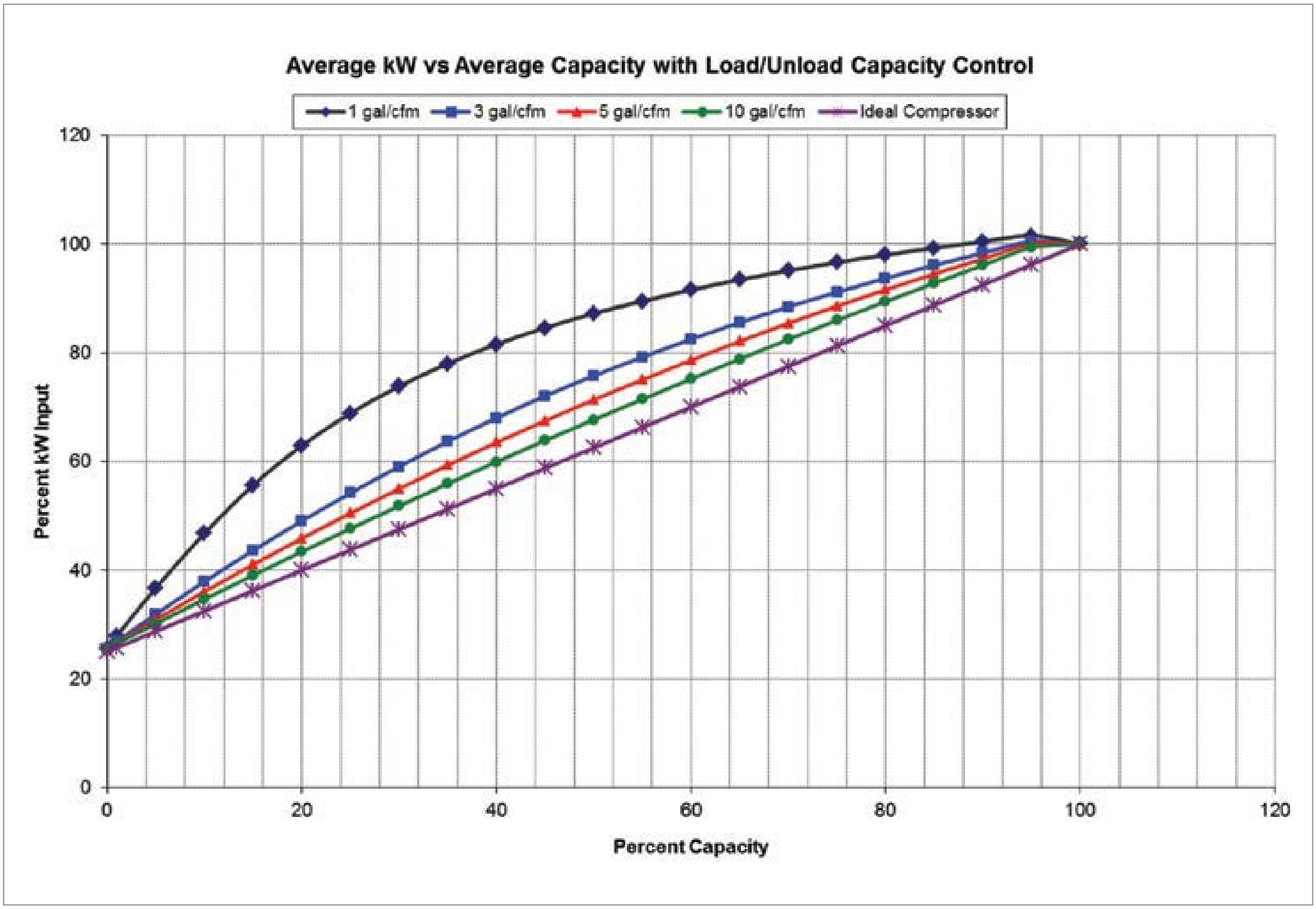

Figure 2: Lubricant Injected Rotary Screw Compressors are less efficient at part loading. Source: Compressed Air Challenge

real world conditions, however, compressors are not always running fully loaded. Figure 2 shows the characteristic curves of lubricant injected rotary screw compressors at various part loads and storage capacity volumes. The line identified as the "Ideal Compressor" is often incorrectly used to calculate part load power under part load conditions, but this does not represent real world conditions.

If a compressor was running at 40 percent loading conditions with one gallon per cfm of storage volume, a 10 psi pressure band and 40 second blow down time, it would be consuming 82% of its full load power. With these conditions its specific power would be more than double its full load rating.

Real World Problem #3: Systems have leakage losses

The model used in the calculation of the ratio assumes that all the air produced by the compressor is consumed by the air motor. In real world conditions compressed air systems have losses. The USDOE and Compressed Air Challenge studied many compressed air systems and found that typically only half of the compressed air produced by the compressors actually makes it to appropriate end uses. Some of the air is wasted by compressed air consumption caused by pressure that is higher than required (as caused by problem #1). This is called artificial demand. A portion of the air is used by inappropriate equipment that should not be connected to the compressed air system because there are other more

COMPRESSED AIR SYSTEM COSTS MEET THE REAL WORLD

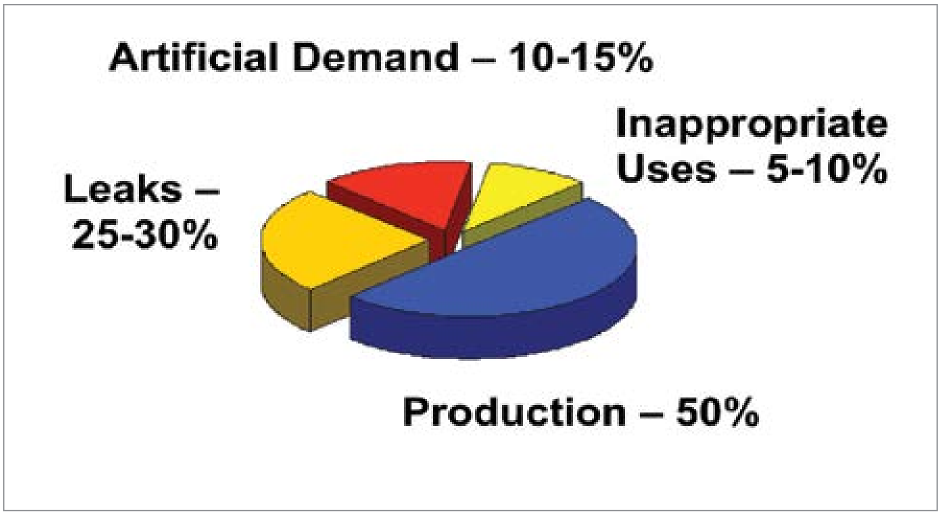

Figure 3: Typically half the compressed air produced is wasted. Source: Compressed Air Challenge

efficient ways to do the same function. And typically about 25 to 30% of all the air produced is lost before it gets to the air motor due to leakage from the system. This 25 to 30 percent is an average value, in some extreme cases leakage rates as high as 85% have been found.

Since in a real world system you must produce more air that you actually consume, the effective specific power of the system increases to compensate.

Real World Result

So what does this all mean? Let's adjust our model for an example real world system:

- Producing air at 10 psi higher pressure than it is used to overcome pressure differentials might increase the specific power to 19.6 kW/100 cfm
- Part load efficiency reduction due to 40% loading and inadequate storage might double the specific power to 39.3 kW/100 cfm
- Producing more air than actually required by compressed air equipment to overcome a 25% leakage rate would boost specific power by 33% resulting in a final number of 52.3 kW/100 cfm.
- This number yields a real world ratio of 21 hp input to 1 hp output. In this example case only about 5% of the energy input would result in equivalent mechanical output.

What can be done?

Can you improve on this efficiency ratio if you are seeing these same conditions in your system? The answer is yes, by applying commonly applied efficiency measures.

Basically there are three ways to reduce the operating costs of a compressed air system:

1. Produce the air more efficiently
2. Produce less compressed air
3. Use the heat of compression for some useful purpose

Producing More Efficiently

There are a number of ways to produce compressed air more efficiently; most of these apply to equipment located in or near the compressed air room. These measures apply to both the air compressors and the compressed

> "Since in a real world system you must produce more air that you actually consume, the effective specific power of the system increases to compensate."
>
> — Ron Marshall for the Compressed Air Challenge®

air treatment systems (air dryers, filters, drains). Some of the most common measures are:

- Purchasing compressors with low specific power (consulting CAGI specifications) including a properly sized VSD controlled compressor.
- Controlling the compressors to minimize unloaded run time, reduce discharge pressure, and to run the most efficient compressors at times where appropriate.
- Applying large storage receiver capacity to allow compressors to run efficiently and turn off when not required.
- Reducing compressor discharge pressures by minimizing pressure differentials caused by air dryers, filters, undersized piping. Piping, fittings, compressed air conditioning equipment, connectors and hoses should be selected so that these provide a minimal restriction to flow even in peak conditions to allow the lowest possible compressor discharge pressure.
- Purchasing efficient air drying equipment that cycle to reduce power a reduced load and turn off when the associated compressor is off.
- Turning the compressors off when compressed air is not required.
- Eliminating wasteful condensate drainage and leakage.
- Application of pressure/flow controls to reduce plant pressure and eliminate artificial demand while maintaining an adequate supply of stored air for better compressor control.

COMPRESSED AIR SYSTEM COSTS MEET THE REAL WORLD

Using Less Compressed Air

This category represents the biggest payoff in reducing compressed air costs. Some common ways to do this are (not a complete list):

- Starting and maintain a leakage repair program and reduce leakage rates to a target level of 5% of average flow.
- Investigating compressed air uses to determine if the consumption of compressed air is appropriate. Eliminate all inappropriate uses that could be operated using direct drive electric or some other more efficient method.
- Eliminating drainage from downstream filter separator bowls and condensate drainage points.
- Redesigning problematic compressed air powered equipment that forces compressor discharge pressure up, causing inefficient artificial demands for all other end uses. Target a maximum plant pressure of 90 psi or lower as an overall plant policy.
- Designing in shut off valves to automatically turn off the flow of compressed air when production stops. The best kind of shut off strategy is to completely turn off the flow of compressed air to zones of equipment during non-production hours, reducing leakage.

Use the Heat

The product air compressors best produce is heat. This heat can be used to:

- Displace building heat
- Create hot water for boiler or process use
- Regenerate the desiccant in heat of compression dryers

Want to learn more?

If you are new to compressed air terminology some of the terms used in this article may be unfamiliar to you. If you want to learn more about compressed air energy consumption and what to do about it go to compressedairchallenge.org and sign up for one of our awareness seminars. Higher awareness of the energy related issues involving the production and usage of compressed air is one of the most important first steps in controlling your compressed air costs.

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

To read more ***Compressed Air System Assessment*** articles, please visit http://www.airbestpractices.com/system-assessments

> "Higher awareness of the energy related issues involving the production and usage of compressed air is one of the most important first steps in controlling your compressed air costs."
>
> — Ron Marshall for the Compressed Air Challenge®

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Kaeser Redesigns SFC 132 and 160 Variable Frequency Drive Compressors

Kaeser's redesigned SFC 132 and 160 variable frequency drive rotary screw compressors are now available. These new models deliver the "built-for-a-lifetime" reliability, simple maintenance, and sustainable energy savings you expect from the Kaeser name.

The SFC 132 has a flow range of 194 - 918 cfm at 125 psig, while the SFC 160 has a flow range of 240 - 1090 cfm at 125 psig. Both models feature the latest in Siemens drive technology.

These models deliver lower life cycle costs with their simple maintenance and reduced energy costs and are up to 24% more efficient than the competition. Additional built-in heat recovery options multiply energy savings potential.

Kaeser has redesigned their SFC 132 and 160 variable frequency drive rotary screw compressors.

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 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/SFC132_160. To be connected to your local representative for additional information, please call 877-586-2691.

Baldor RPM XE Motor Exceeds Premium Efficiency Performance with Hybrid Technology

Baldor Electric Company is proud to announce the latest motor technology - achieving efficiency performance two to four efficiency bands above NEMA Premium® efficient levels (IE3) by utilizing a hybrid motor design. Using advanced technology, which combines the starting attributes of an induction cage with permanent magnets, the new RPM XE platform can provide substantial energy savings and performance for most centrifugal load applications.

TECHNOLOGY PICKS

The new Baldor RPM XE utilizes a hybrid motor design.

The hybrid design exceeds premium efficiency performance on sine wave power while meeting IE3 as a combined motor and drive package. The motor starts like a traditional design B induction motor and pulls into true synchronous speed and operates as a true synchronous machine.

Laminated finned frame construction also contributes to power density and enhanced thermal performance by providing greater heat dissipation, which results in cooler operation and longer motor life. The operating temperature is lower than typical B and F rise temperatures found in the traditional cast iron or steel band induction motors.

The RPM XE platform is available in two design configurations, a power dense and standard NEMA frame. The power dense design offers horsepower in a smaller frame best suited when the driven equipment or machine is limited on space. The standard NEMA offers a drop-in replacement solution for traditional induction motors.

Baldor Electric Company is a leading marketer, designer and manufacturer of industrial electric motors, drives and mechanical power transmission products. Baldor, a member of the ABB Group, is headquartered in Fort Smith, Arkansas.

Visit our website at www.baldor.com

Michell Instruments Introduces New HygroSmart HS3 Probe

The new HygroSmart HS3 probe from Michell Instruments has been designed to withstand the kind of harsh and demanding conditions found in industrial processes. Unlike many 'disposable' probes that have a short life within harsh conditions before needing to be replaced, the HygroSmart HS3 sensor uses Michell's polymer tile to give long-term reliable measurements. In addition, it also has an accuracy of 0.8%RH, making it among the most accurate and reliable RH probes on the market, as well as allowing for longer recalibration periods.

This not only gives peace of mind to process operators, but also provides a low life-time cost of ownership when compared to the disposable probes. The HygroSmart HS3 consists of a solid, corrosion-resistant probe body with an interchangeable sensor. When recalibration is due, the old HygroSmart HS3 sensor is simply exchanged for a new, freshly calibrated one. This simple procedure takes only a few seconds to carry out with the probe itself remaining installed. Replacing just the sensor, rather than the whole probe, is not only quick and simple, it also saves users money over the lifetime of the probe.

The HygroSmart HS3 sensor uses Michell's polymer tile to give long-term reliable measurements and has an accuracy of 0.8%RH.

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

In most industrial applications, RH probes have to withstand vibration, exposure to water, occasional heavy shocks and high levels of electrical interference. The HygroSmart HS3 body is designed to cope with all these environmental factors. As well as the solid body, the probe also has a 145 psi (10 bar) pressure rating, rfi/emc electrical noise approvals and IP67, NEMA 6 ingress protection rating.

As well as its ability to withstand harsh process conditions, the HygroSmart HS3 probe also gives control to the user, as it is 100% configurable. This gives users the ability to alter their RH and temperature measurements to keep step with changes or developments in their process, with no extra costs.

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 dew-point, humidity and oxygen in applications and industries as diverse as compressed air, power generation, petrochemical, oil and gas, food processing and pharmaceutical. Michell's innovative products make processes cheaper, cleaner, more energy efficient and safe.

The Group has multiple manufacturing locations across Europe with their international headquarters located in Ely, UK and a North America sales and service headquarters located in Rowley (MA). It has its own facilities in 10 countries with an extensive network of factory trained application and service engineers, subsidiaries and distributors stretching across 56 countries.

For more information, visit www.michell.com/us

New Festo Low-Cost EtherNet/IP Connectivity to Valve Terminals

The new CTEU-EP universal interface module from Festo makes EtherNet/IP connectivity low cost and plug and play for an extensive range of economical Festo valve terminals. The CTEU-EP is ODVA conformant and a Rockwell Encompass referenced product.

For maximum flexibility, OEMs can configure up to 96 valves on multiple valve terminals with a single EtherNet/IP node. Basic diagnostics reduce downtime through faster identification of such fault conditions as under voltage and short circuit.

The CTEU-EP offers plug and play connectivity and automatic identification of the valve terminal type and configuration. These attributes simplify and speed up installation. CTEU-EP lowers inventory requirements – a single part number covers multiple configurations – and, with an adapter, a single CTEU-EP can interface two valve terminals for even more efficiency and savings.

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TECHNOLOGY PICKS

The new CTEU-EP universal interface module from Festo

The CTEU-EP connects to all Festo I-Port enabled valve terminals, including VTUG, VTUB, MPA-L, VTOC, and CPV. In harsh environment applications, CTEU-EP can interface EtherNet/IP to the MPA-C IP69K rated valve terminal. CTEU-EP is also compatible with other Festo I-Port enabled products such as the CTSL input module, SDAT cylinder position transmitter, OVEM vacuum generator, VPPM pressure regulator, CMMO-LK stepper motor controller, and to a number of pressure sensors. I-Port relies on standard single pin M12 male and female connectors, which eliminate the installation complexity and cost associated with multipin connectors.

The CTEU family of universal interface modules is compatible with other leading Fieldbuses, including DeviceNet, Modbus TCP, EtherCAT, ProfibusDP, Profinet, CANopen, and CC-Link. In addition, CTEU modules can be connected via CANopen to Festo CPX-CEC front end control.

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 on the new Rockwell Encompass referenced CTEU-EP universal EtherNet/IP connector module and other models in the CTEU family, call Festo at 800-993-3786 and visit www.festo.us.

ADVERTISER INDEX

THE MARKETPLACE

JOBS

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Telephone 402-339-0500 • 800-727-7693

EXECUTIVE POSITION OPENINGS

AIR POWER OF NEBRASKA INC, a stocking distributor of compressed systems and affiliated industrial equipment since 1979, the Nebraska /Iowa distributor for GARDNER DENVER industrial and ATLAS COPCO portable compressors, is in need of two executive managers. Due to the upcoming retirement of long term employees, one with 20 years history here the other with 24 years history. Both individuals will retire in 2017 we will hire replacements in sales and general management in the new future.

PLEASE PROVIDE PERSONAL LETTER OF INTEREST AND RESUME TO:
Tracy Macintosh White, Vice President, Administration, a 28 year employee of Air Power
twhite@air-power.com • 402.339.0500

BOGE COMPRESSED AIR SYSTEMS

AREA SALES MANAGER (2 POSITIONS)

BOGE America Inc. is growing and looking increase our footprint in the marketplace. Critical to this is the addition of two (2) Area Sales Managers to Grow our Distribution Based Compressor Business with Complimentary Approach to Strategic/OEM Accounts. Locations preferred are Houston, TX and Atlanta, GA.

We are seeking individuals with Distributor Sales Support Experience and Customer Orientation. Additional Languages a plus (Spanish, French, German). Competitive Compensation Package inclusive of Benefits/Health Insurance/Disability, 401K with company contributions, Company Car etc..

Please submit resume's to usa@boge.com

COAIRE

REGIONAL SALES MANAGER

Coaire, Inc. is looking for a highly experienced professional Air Compressor & Air Dryer Regional Sales Manager for the Western Part of North America.

We are seeking individuals with a strong mechanical, refrigeration and electrical background.

Our competitive benefit package includes, Health Insurance and 401K with company contributions.

Will provide relocation assistance if required (certain conditions apply).

Please contact Sang W. Lee at sangl@coaire.com.

Job & Product Marketplace Advertising Information

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

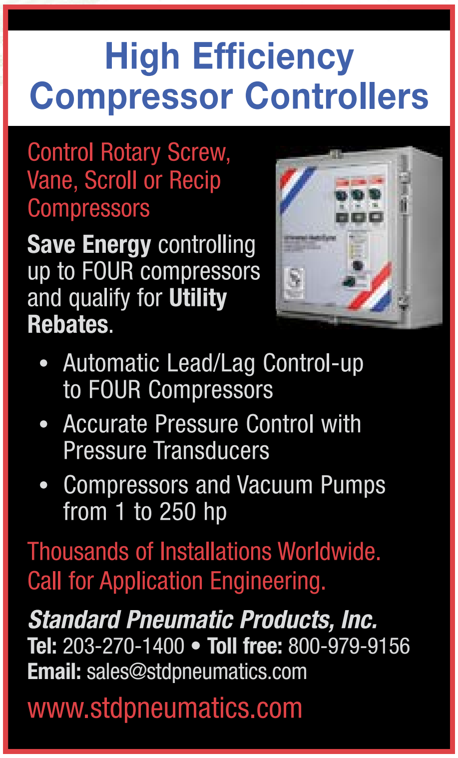
Prices are $300.00 per Job Marketplace Ad and $350.00 per Product Marketplace Ad ($300 if 6 or more ads are placed).

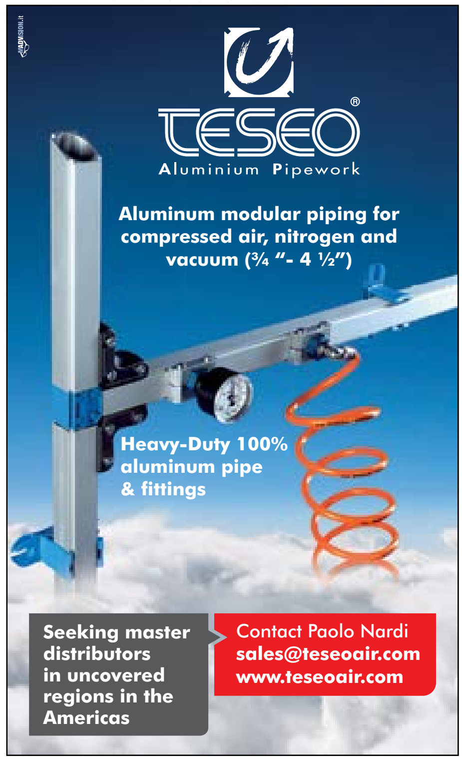
Contact Rod Smith at rod@airbestpractices.com to schedule your Marketplace Ads.

TECHNOLOGY

THE MARKETPLACE

TECHNOLOGY





KAESER COMPRESSORS
Built for a lifetime.™

Seize the Savings!

A fresh approach yields sweeping savings for a quick ROI

PROBLEM:

At a plant manufacturing turbines for hydro-electric power plants, excess capacity had been a source of comfort for many years despite recommendations for system updates. Four modulating, twenty-year old compressors, two 75 hp, two 25 hp, supplied the system—without central controls—causing excessively high energy costs. When a new plant engineer came on board, he took a closer look at the energy efficiency. Having attended a Kaeser Compressed Air Seminar, he knew a systems approach could unlock significant savings.

SOLUTION:

Kaeser ran a KESS (Kaeser Energy Saving Simulation) using supply side audit data and designed a complete system solution that would dramatically reduce the specific power from 62.0 kW/100 cfm to 17.5 kW/100 cfm. New energy efficient compressors, an air receiver, as well as a system master controller were installed. The new system has the same number of compressors and total horsepower as before, but it provides even more flow.

RESULT:

The Sigma Air Manager (SAM) master controller monitors the four new compressors and selects the most efficient combination of units to meet the plant demand. With its built-in SAC *Plus* software, SAM continually tracks energy consumption so the plant benefits from having an ongoing compressed air energy audit. As a matter of fact, the specific power has been reduced more than anticipated—all the way down to 16.7 kW/100 cfm.

Annual Energy Costs of Previous System:	$59,780 per year
Reduction in Specific Power:	45.3 kW/100 cfm
Annual Energy Cost Savings:	$22,680 per year
Additional Savings in Maintenance Costs:	$7,240 per year
TOTAL ANNUAL SAVINGS:	**$29,920**
Simple Payback Period:	**14 months**

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

Visit us at WEFTEC in Booth #2307

kaeser.com

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

 customer.us@kaeser.com