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July 2013

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FROM THE EDITOR

Retrocommissioning Incentives



The U.S. Department of Energy has posted a Docket on Federal Register to determine if commercial and industrial compressors should be “covered equipment” under Part A-1 of Title III of the Energy Policy & Conservation Act (EPCA). The DoE proposes that classifying equipment of such type, as covered equipment under Part A-1 of EPCA, would require manufacturers to improve the efficiency of electric motors, pumps, and compressors to conserve the energy resources within the nation.

While this is just the first step, it has the attention of the members of the air compressor industry. As our magazine title suggests, real energy savings come from matching the supply side (compressor room) to the demand side (the plant floor). With the (DoE supported) Compressed Air Challenge[®] publishing widely-confirmed data stating that most plants waste fifty percent of their compressed air, shouldn't the focus be on conducting demand-side system assessments? We will continue to monitor this situation which could require air compressor manufacturers to conduct additional testing, potentially require labeling or even mandate efficiency improvements over time.

When I speak to energy-saving, system assessment experts, they say the number one obstacle, to getting projects done, is the initial cost of a system assessment. They would like to see more utilities help factories with this initial system assessment cost by deploying retrocommissioning incentives (also called RcX programs) to complement their portfolio of energy conservation incentives. According to Don van Ormer of Air Power USA, “RcX programs help plants return both the supply and demand side of the system back to their original optimal working conditions. They provide funds to troubleshoot current air system problems and bottlenecks while reducing air demand and pressure.”

Subscriptions continue to grow for our publication from new subscribers who drop me notes reading, “We manufacture automotive components and compressed air represents 33% of our total energy costs. We look forward to learning Compressed Air Best Practices.” It's for these readers that we publish this magazine. Thanks go to the authors and auditors who share their knowledge with our readers and who are “making a difference” daily in helping factories profitably reduce the energy consumption related to their compressed air systems.

Thank you for your support and for investing in **Compressed Air Best Practices[®]**. 

ROD SMITH

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COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

Atlas Copco Compressors Announces New Structure to Support Enhanced Distributor Network

Atlas Copco Compressors has created a new centralized Distributor Support Service to provide administrative sales support and technical assistance for Atlas Copco Compressors' complete product portfolio. "Sales support administration and technical assistance make up greater than 90% of the calls we receive from our expanding distributor network, making the synergies that come from centralizing these functions critical for our future successes' together," said John Brookshire, president, Atlas Copco Compressors LLC. "The new group will provide first-class customer service and ensure our distributor support rises to the next level." The centralized Distributor Sales Support Group will support distributors with pricing inquiries and advise on lead times and delivery dates for new and existing orders, while fully supporting the distributors with the extranet tools they work with today — Global Business Portal (GBP) and ACConnect.

The creation of the centralized Distributor Technical Support Group is at the center of Atlas Copco's strategy to align technical support with product competencies as opposed to geographic regions. The new group will expand the current customer service model to include high-level technical support and product knowledge available to distributors across the U.S. Both teams will provide coverage across all U.S. time zones and can be reached by calling one dedicated number — 866-865-7999. All distributors will continue to be managed by their dedicated field-based Sales Manager.

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Kaeser Compressors Announces Association with Gas Monkey Garage

Kaeser Compressors, Inc. is proud to announce our association with Gas Monkey Garage, the automotive fabrication and restoration shop featured on Discovery Channel's original series *Fast N' Loud*.

Fast N' Loud features car fanatics Richard Rawlings and Aaron Kaufman as they restore derelict classic cars to their full throttle

glory. Kaeser designed and installed the compressed air system for Gas Monkey Garage's new facility in Dallas, Texas. Two 15hp rotary screw compressors with dryers, filtration, air tanks, and SmartPipe™ will provide the quality air and storage needed for the blast cabinet, grinders, sanders, and spray booth that the Monkeys use to bring gone-but-not-forgotten classic cars back to life. *Fast N' Loud* airs on the Discovery Channel, Mondays at 9 pm/8 pm Central Time.

Visit www.kaesernews.com/GMG or please call 877-586-2691.

For more information on Gas Monkey Garage and *Fast N' Loud*, visit www.gasmonkeygarage.com or www.dsc.discovery.com/tv-shows/fast-n-loud.

COSE Partners on New Ohio Energy Resource Fund

Manufacturers, schools, churches, and clinics throughout the Buckeye State could cut tens of millions of dollars a year on their energy bills, thanks to a new pioneering financial tool launching today by the Council of Smaller Enterprises (COSE), efficiency-services financier Metrus Energy, and CalCEF, an organization focused on accelerating clean energy technologies.

The new Ohio Efficiency Resource Fund provides otherwise hard-to-get financing for small and medium-sized businesses to make energy-efficiency improvements, with no upfront costs and no risk. This innovative approach bridges the funding gap that has stymied small- and mid-sized retrofit projects — thousands of buildings statewide.

Here's how it works: The Fund signs an Efficiency Services Agreement (ESA) for up to 10 years with a building owner, purchases the new equipment, and hires contractors to design, install, measure, and maintain the energy-saving improvements. As a result, the customer sees a reduction in its total utility bill, while the building becomes more functional, productive, and comfortable. The Fund recoups its investment by billing customers for their actual *realized* efficiency gains. Since the useful life of the energy-efficiency equipment continues well beyond the life of the contract, customers continue to save for years to come.



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The Fund also will help property owners meet the state's Energy Efficiency Resource Standard, which calls for cutting electricity use 22.2 percent by 2025. The Fund is now accepting applications from facility owners who have efficiency retrofit projects costing less than \$1 million.

"Like a utility sells electricity, the Fund will sell efficiency as a service to building owners, delivering savings to local businesses," said Bob Hinkle, President and CEO of Metrus Energy, the Fund's manager and creator of the Efficiency Services Agreement. "We are excited to partner with COSE to bring our efficiency finance know-how to this market."

COSE, the largest small business support organization in Ohio with more than 14,000 members, will play the critical role of helping identify and match suitable projects with vetted local contractors. This is well-trodden territory for COSE, which offers several energy programs to save Ohio businesses — including an efficiency financing program recently recognized by Chambers for Innovation and Clean Energy (CICE).

"This strategy makes the most of smart financing and local expertise," said Nicole Stika, Senior Director of Energy Services for the Council of Smaller Enterprises. "It's also a great way to generate jobs. Ohio, by conservative estimates, already has more than 10,000 jobs tied to energy efficiency, but that's just the start; there's tremendous potential in the energy efficiency sector."

By providing much needed financing, the Fund will help network service providers conducting audits and recommending energy efficiency measures to retrofit existing buildings.

"Our team is skilled at helping building owners identify and implement energy projects that pay for themselves through the utility bill savings they create," said David Zehala, President of Columbus-based energy services company Plug Smart. "This program obliterates all the financial barriers associated with these projects making it easier for our clients to say yes."

"By more effectively connecting the supply of products and materials from Ohio companies to Ohio projects, the Fund will be an economic boon for the state," said Shanelle Smith, Director, Emerald Cities Cleveland, a Fund partner. EC Cleveland, an arm of the Emerald Cities Collaborative, is a network of organizations working together to advance a sustainable environment while creating greater economic opportunities. "The Efficiency Resource Fund is enabling a whole class of projects that may otherwise not be completed," she said.

Visit www.cose.org

Atlas Copco Compressors Opens Central Technical Support Competency Center

Atlas Copco Compressors opened the new Technical Support Competency Center in Rock Hill, S.C., on May 21, 2013. The event began with brief remarks and a ceremonial ribbon-cutting by Atlas Copco Compressors' leadership, which included John Brookshire, president, Mike Iacino, vice president service operations, Jim Bruce, national technical support training manager and guests of honor Doug Echols, Rock Hill mayor and Andrew Walker, divisional president Atlas Copco Compressor Service (CTS). Following the ribbon-cutting, guests toured the facility and viewed demonstrations of the new remote monitoring center in action. Over 80 Atlas Copco employees and several members of the Rock Hill chamber of commerce attended the event.

The Center will house dedicated technical support liaisons who will expand the current customer service model and provide high-level technical support and product knowledge to customers across the U.S. The support group will also manage the new remote monitoring service offering and will work with local regional liaisons or distribution partners to address customer needs as they develop. The group is conveniently located near the product management team and can be reached by calling one dedicated number — 866-865-7995.

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Kaeser Factory-Direct Facility Now Open in Philadelphia

Kaeser Compressors, Inc., a leading worldwide manufacturer of industrial air compressors, blowers, and related equipment, opened a new factory-direct facility to support Kaeser's industrial and commercial customers in the greater Philadelphia area. The new branch supplies and supports the company's entire product offering. The branch team of factory-trained sales and service professionals is led by Dan LeViness and offers a full range of services, including:

- Air system audits for energy reduction and process improvement
- Air system design and installation
- New equipment sales
- Scheduled preventive maintenance
- Equipment repair services

"We are excited to have the opportunity to support the compressed air needs of the Philadelphia area," said LeViness. "Kaeser has a well-

earned reputation for providing superior service and energy efficient compressed air solutions. We are confident that area businesses will quickly understand why Kaeser is the best choice.” For more information about the facilities or to discuss air system needs, call 888-684-9533.

Visit www.kaeser.com/cabp

California Energy Commission Keeps State on Track to Reach Clean Transportation Goals

The California Energy Commission unanimously adopted the 2013-2014 Investment Plan Update to support the development and use of green vehicles and alternative fuels. The update sets funding priorities for the approximately \$100 million in annual state funds under the Commission’s Alternative and Renewable Fuels and Vehicle Technology (ARFVT) Program, created by Assembly Bill 118.


“This investment plan provides a solid foundation for the continued transformation of California’s transportation sector,” said Energy

Commission Chair Robert B. Weisenmiller. “The plan will guide the Commission in supporting projects that reduce greenhouse gas emissions, improve air quality, increase fuel diversity to reduce reliance on petroleum, and help create jobs. These efforts benefit all Californians by protecting the environment and public health, and ensuring the state continues to be a leader in green technology.”


Funding priorities through the ARFVT Program support fuel and vehicle development to help attain the state’s climate change policies. In addition, the program funds projects that assist in fulfilling Governor Brown’s Zero Emission Vehicles (ZEV) Action Plan, with a target of installing enough infrastructure to support 1 million ZEVs by 2020, and a 2025 target of having 1.5 million ZEVs on the state’s roads.

Investments made through the program’s competitive solicitation process provide a crucial jump-start in funding to overcome market barriers for new fuels and technology, while leveraging additional investment from federal agencies, research institutions, private investors and other stakeholders.

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“We provide needed funding to cutting edge technologies. Using public money to supplement private sector investments and hedge financial risk is critical to getting new technology cars, trucks and fuels into our California markets,” Chair Weisenmiller said.

The program funds projects to encourage the development and use of new technologies and alternative and renewable fuels, including electricity, natural gas, biomethane, hydrogen, and gasoline and diesel substitutes, such as cellulosic ethanol (derived from woody materials, including agricultural waste), and biodiesel from waste grease. Funding sources include small surcharges on vehicle and vessel registrations, and license plate and smog abatement fees.

The program is essential to California’s efforts to reduce greenhouse gas emissions to 80 percent below 1990 levels by 2050, as required by AB 32; decrease petroleum fuel use to 15 percent below 2003 levels by 2020; increase the use of alternative fuels to 26 percent of all fuel consumed by 2022; and reduce emissions of nitrogen oxides to 80 percent of 2010 levels by 2023 to help meet federal ozone standards in areas of California such as the San Joaquin Valley and South Coast air basins.

Currently, the state’s transportation sector accounts for nearly 40 percent of the state’s greenhouse gas emissions, and more than 95 percent of all transportation energy consumed in California is petroleum-based.

The 2013-2014 plan update allocates \$100 million to projects in the following areas:

- \$23 million for biofuels production and supply, with an emphasis on fuels made from waste-based and other low-carbon, sustainable materials.
- \$20 million for hydrogen fueling infrastructure. An estimated 68 stations are needed to support the anticipated rollout of these vehicles in 2015-2017. Roughly 24 stations are built or in development.
- \$15 million for medium- and heavy-duty electric truck and hybrid vehicle demonstration projects.
- \$12 million for natural gas vehicle incentives. These incentives help to pay the difference between the cost

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- Paper Mill Saves \$207,000 or 4.5 Million kWh per year.



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of alternative-fuel vehicles and conventional vehicles. Buyers must agree to register and operate the vehicles in California at least 90 percent of the time for three years.

- \$7 million for electric vehicle charging infrastructure, coordinated to fulfill the Governor's ZEV Action Plan. Workplace, fleet and multi-unit dwelling projects will be given priority.
- \$5 million for light-duty plug-in electric vehicle rebates to meet high demand for the Clean Vehicle Rebate Program, administered by the California Air Resources Board.
- \$5 million for manufacturing projects, supporting economic development and clean transportation technology.
- \$4 million to emerging opportunities. This allocation is not specifically tied to any single fuel or technology type, with a priority for projects that can leverage federal funding.

- \$3.5 million for regional alternative fuel readiness and planning, building on previous projects supporting these efforts.
- \$2 million for centers for alternative fuels and advanced vehicles to support collaborative efforts that promote innovation, demonstrate new technologies, leverage venture capital and federal funds, and provide workforce training.
- \$2 million to workforce training and development.
- \$1.5 million for natural gas fueling infrastructure to support growing use of these alternative fuel vehicles by many entities, including school districts.

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AIR SYSTEM PRESSURE INFLUENCES COMPRESSOR POWER

Part 1: System Pressure's Influence On Rotary Screw Air Compressors

This is the first article in a three-part compressed air series by Mark Krisa,
Director – Global Services Solutions, Ingersoll Rand

► Energy conservation measures (ECMs) associated with compressed air have received a significant amount of attention over the years, mostly due to a reasonably short financial return compared with other energy-consuming equipment. Over time, many of the recommended corrective actions to reduce compressed air energy consumption were simplified so much that they did not lead to positive results. One of the most common compressed air ECMs is reducing system pressure, and it leverages the best practice calculation — .5 percent power per psi — outlined in the Department of Energy's Compressed Air Challenge. This article highlights more common issues associated with estimating energy conservation resulting from changing system pressure.



Mark Krisa, Director-Global Services Solutions,
Ingersoll Rand

Benefits of Reducing Network Pressure

Efforts to reduce compressed air system pressure have become a fundamental part of many air system assessments for two simple reasons: opportunity and return. Most facilities operate their compressed air system based on a perceived pressure requirement with a generous safety factor added to account for future network losses. Compressor controls build upon this minimum requirement, forcing the system to operate at a higher pressure with the amount and variability dependent upon components, configuration and system characteristics. In addition to compressor controls, pressure is elevated several psi to compensate for pressure/friction losses through piping, dryers, clean filters, dirty filters and miscellaneous valves. In addition to the pneumatic components, operating pressure is elevated to account for instrument calibration and several years of staffing changes and system growth. Compounded by marginal levels of system instrumentation and trending, the opportunity to reduce system pressure becomes not only significant, but reasonably common. The return derived from lowering system pressure is summarized into two categories: a reduction in pressure at the discharge of the compressor and a potential reduction in compressed air demand. Both of these ECMs can be accomplished independently and/or simultaneously —

depending on the method — with marginal investment.

Controlling Network Pressure

There are several ways to reduce network pressure. To simplify, they can be categorized into actions that reduce pressure at the discharge of the compressor, pressure supplied to the compressed air network and pressure at the point of use. Point-of-use pressure is normally controlled using some form of pressure regulator dedicated to a local circuit or directly at the point of conversion where compressed air is expanded to do work. Network pressure can be reduced by adjusting local compressor controls or managing multiple compressors using some form of multiple compressor controller. Another method for controlling system pressure that has gained increasing popularity over the years is a system-pressure-reducing device. Common names for this type of pressure-reducing device are demand expander, flow controller and pressure-reducing valve (PRV). Whether network pressure is reduced at the compressor or using a dedicated network pressure device, the impact on compressed air consumption is the same. However, the impact on compressor operation, supply efficiency and air quality will vary. For this discussion, compressor operating strategies and demand management will be

excluded, limiting scope to the influence of pressure on compressed air consumption and compressor power.

Strategies for Reducing Network Pressure

Before attempting to calculate energy savings associated with reducing compressed air pressure, operations must be willing to support change. In most facilities, people on the plant floor typically believe more pressure is better and anything that reduces the current network pressure causes issues. To overcome perceived requirements, facility managers can dictate a change and force operations to adapt. For some organizations this is an effective strategy, but it can often create an adversarial environment where operations associate production issues with insufficient pressure, quickly allocating blame to recent changes in network pressure. When this occurs, raising the pressure can seem like the ideal solution to problems believed to be associated with the recent reduction in system pressure, and this negatively impacts energy savings over time.

Ideally, a collaborative approach that engages operations in the project delivers the best returns and sustainable results. This approach requires an understanding of current and historic issues that helped define the perceived compressed air system pressure requirements.

As an organization that has successfully implemented thousands of compressed air audits over the years, Ingersoll Rand has found that it is best to start with how pressure is supplied. Using pressure recording devices helps accurately define what pressure is delivered with respect to time. For many systems, pressure varies throughout the day and week, frequently falling below perceived requirements. Provided no production issues occurred, the data helps educate operations

regarding how the system currently functions and how minimizing pressure variance reduces average pressure without reducing pressure below their current state. This also assists in defining pressure goals based on quantified data, independent of operator perception or anecdotal beliefs.

Pressure at the discharge of the compressor can be reduced independently of changing network pressure by minimizing pressure losses across piping and air treatment equipment. In this situation, it is important to measure pressure accurately across components at various supply loads. These corrective actions can be costly and intrusive, so accuracy of current and proposed state is essential to ensure corrective actions will deliver defined returns.

Estimating Energy Reduction for a Sample System

Reducing system pressure can potentially lower compressed air consumption and compressor power. The balance of this article reviews the influence of pressure on compressor power. Compressor power savings are typically estimated using the industry-recognized rule of thumb where power is assumed to decrease 0.5 percent for every 1 psi reduction in pressure.

This example is based on a simple system with four identical 100 hp compressors operating using loaded/unloaded local controls, and a simple pressure cascade between compressor control settings. Compressors are rated for 400 scfm at site conditions, consuming 100 hp at 115 psig and 70 hp at 50 percent load. Each compressor has a 20-second start-permissive (off to full-load). Total system storage is 660 U.S. gallons. For simplicity, the system has no filters or dryers and total ΔP from compressor package discharge to furthest point in the



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AIR SYSTEM PRESSURE INFLUENCES COMPRESSOR POWER

network is <0.4 psi. After recording pressure, amps and flow for a seven-day period, four distinct load conditions were identified in this system.

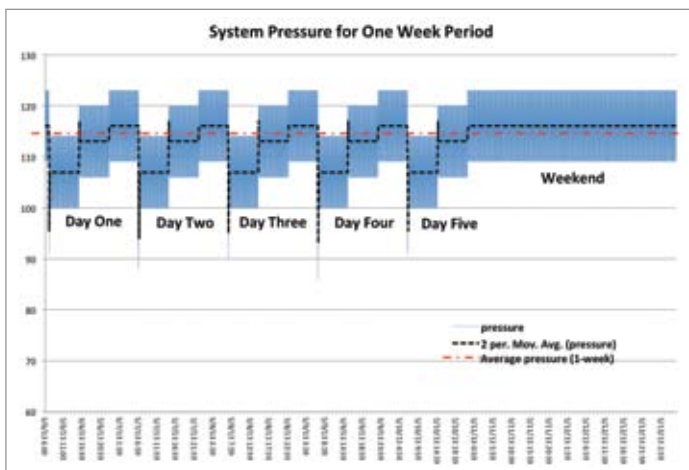
- Day shift, operating eight hours per day, 40 hours per week with an average pressure of 107 psig, three compressors fully loaded and a fourth unit in trim, using an online/offline control constantly cycling between 114 psig and 100 psig at 50 percent load.
- Afternoon shift, operating eight hours per day, 40 hours per week with an average pressure of 113 psig, one compressor fully loaded and a second unit in trim, constantly cycling between 120 psig and 106 psig at 50 percent load.
- Night shift and weekends, operating 88 hours per week with an average pressure of 116 psig, with only one compressor in trim, constantly cycling between 123 psig and 109 psig at 50 percent load.
- Weekdays at 7 a.m. the day shift starts with demand transitioning from lowest load to highest load linearly in 60 seconds. Since demand increases faster than compressor supply, pressure falls below 100 psig, at times as low as 86 psig before recovering back to 100 psig. The total event lasts approximately 90 seconds followed by the system returning to the normal day shift condition (6.5 h/y). This occurs every weekday morning and no one at the facility has ever complained about insufficient pressure.

For this system, Ingersoll Rand recommended that the customer install a compressor system controller that would operate any combination of compressors within a 10 psi control band using a rate-of-change

anticipatory control logic, and limiting pressure decay to less than 5 psi during the transition from night to day shift. The new system proposed by Ingersoll Rand would operate at an average pressure of 96 psig +/- 5 psi.

Based on the proposed system and data supplied, what values should be used to calculate potential savings? There are three common recommendations, but they do not always yield accurate estimates.

- Since the system already operates as low as 86 psig and can still decay 5 psi during the transition to day shift, set the controller for 91 to 101 psig, limiting potential for pressure to fall below 86 psig. The savings calculations are based on 123 to 96 psig, representing a 27 psi reduction on 370 hp for 8,760 hours per year. Assuming a 0.5 percent reduction in power per psi reduction, this represents >326,000 kWh/y. This is incorrect because the system does not operate at 370 hp and 123 psig for the entire year. Variation in pressure and power must be considered to provide an accurate savings estimate.
- One week of data shows the facility's average pressure is 113 psig, and average power is 165 hp. Savings calculation (based on 113 to 96 psig) 17 psi reduction on 165 hp represents 92,500 kWh/y savings. The issue with this calculation is the disproportionate weight between power and pressure.
- The calculations based on the average pressure and power for each load condition relative to the proposed average pressure of 96 psi and annualized hours represent 78,000 kWh/y. Although this calculation method accounts for average pressure and power for each load condition, savings are elevated because they are based on an average power that includes periods of time when trim compressors are unloaded. Since reducing system pressure does not impact unloaded power, only loaded power can be used to estimate the energy savings. With this correction, savings is closer to 67,000 kWh/y — 28 percent lower than the weekly system average method.



This chart illustrates the difference between average weekly pressure and average pressure by load segment based on one week of operating data.

It is important to accurately segment potential energy savings calculations based on load condition, time and relative change in pressure. A common error involves calculating savings based on the highest measured load relative to the highest and lowest measured pressures. For many systems the highest pressure occurs at the lowest load when compressed air consumption and supply power are at their lowest. Depending on the changes in pressure at various load conditions, the potential energy savings can be grossly overestimated. Data from isolated events or anomalies occurring during a recorded

period of time must be applied with caution. Referring back to the previous example, operating the system at a pressure below 100 psig is a risky assumption because the pressure is only below 100 psig for <90 seconds per day at the start of a shift. For a few seconds at the start of a shift, any potential issues associated with insufficient pressure could easily be ignored or blamed on equipment start-up. A more detailed investigation of the production equipment needs to be done next to confirm required pressure and the ability to operate at a reduced value without issue.

Compressor Power Savings from Pressure Reduction

To describe the benefits of lower pressure at the discharge of a compressor, it is best to differentiate between positive displacement and dynamic compressors. How air is compressed and the influence of air pressure is very different for these two technologies. This article focuses on positive displacement air compressors, more specifically rotary screw type compressors.

Estimating the Effect on Positive Displacement Compressors

The best way to describe a positive displacement compressor is to give the example of an old-fashioned bicycle pump. At first, the pressure is low, and moving the handle up and down is easy. As pressure increases, it becomes more difficult to push on the handle. If the pump has a 2" diameter piston, one would need to put all of his or her weight on the handle to push 60 psi of pressure into the tire. This is because work is done as a function of the piston area and the air pressure within the pump. With a 2" piston and a surface area of 3.14 in², the force acting against the piston is in excess of 188 lbf.

A positive displacement rotary screw compressor is very similar because the torque required to turn the rotors is a function of the pressure pushing against the rotors. Considering this fact, the torque required to move a given volume of air through the compressor is reduced as the discharge pressure is reduced. For a positive displacement compressor, like a rotary screw compressor or a reciprocating (piston) compressor, this change in pressure is generally assumed within the industry to represent approximately 0.5 percent drop in power for every 1 psi reduction at the discharge. Although this rule of thumb has been embraced as a scientific fact by many in the industry, it only serves to provide an estimated change in power for positive displacement compressors and should not be considered an accurate calculation. If the 0.5 percent theory held true, manufacturers would design compressors for 300 psig and then run them at 100 psig

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AIR SYSTEM PRESSURE INFLUENCES COMPRESSOR POWER

with 0 percent power. This is not the case due to the influences of friction, heat, internal pressure ratio, and friction losses across internal components.

Ideally, the manufacturer is consulted to determine their anticipated rated power. Unfortunately, this information is not always readily available and quite often a sales or technical support person with the best of intentions simply multiplies 0.5 percent by the stated pressure reduction to give the manufacturer a new number. Considering the effort required to gain support for pressure reduction projects, it is very unfortunate when projects move forward and anticipated savings are not realized. To help determine if predicted savings are realistic, the influence of the pressure reduction on the compressor is estimated using empirical methods.

Estimating the Effects of Internal Friction Losses

If one were to assume 0.5 percent less power for every one psi reduction in pressure at the discharge of the compressor, this is the pressure at the discharge port of the air end (pump), not the package. Pressure at the discharge of the compressor package includes pressure losses across internal components.

Consider another example using a rotary screw compressor designed for 100 psig discharge pressure at full flow. This is one of the more common types of compressors used for industrial applications. Consider the difference between pressure at the discharge of the compressor element and the compressor package. For a contact cooled (oil-flooded) screw compressor, air goes through internal piping, an air/oil separator element, baffles, minimum-pressure check valve, heat exchanger and a moisture separator before exiting the package. To simplify, assume 15 psi of pressure loss across

all these components with an average pressure loss across the air/oil separator element. If pressure at the discharge is reduced to 20 psi, the anticipated reduction in power would be 10 percent. However, as the air expands to a lower pressure, the gas is less dense.

Assuming constant mass flow at full load, the volume of air moving through the compressor at 80 psig is greater than the initial volume at 100 psig. Calculating the difference based on the absolute pressures, volume should increase approximately 1.212 times. Since the cross-sectional area does not change for the compressor components, the velocity also increases by a factor of 1.212. Since pressure drop increases as a square function of the change in velocity, the pressure drop increases by 1.47 times and the 15 psi pressure drop across the compressor package components now is closer to 22 psi. Considering the 20 psi reduction at the discharge of the compressor and the 7 psi increase in pressure loss across internal components, the compressor element only sees a 13 psi reduction in pressure, not the 20 psi seen at the discharge of the compressor. Consequently, the power reduction is only 6.5 percent as opposed to the assumed 10 percent if only the 1:2 rule-of-thumb calculation were considered. The velocity influence on heat exchanger performance compounds velocity and pressure drop issues, deflating the savings projections even further. There are also velocity constraints that may be an issue in some compressors since air does not have an unlimited velocity.

Estimating the Effects of Internal Components and Design

Two other factors within a rotary screw compressor package influence the change in power relative to system pressure, independent of changes in pressure drop across the package components. The minimum pressure check valve prevents network (system) air

from flowing back into the sump when the compressor is unloaded or off. The valve also serves to maintain a minimum sump pressure when the compressor is loaded to prevent excessive oil carryover associated with high air velocity across the air/oil separator at low pressures. It also maintains a minimum internal pressure required to promote sufficient oil movement through the compressor circuit. This minimum pressure check valve limits pressure reductions to the compressor element when pressure is lowered at the compressor package discharge below a set value. Depending on compressor design and temperatures, the pressure check valve can impact internal pressure at package discharge pressures less than 80 to 70 psig.

A rotary screw compressor has a minimum discharge pressure in the design of the rotors, stator and discharge port. This is based on a compression ratio in the design and how air exits the rotors through the discharge port of the pump. Based on design, the air end (compressor element) will have a minimum pressure generated internally before the compressed segment of air is opened to the discharge port. As pressure at the discharge port deviates from design pressure, the net effect of system pressure is dampened by the compressor's need to build a minimum internal pressure. Consequently, the influence on power diminishes as the discharge pressure gets further away from the design pressure. This internal pressure ratio can be different between manufacturers, compressor models and manufacturing date.

Testing Power Change

There is not a 0.5:1 law of thermodynamics or similar constant relationship between pressure and power for all compressors. This is nothing more than a general assumption intended to provide a quick estimate within a narrow

range of pressure deviation from design. Unfortunately the truth is not well-known, and the math required for calculating power relative to discharge pressure for a specific compressor package is very complex.

The most accurate method of confirming the change in power associated with a reduction in pressure is to measure it. Run the compressor during a night or weekend shift when demand is lower and system pressure can be reduced. If this is not possible, drop system pressure carefully during normal production and note the change in power. Ideally, actual power (kW) is measured, not apparent power (kVA). Apparent power is normally calculated by measuring amperage and voltage. Utility companies charge based on actual power in kW so appropriate testing equipment is essential. The need for kW meters is due to the change in power factor associated with a reduction in motor load. The power factor is also influenced by loads placed on the electrical system, independent of the compressor. As the power factor value becomes lower, the amperage will increase, which misrepresents the actual power. Since power factor and voltage can change independent of the compressor operation, measuring amperage only and applying a constant to calculate compressor power can be misleading and lead to incorrect assumptions associated with compressor operation and estimated energy savings.

Final Savings Estimate for the Sample Problem

Referring back to the first example introduced in this article, savings ranged from a grossly overestimated 326,000 kWh/y to 67,000 kWh/y after considering details associated with pressure acting on the compressor package and the different load conditions. Ignoring any potential

changes associated with pressure loss across piping, dryers and filters, the influence of changes on internal pressure loss and a measured 0.3 percent change in power per psi change at the air-end discharge results in a savings estimate of 23,000 kWh/y. The most common assessment practices are based on averaging seven days of recorded data and then calculating savings relative to some proposed state. For the sample system used in this article, the common approach estimates savings at 92,500 kWh/y. Consequently potential savings could be inadvertently inflated four times greater than the actual savings. This illustrates the importance of employing more detailed analysis and testing methods when attempting to develop energy conservation projects with verifiable results. **BP**

Read Part 2: The influence of system pressure on centrifugal compressors in the August issue of Compressed Air Best Practices

ABOUT THE AUTHOR

Mark Krisa is Director — Global Services Solutions at Ingersoll Rand, and leads the company's compressed air audit program. This program is designed to deliver customer value by leveraging engineering and compressed air science to improve system reliability, quality and efficiency.

Krisa graduated from the University of Western Ontario in Canada with a degree in engineering science, and has worked in the compressed air industry for more than 20 years. His experience in the industry is diverse, ranging from compressor service technician to engineering and compressed air system auditor. Krisa authored several papers and speaks regularly at conferences and training events across the Americas.

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THE COMPRESSED AIR SYSTEM ASSESSMENT

Pneumatic Conveying Energy Assessment Saves \$321,000

By Don van Ormer, Air Power USA

► Introduction

This factory, located in the U.S. northeast, spent an estimated \$890,205 annually on energy to operate the compressed air system. The group of projects recommended below reduced these energy costs by \$321,000 or 36% of current use. These estimates are based upon a blended electric rate of \$0.118/kWh.

Estimated costs for completing the recommended projects total \$625,500 — providing a simple payback period of 48 months. This does not take into account the real possibility of energy incentives of up to \$250,000 being awarded to this project. Due to article length constraints, only selected energy-efficiency projects will be reviewed.

The Existing Compressed Air Installation

There are two main air systems in the facility, the plant air and the bagger air systems. There are a total of nine compressors in the plant to supply compressed air to the end users. Eight compressors are for the main plant air system and one compressor is dedicated to the Bagger system and camera cooling.

The plant air system consists of eight, single-stage, lubricated, Sullair rotary screw compressors. All units are in good working order. Units 2, 3, 4 and 7 are water-cooled and units 6, 8, 9, 10 and 11 are air-cooled. The main plant air system has two primary compressed air dryers, a Thompson Gordon model TG 2000 refrigerated dryer, and a Sullair model SAR 1350 heatless desiccant dryer. Both units are working according to their design. The TG 2000 uses approximately 11.2 kW and is a non-cycling type unit, and the SAR 1350 uses approximately 200 cfm of purge air to regenerate the wet tower.

The Bagger system has a Sullair 20-100H producing 409 scfm at 115 psig discharge pressure. This unit is also in good working order. This system is tied into the main system in case of shut down or for maintenance. The dryer for part of the Bagger system uses a CompAir model AP 380 heatless desiccant dryer consuming 45 cfm for regeneration of the wet tower.

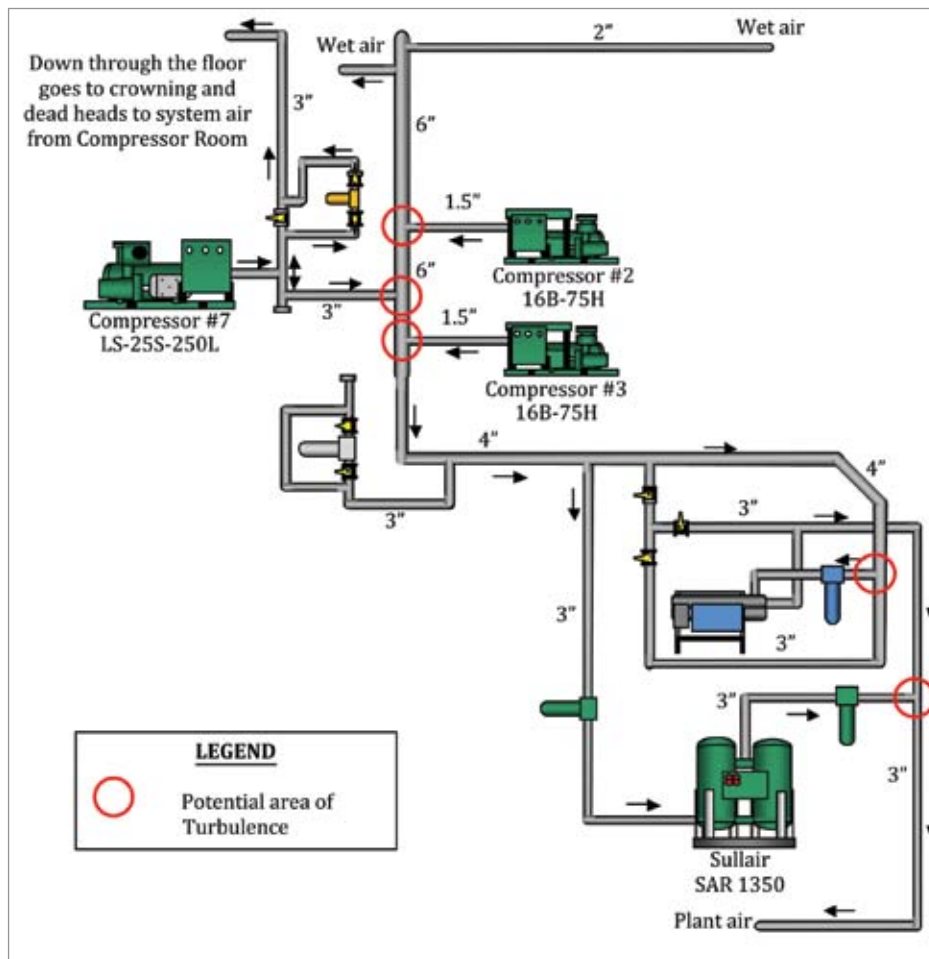


Figure 1. Current Compressed Air System-Compressor Room #1

The air compressors are located in basically two rooms. Compressor room #1 has Units 2 and 3, with 7 outside the wall connected to the 6" header in the room. Compressor room #2 has Units 4, 6, 8, 9, 10, and outside is compressor 11 feeding the Bagger line and camera cooling.

Main End Users of Compressed Air

One significant end user of compressed air is the Bagger on Line 3, operating the large cylinders for filling the bags with loose material. Not all of the air for the Bagger is dried meaning saturated and oily compressed air is going into this process. This system also supplies the Crown Blowing camera coolers allowing operation personnel to monitor the process.

The Blowing Crown air, which is regulated down to between 40 and 60 psig, is fed from the main plant air system. According to plant personnel, each Crown blow uses 280 to 340 cfm, with a total of nine for the three production lines. There are also seven atomizers for each Crown Blowing on Lines 1 and 2, using 45 to 70 cfm each at 25 to 45 psig.

The other main user is the raw material transport system, which according to plant personnel uses between 700 to 800 cfm for up to six minutes for each transport session. This system is regulated down to 45 psig from the main plant air system. Plant personnel are interested in separating the Crown blow and the transport air system air off of the main plant air system. For this report we will identify the cost savings of running dedicated low-pressure systems for these two identified high use demands.



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Establishing the Energy Baseline

Annual plant electric costs for compressed air production, as operating today, are \$878,628 per year. If the electric costs of \$11,577 associated with operating ancillary equipment such as dryers are included the total electric costs for operating the air system are \$890,205 per year. These estimates are based upon a blended electric rate of \$0.118 /kWh.

The system assessment focused on air-flow reduction opportunities, installing a separate, dedicated low-pressure air system to supply the

Crown Blowing air, and to supply the Bagger from the main plant air system.

Air Flow Reduction Projects

The system assessment revealed air flow reduction projects totaling 750 cfm. The projects included replacing timer drains with zero air-loss condensate drains (36 cfm), replacing open blows with Venturi nozzles (370 cfm), repairing identified air leaks (106 cfm), and replacing heatless desiccant air dryers with a refrigerated air dryer (247 cfm).

Due to article space constraints, we will only show the detail on the Venturi nozzle project.

We replaced high pressure air blow offs with Venturi nozzles as listed below. It's a "best practice" to use Venturi air amplifier nozzles whenever and wherever possible — properly selected and applied for needed thrust and volume, this will usually reduce blow-off air at least 50%, freeing up more air flow for other more valuable applications.

Number of blow offs	98
Estimated high pressure air used currently	590 cfm
Estimated high pressure air used after installation of Venturi nozzles	220 cfm
Estimated compressed air savings with Venturi nozzles	370 cfm
Value of air reduction	\$215.18/cfm yr
Total electrical energy cost recovery by installing Venturi nozzles to reduce blow	\$79,618/yr
Cost of nozzles and installation (\$35 per nozzle plus \$65 per installation)	\$10,000

COMPRESSOR USE PROFILE — CURRENT SYSTEM		
MEASURE	PLANT AIR SYSTEM	BAGGER AIR SYSTEM
Average System Flow (scfm)	3,820	184
Average Compressor Discharge Press	89	112
Average System Pressure	87	98
Input Electric Power	765	85
Operating Hours of Air System	8,760	8,760
Specific Power (scfm/kW)	4.99	2.16
Electric Cost for Air /Unit of Flow	\$206.95	\$477.52
Electric Cost for Air /Unit of Pressure	\$3,954	\$423.81
Annual Electric Cost for Compressed	\$790,765	\$87,863
	\$878,628	

*Based upon on a blended electric rate of \$0.118 per kWh and 8,760 hours/year.

The Crown Blowing System

In this manufacturing operation, a significant volume of 100 psi compressed air is being regulated down to the 40 psi application of the crown blowing system. This is a savings opportunity. In general terms, let's take a look at what is the relative electrical energy cost to produce 1,000 cfm of compressed air at

ELECTRIC COST OF 1,000 CFM 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

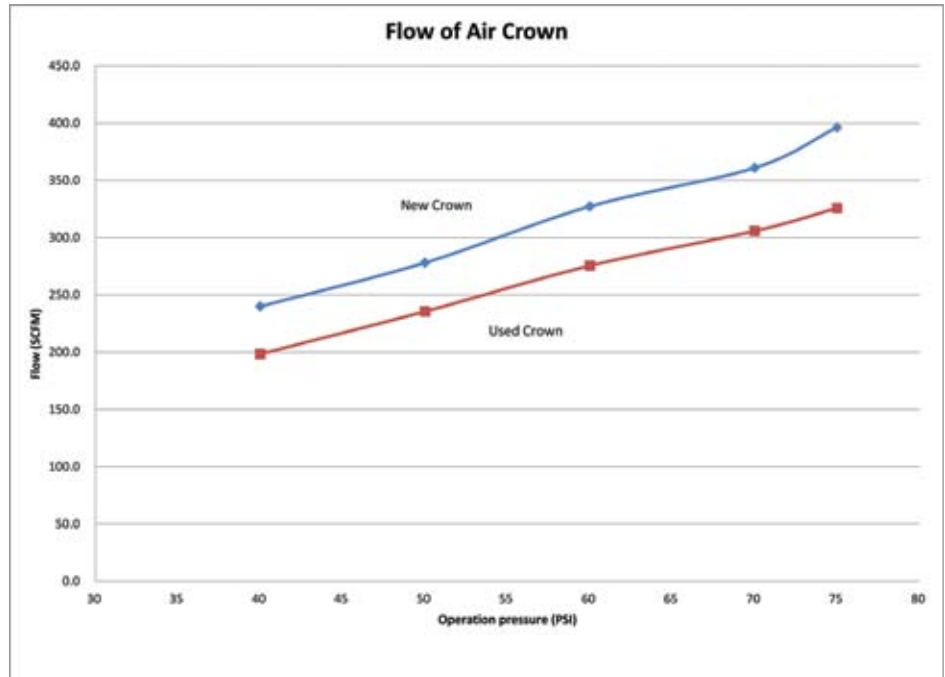
COMPRESSOR USE PROFILE — CURRENT SYSTEM							
UNIT #	COMPRESSOR: MANUFACTURER/ MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (SCFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL SCFM
Plant Air System: Operating at 89 psig discharge pressure for 8,760 hours							
2	Sullair 16B-75H	56	300	OFF			
3	Sullair 16B-75H	56	300	OFF			
4	Sullair 25-300L	271	1346	100%	271	100%	1346
6	Sullair 25-200L	171	910	100%	171	100%	910
7	Sullair 25S-250L	217	1108	80%	174	73%	809
8	Sullair LS 25-200L	171	910	OFF			
9	Sullair 25-200L	171	910	87%	149	83%	755
10	Sullair LS 25-200L	171	910	OFF			
TOTAL (Actual):				765 kW		3,820 scfm	
Bagger System: Operating at 112 psig discharge pressure and 8,760 hours							
11	Sullair 20-100H	92.5	409	92%	85	45%	184
TOTAL (Actual):				85 kW		184 scfm	

various pressures (based on .05 kWh, 8,760 hrs/year, and .93 ME).

According to plant personnel, each Blowing Crown uses 280 to 340 scfm. Air Power calculates average of 310 with six Crowns — as running during our site visit equals 1,860 scfm. An additional 57 scfm average for four atomizers running on Line 2 for a demand of 228 and 20 scfm for the three atomizers running on Line 1 is 60 scfm for a total of 288 scfm for the atomizers would be a total low pressure demand average of 2,148 scfm. This demand is subtracted from the current Plant system demand with the Bagger system added to it, subtracting the 45 scfm from the dryer purge leaving 1,794 scfm left on the Plant air system.

The system assessment recommended installing one 600 horsepower, 2-stage, water-cooled, low pressure centrifugal to supply the Crown Blowing system with 40 psig air. The centrifugal will come equipped with inlet guide vanes for efficient turn down. This unit produces 3,350 scfm at 40 psig and 3,150 scfm at 60 psig. The plant can use the current 100 psi system as emergency back-up. The piping to the Blowing Crown will have to be modified to carry the air demand at 40 psig with little or no pressure loss from the compressor to the Crowns.

Annual hours of operation for current system	8,760 hrs
Annual energy cost of current system after air reductions and combining Bagger System with Plant Air System	\$680,161/yr
Annual energy cost of proposed system	\$591,265 / year
Annual energy savings	\$88,896 /year
Estimated equipment cost for new unit / modifications	\$200,000
Estimated installation cost	\$150,000
Estimated total project cost	\$350,000



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VENTURI INDUCER NOZZLES IN PLACE OF OPEN BLOW									
LOCATION	QTY	TYPE / SIZE	ESTIMATED CURRENT CFM USAGE	UTILIZATION %	NET AVG CFM	RECOMMEND VENTURI NOZZLE	NEW AVG NET CFM EACH	NET AVG CFM USAGE	EST NET AVG CFM SAVED
Bagger line Plenum *	1	8"x1" x10 nozzles	10@40psy	100%	100	40008SS	10@6=60	60	40
Bagger Tower	4	1/4" Copper	15	100%	60	Use existing blower – repair ducting	—	—	60
Line 1 Drum Roller	1	8"x2"x20 nozzles	10@40psi	50%	100	40008SS	10@6=60	40	60
Line 1 Puffer Bar	1	8"x2"x20 nozzles	10@40psi	50%	100	40008SS	10@6=60	40	60
Line 2 Drum Roller	1	8"x2"x20 nozzles	10@40psi	50%	100	40008SS	10@6=60	40	60
Line 2 Puffer Bar	1	8"x2"x20 nozzles	10@40psi	50%	100	40008SS	10@6=60	40	60
Line 2 Convey	4	Silvent 9005W	15@40psi	50%	30	Remove	—	—	30
Total	98 nozzles				590	Proposed Usage		220	370

*Estimated could not see inside to view nozzles.
Note: there are several Guard Air Force 5 blow guns located in the plant. These blow guns use 185 cfm at 90 psig.

COMPRESSOR USE PROFILE — PROPOSED SYSTEM							
UNIT #	COMPRESSOR: MANUFACTURER/MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (SCFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL SCFM
Plant Air: Operating at 90 psig discharge pressure for 8,760 hours							
2	Sullair 16B-75H	57	300	OFF			
3	Sullair 16B-75H	57	300	OFF			
4	Sullair 25-300L	274	1347	94%	258	81%	1,097
6	Sullair 25-200L	172	910	OFF			
7	Sullair 25S-250L	219	1108	OFF			
8	Sullair LS 25-200L	172	910	OFF			
9	Sullair 25-200L	172	910	OFF			
10	Sullair LS 25-200L	172	910	OFF			
11	Sullair 20-100H	93	409	OFF			
TOTAL (Actual):				258 kW		1,097 scfm	
Low Pressure System Blowing Crown Air: Operating at 40 psig discharge pressure for 8,760 hours							
1	600hp 2-Stage Centrifugal	408	3,350	77	314	64	2,148
TOTAL (Actual):				314 kW		2,148 scfm	
1	Single Stage Oil Free 150hp	116	880	67	77	60	480
TOTAL (Actual):				46 kW		1,140 scfm	

Pneumatic Conveying Application

The current application is using the main plant air system to provide the transport air for the raw material. There are three different transporters: mixed material to feed furnace, glass powder and minor ingredient. According to plant personnel the transport system consumes between 700 to 800 scfm for around six minutes for mixed material per transport and operates approximately 60% of the time. This equates to a 480 scfm average demand on the system. The glass powder transport operates two to three hours per day while the minor ingredient operates the same time frame as mixed material.

The configuration and transport demands are:

Worst Case product bulk density	1.20 MT/m ³
Length of Run	150 feet
Number of Elbows	5 x 90° Elbows pocket elbow, short radius
Line Size	4" #80 Black Pipe
Convey Rate	400-600 lbs. per minute

SYSTEM COMPARISON	CURRENT SYSTEM		PROPOSED SYSTEM		
	PLANT AIR SYSTEM	BAGGER AIR SYSTEM	PLANT AIR WITH BAGGER SYSTEM	NEW LOW PRESSURE 40 PSI SYSTEM	DENSE PHASE TRANSPORT 50 PSI SYSTEM
Average Flow (scfm)	3,820	184	617	2,148	480
Compressor Discharge Pressure (psig)	89	112	90	40	50
Average kW	765	85	155	322	77
Average System Pressure (psig)	87	98	90	40	45
Electric Cost per cfm	\$206.95	\$472.55	\$259.68	\$154.95	\$165.82
Electric Cost per psig	\$3,954	\$423.81	\$801.10	N/A	N/A

PROJECTED ENERGY COST SAVINGS FOR PROPOSED SYSTEM

AIR SYSTEM COMPONENT	ANNUAL ELECTRIC COST OF CURRENT SYSTEM	ANNUAL ELECTRIC COST PROPOSED SYSTEM	ANTICIPATED ANNUAL SAVINGS	ESTIMATED PROJECT COST	NET PROJECT COST AFTER REBATES
Compressor System Operations	\$878,628	\$564,389	\$314,239	\$475,500	Potentially down to \$375,500
Ancillary Air Equipment (dryers, etc.)	\$11,577	\$4,755	\$6,822	\$150,000	
Total Compressed Air System	\$890,205	\$569,144	\$321,061	\$625,500	

The transport system has a very detrimental effect on the main plant air system, when it operates it draws the plant system air pressure to unacceptable levels. The plant air is regulated down from plant pressure to 45 psig at the transport system feed.

The system was set up for dense phase transport and over the years has been converted to dilute phase. On a typical dilute phase system with the maximum pressure being 15 psi, running at 14 psi doesn't allow any room to account for pressure spikes or other possible upset conditions. Most systems run at no higher than 12 psi, allowing 3 psi to account for the spikes and other unforeseeable issues.

Ideally, it would be best to change the system to a 6" line, and then the following could be accomplished:

400 ppm in a 6" line =
approximately 1135 cfm at 6.9 psi

500 ppm in a 6" line =
approximately 1140 cfm at 8.2 psi

600 ppm in a 6" line =
approximately 1150 cfm at 9.5 psi

We nevertheless recommend returning the system back to Dense Phase with a dedicated low pressure (50 psi) compressor to replace the high-pressure plant air now being used. We recommend installing a 150 horsepower oil-free rotary screw compressor to provide the 800 scfm peak flow to properly operate the transport system

Conclusion

This system assessment case study is interesting in that many plants use 100 psi compressed air and regulate it down for applications ranging in the 15 to 40 psi range. Particularly plants deploying dilute or dense phase transport systems need to take a good look at the energy efficiency of their supply-side compressed air system. This plant was able to realize \$321,000 in yearly energy savings by identifying this opportunity. ^{BP}

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The Six Basic Types of Liquid Cooling Systems

By Bruce Williams, Regional Sales Manager, Hydrothrift Corporation

► There are six basic types of cooling systems that you can choose from to meet the cooling needs of your load. Each one has its strengths and weaknesses. This article was written to identify the different types of cooling systems and identify their strengths and weaknesses so that you can make an informed choice based on your needs.

There are six basic types of liquid cooling systems:

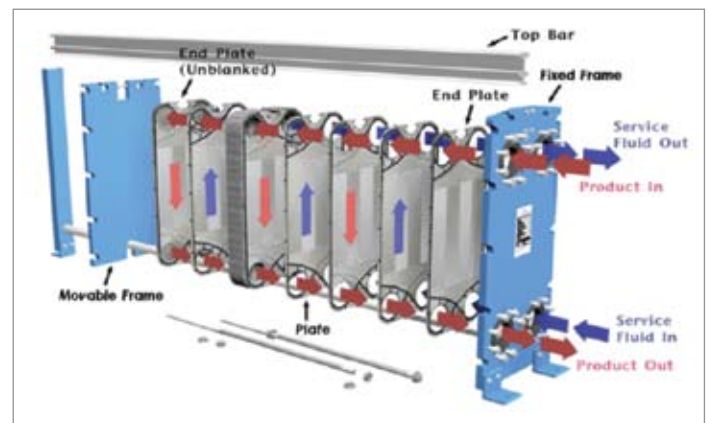
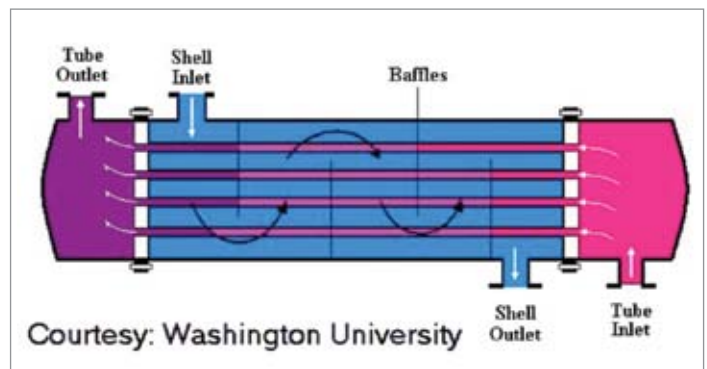
1. Liquid-to-liquid
2. Closed-loop dry system
3. Closed-loop dry system with trim cooling
4. Open-loop evaporative system
5. Closed-loop evaporative system
6. Chilled water system



Liquid-to-Liquid Cooling Systems

Liquid-to-Liquid Cooling Systems

The simplest of these systems is a liquid-to-liquid cooling system. In this type of system your plant has an abundance of some type of cooling liquid already available but you do not want to provide this coolant to the compressor. For example: you have well water available but you do not want to put the well water through your new compressor because the water quality is very poor (lots of dissolved solids like iron and calcium



etc.), and you have had trouble with the well water fouling your heat exchanger/s in the past.

A liquid-to-liquid cooling system is an ideal fit for this situation. It uses the well water on one side of an intermediate heat exchanger and a coolant such as glycol and water on the other side of the intermediate heat exchanger in a closed loop to cool the compressor. The heat is exchanged through the intermediate heat exchanger without fouling the heat exchanger/s. Fouling of the intermediate heat exchanger will likely happen on the well-water side, however, if the intermediate heat exchanger is selected properly it can be taken apart easily and cleaned. The most common intermediate heat exchangers are either plate and frame or shell and tube type. Coolant temperatures of 5 degrees above the plant cooling "water" are possible with a liquid-to-liquid type system. In the well water example above if the well water is available at 55 °F the liquid to liquid cooling system is capable of supplying 60 °F coolant to the load.

The strength of a liquid-to-liquid cooling system is that it is relatively inexpensive to purchase and install. The components can be installed inside or outside. The system is inexpensive to operate with only the closed loop pump using any additional energy. Maintenance is relatively simple demanding only a periodic inspection, lubrication, and cleaning of the heat exchanger as necessary.

Weaknesses of the liquid-to-liquid cooling system include periodic downtime of the cooling system for cleaning. This can be offset by installing a standby intermediate heat exchanger that is put into service while the primary intermediate heat exchanger is cleaned. A standby heat exchanger adds additional cost but allows for continuous operation of the cooled load while cleaning is accomplished. This system requires a regulated supply of plant coolant like the well water

example above for proper cooling of the load. There can be times that the cooled load does not operate at maximum capacity and the plant primary cooling "water" must be regulated to insure the load is not over or under cooled.

Closed-Loop Dry Cooling Systems

A closed-loop dry cooling system is very much like the radiator in your car. The system uses an air-cooled fluid cooler to transfer the heat from the closed-loop coolant fluid pumped through rows of finned tubes that have ambient air blown/drawn across them. The basic components to a closed-loop dry cooling system are the fluid cooler, which contains the air to liquid heat exchanger with the fan/s, the pump and control skid, the coolant, and the field installed system piping. The closed-loop dry cooling system fluid cooler will be



Closed-loop Dry Cooling Systems

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THE SIX BASIC TYPES OF LIQUID COOLING SYSTEMS

located outside and use the ambient air to reject the heat. Coolant temperatures of 5 to 10 °F above the ambient dry bulb temperature are possible with a closed-loop dry cooling system. The system is relatively inexpensive to operate with only the coolant pump and the fluid cooler fan/s using energy. The fan/s are thermostatically controlled to regulate the temperature of the cooling fluid so that the load is not over or under-cooled. Periodic cleaning of the fluid cooler may be necessary due to dirty atmospheric conditions at the site location. Fouling of the fluid cooler is typically caused by dirt, leaves, cotton-wood seeds, etc.

The strength of a closed-loop dry cooling system is that the unit is very simple and relatively easy to install. The energy requirements are relatively low and it is easily

controlled. Maintenance is normally low requiring only periodic inspection, lubrication, and testing of the fluid.

The weakness of a closed-loop dry cooling system is that it is dependent on the atmospheric dry bulb. For example, if your location's design dry bulb is 100 °F in the summer and your equipment requires 90 °F coolant; at best the system can only supply around 105 to 110 °F coolant to the load. In this case you would need supplemental cooling to get the coolant temperatures down to 90 °F.

The closed-loop dry cooling system also requires free clear air to work efficiently. This means that the fluid cooler must be placed in a location that is not affected by the prevailing winds, not too close to a building that will allow the warm exhaust air from the

fluid cooler to be recirculated back to the fluid cooler, and finally not in a location that has heavy concentrations of dust, dirt, leaves, seeds, etc.

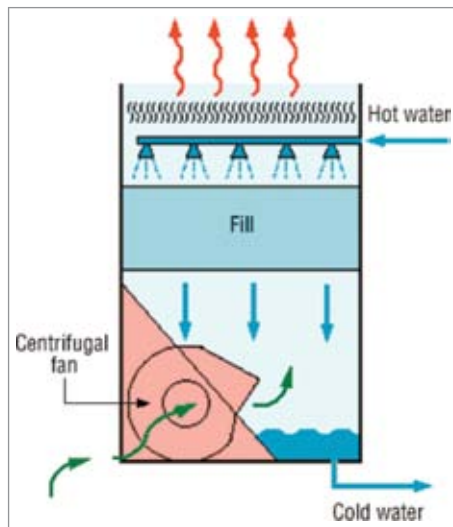
Many times the best location for the fluid cooler is on the roof. Since the fluid cooler is located outside the coolant must also have a concentration of some type of glycol to prevent freezing if your location has a design dry bulb in the winter that dips below freezing. If the location is very cold, the concentration of glycol may need to be significant to prevent freezing. Glycol concentrations as they increase begin to reduce the rate of heat transfer. For example, if you need 50% ethylene glycol concentration with water the heat exchanger equipment and the flow/pressure of the coolant will need to increase to adjust for the glycol

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Open-loop Evaporative Cooling Systems

concentration. Larger fluid coolers and pumps will increase the cost of the system over those with lesser concentrations of Glycol/water. This cannot be prevented in colder climates.

Closed-loop Dry Systems with Trim Cooling

A closed-loop dry system with a trim cooler is the same as the closed-loop dry system but adds a supplemental fluid cooler. This system is typically used in a location that has too high of a dry bulb in the summer to provide the proper coolant temperature to the load. With an added liquid-to-liquid trim cooler the customer can use a water source to trim the temperature to the desired set point. Many times closed-loop dry system with a trim cooler are used to reduce the reliance on city water

as a coolant. City water is becoming expensive to buy and to dispose of. These systems may be employed to completely eliminate the city water usage most months in a year, thus reducing the plant's operating costs. The system must have a supply of free clear air and a regulated supply of plant coolant or city water as with a liquid-to-liquid cooling system.

The strength of the closed-loop dry system with a trim cooler is that it can provide coolant temperatures below that of a closed-loop dry system alone. The system will reduce the amount of plant/city water usage during the colder months.

The weaknesses of the closed-loop dry system with a trim cooler include all of those listed for the closed-loop dry system. Also, it now requires some secondary coolant during

warmer times of the year. Additional piping will be required for the trim coolant to/from the skid. Both the trim cooler and the air cooled fluid cooler will require periodic maintenance and cleaning.

Open-loop Evaporative Cooling Systems

The next system, an open-loop evaporative cooling system is completely different than the first three listed above. This system has the ability to use the design wet bulb as the basis for the outlet temperature of the cooling water. For example if the design dry bulb for the location is 95 °F and the design wet bulb is 75 °F, the system can provide approximately 82 °F water to the load.

The open-loop evaporative cooling system cascades water through the honeycomb

Measure, discover and save!

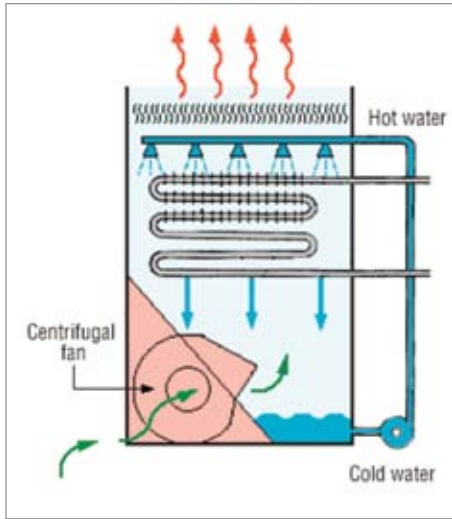
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THE SIX BASIC TYPES OF LIQUID COOLING SYSTEMS



Closed-loop Evaporative Cooling Systems

PVC fill material in the tower along with ambient air blown or drawn through the fill to evaporate the water. During the evaporation, the remaining water is cooled to as close as 7 °F or higher above the wet bulb temperature. The evaporated water is replaced with some type of make-up water system like a float valve. The remaining water and the make-up water are collected in a basin and then pumped to the load and the cycle repeats. On average an open-loop evaporative cooling system requires 4 GPM of make up and blow down water per 1,000,000 Btu/hr of heat rejected.

The advantage of this system is that the equipment is typically inexpensive. The systems can be simple to employ in warmer climates but may require more controls in colder climates.

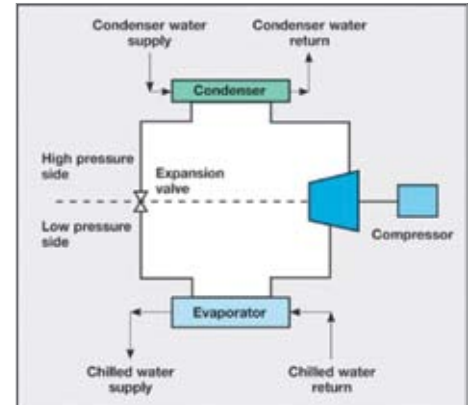
The weaknesses of this type of system are that they normally require an extensive water treatment system. The water treatment system uses expendable chemicals to keep the calcium and dissolved minerals in suspension. The chemical treatment is necessary to ensure that the cooling tower, piping, and heat exchangers do not become fouled. An inherent issue with the open tower evaporative system is that the water that flows through the tower is also the heat transfer fluid that is pumped through the load. This water comes in contact with the dirty atmosphere. It picks up pollutants such as dust, vegetation, etc. These contaminants end up in the heat exchangers and piping and can cause significant maintenance issues.

Open towers can have control issues in the winter months. They are designed to run at full load. They do not always perform well under part-loading in very cold climates. If the basin is part of the tower, a heater is required for cold weather operation to keep the basin water from freezing when the load is not present.

The piping will normally require insulation and heat trace in cold climates to prevent freezing. A drain will be required for blow-down of the water to keep the conductivity in check from the constant evaporating and concentrating of the dissolved solids. Make-up water is continually required from external source such as city water or treated well water, etc. Biological control of bacteria, slime, and mold are major concerns for proper operation of an open evaporative tower system.

Closed-loop Evaporative Cooling Systems

A closed-loop evaporative system is a hybrid system. The closed loop evaporative system is an open tower with a closed-loop heat exchanger built into the tower. The tower water stays outside in the tower and does not circulate through the coolant piping. The coolant piping is a closed loop, with a glycol/



Chilled Water Cooling Systems

water solution flowing from the tower to the load and back. The separate tower water is pumped from the basin to the top of the tower and sprays across the heat exchanger (normally an array of tubes) with air blown or drawn through the tower across the heat exchanger where evaporation of the water transfers the heat from the closed coolant loop to the ambient air. The remaining tower water falls to the basin where it is again pumped up to the top of the tower and repeats the process. The closed-loop evaporative system tower water requires make-up water, chemical treatment, a drain, cold weather basin heater, and blow-down just like the open-loop evaporative system discussed above.

The advantage of the closed-loop evaporative system is that it can deliver closed loop coolant to the load at approximately 7 to 10 °F above the wet bulb temperature. The closed-loop

coolant remains free of contaminants and allows the equipment heat exchanger and piping to remain clean. Any contaminants from the atmosphere will stay outside with the tower. Fewer water treatment chemicals will be used because they are only treating the open water in the tower and not the coolant in the piping and system heat exchangers.

The drawbacks of a closed-loop evaporative system are that you will need water treatment, blow-down, and make-up water for the tower water side of the system. The system will require a drain and heat-traced and insulated piping for cold weather applications. There is a basin heater required to prevent freezing of the basin in cold weather off-time operation. The system requires an additional pump connected to the tower which circulates the basin water.

Chilled Water Cooling Systems

The last type of cooling system we will discuss is the chilled water system. A chiller normally has a mechanical compression device that converts energy into compressed refrigerant by using some type of compressor. The compressed refrigerant is piped to a condenser that rejects the heat from the refrigerant to the atmosphere or some type of liquid coolant. The compressed refrigerant changes state from a gas to a liquid in the condenser and is piped to an evaporator where it is metered or expanded in the evaporator. The expansion of the high pressure liquid refrigeration reduces the temperature of the evaporator. The liquid to be cooled is pumped through the evaporator heat exchanger and heat is transferred to the refrigerant. The low pressure vapor is carried back to the compressor and the cycle begins again for the refrigerant. The coolant flows from the evaporator heat exchanger to the load where the heat is transferred to the coolant in the load heat exchanger and then returns back to the evaporator to repeat the cycle.

The strengths of a chiller are that it can produce coolant temperatures far below the design wet bulb or dry bulb. It is not as dependant on the ambient temperature for the outlet coolant temperatures.

The weaknesses of a chiller are that it is a fairly complex piece of machinery. Chillers cost more than all other forms of cooling equipment. They require specialized periodic maintenance and trained certified repair technicians for proper operations. Chillers themselves introduce additional heat loading from the compressors that must also be removed in the condenser. The power required to operate a chiller is much higher than the other types of cooling systems discussed above. Cold weather operation of chillers requires special additional

components on the chiller. Load variations may require special controls and/or multiple chiller circuits for efficient operation all adding to the overall cost of the equipment.

Conclusion

As you can see there are many types of cooling systems available to satisfy your requirements. It is best to involve your cooling system specialist early in your planning to help you choose the best system to fit your needs. **BP**

For more information contact Bruce Williams, Hydrothrift Corporation, tel: 330-264-7982, bwilliams@hydrothrift.com, www.hydrothrift.com

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Association of Independent Compressor Distributors (AICD) Membership Meeting & Exhibition

2013

By Rod Smith, Compressed Air
Best Practices® Magazine



► The 2013 edition of the AICD was held June 2-4 at the Gaylord Opryland Resort in Nashville, Tennessee. A first-timer to Nashville, the venue lived up to its' excellent reputation regarding country music, barbeque, and overall excellent service within the resort's massive botanical gardens.

What exceeded my expectations (and those of many I spoke to) was the "new" AICD. This was the first year the Conference was "opened up" and the new air compressor exhibitors and new distributors attending the conference took the event to another level. The AICD informed us

there were just over twenty-five new compressor distributors that had signed up for AICD membership! AICD President, Manny Cafiero of Scales Industrial Technologies, said, "The AICD has begun an exciting new chapter by welcoming ALL air compressor vendors and distributors to participate."

The Conference

The speaker line-up is vendor-neutral and structured to help air compressor sales and service companies improve their businesses. Open to member companies and vendors alike, the conference room was

AICD Members in Attendance:

Advanced Air & Vacuum	Comp-Air Service	Harris Equipment	National Pump & Compressor
AIM of Louisiana	CFM Solutions	Industrial Air Tool	Q-Air California
AIM Power & Fluids	C.H. Reed	Industrial Compressor Solutions	Quality Compressed Air Services
Air Equipment Sales & Service	Compressed Air & Equipment	J.D. Dickinson Compressor	Repair Compressor Service
A.J. Kollmyer & Son	Compressed Air Power	John Henry Foster of Minnesota	Rogers Machinery
Arkansas Industrial Machinery	Compressed Air Solutions	Lubbock Electric	Scales Industrial Technologies
Atlas Machine & Supply	Compressors Air US Service	Maddox Air Compressor	Southern Parts and Engineering
Bi-State Compressor	Compressed Air Technologies	Maine Air Power	Stansbury Equipment
Burton Compressor	E.A. Nelson	McGee Company	Starr and Company
Brehob Corporation	Engine Service & Supply	Metropolitan Air Compressor	The Titus Company
Burton Compressor	Evapar	Michigan Air Solutions	Vacuum Pump & Compressor
Cascade Machinery	Gregory Pool Compressed Air Systems	Midstate Air Compressor	West Tennessee Air Compressor



Yorrick de Souza, Gavin Monn, Jerry Elsen, Andrew Nachtigall, Lutz Knoke, Scott Woodward, Wolfgang Strobelt, and Josh Chabot at the BOGE booth.



Corey and Becky Turner, Bill Kennedy, and Jay Hedges at the Mattei Compressors booth (left to right).

filled to the last chair! I was not able to attend all the sessions but will provide some comments on those I did attend.

The first speaker was Dr. J. Robert Gillette, a Professor of Economics at the University of Kentucky. His presentation was titled, "State of the Economy". He was such a dynamic speaker, it made me wish he'd been my professor in college! Mixing rambunctious patriotism with graphs, Dr. Gillette showed what an incredible wealth-building machine the U.S. economy has been over the decades. It was refreshing to take a step back and view the macro picture with the help of the trained eye. He described this last crisis as a unique "financial recession" — a crisis of confidence in our financial systems unique since the Great Depression. His future outlook was one of steady if unspectacular growth. A comment he made stuck in my mind, "China will grow its' middle class, over the next ten years, from 230 to 630 million people." I hope our political and business leaders can embrace a future with China rather than push it away into the arms of competitive exporters.

William "Bill" Scales, the CEO of Scales Industrial Technologies, provided an excellent presentation titled, "Changing Landscape of the Compressed Air Industry." As new financial owners and new market entrants arrive on the scene (among the air compressor manufacturers), Bill asked distributors what questions they should be asking themselves to position themselves for the long-term. He brought feedback from sixteen people he had interviewed, asked the audience their opinion and offered his own for a very lively dialogue.

Yours truly (Rod Smith) made a presentation titled, "Advanced Trends in Compressed Air Best Practices." As we publish the magazine I'm able to observe and write about system assessments conducted by corporations with, what I consider, "advanced" compressed air systems. I reviewed flow metering, engineering for lower pressure, and shutdown optimization actions taken by companies like Honda, Visteon, Ball Container, and Saint Gobain.

A full afternoon was dedicated to field service. Sarah Howland, Editor in Chief of Field Service Technologies, presented "The Key Components of Profitable Field Service." She discussed mobile computing, field service software automation tools, and fleet management. Her presentation was followed by a Distributor Panel of AICD veterans, (Ron Nordby, Robert Miller, Dennis Reed, Manny Cafiero, Patrick Lorenz), who discussed "How Cost-Effective Technology & Field Service Mobility are Transforming the Industry."

The Exhibition

The 2013 AICD Exhibition blew out the doors with regards to exhibitors. Exhibitors who were pleased to see a record number of AICD Members from strong air compressor sales and service companies. The show hours are from 4:30 to 7:00 pm, on two consecutive evenings after the conference sessions, and I wander the booths, armed with my cheap digital camera, and salute old friends and make new ones. My apologies go out in advance to the many booths and firms not mentioned here due to the space limitations of the article.

THE 2013 AICD MEMBERSHIP MEETING & EXHIBITION



Richard Hinkle, Vinson Sill, Grant Hebert, Larry Rhodes, Dean Chew, Cheryl and Bill Kiker at the CompAir booth.



Keith Sportsman, Jay Varadaraj, Gary Valvo, Bob Philips, and Hannu Heinonen at the ELGI Compressors booth.



Brent Becker, Matthew Hanna, Joshua Wamser, Charlie Hovis and Kent Waldeck at the FS-Curtis, FS-Elliott and ALMiG booth.

The huge island booth that hit me, right when I walked in, was the booth of BOGE Compressors. Gavin Monn and Scott Woodward have put together a strong team, in the U.S., and had many oil-free air compressor technologies on display. This included the 60-480 hp SO Series oil-free rotary screw line and the Bluekat BC Series that allows a lubricated compressor to deliver oil-free air by means of a catalytic converter. They displayed an oil-free line-up of piston compressors with 4-15 hp units for 180 psi pressure and 7.5 hp and 15 hp boosters capable of taking ambient air (or pressurized air) to 580 psig.

Mattei Compressors is excited about their new BLADE Series belt-drive rotary vane air compressors. Bill Kennedy and Jay Hedges were hanging out in their big “truck racing” booth talking about the durability of this new product line from Mattei. I don’t know anything about racing (except that Mattei distributors enjoy them) but I do know that this belt-drive unit is going to make a difference in their “No Vain No Gain” mission! The low rotational speeds and the solid durability of vanes have always appealed to me.

Sullivan Palatek Compressors had a big booth. Palatek President Steve Van Loan reluctantly divulged that the company has grown significantly over the past few years and has moved into a significantly larger space. Palatek has truly developed a loyal following of distributors who like the service-friendly and rugged design of their rotary screw air compressors.

CompAir was in attendance for the first time, displaying CompAir, Hydrovane, and Champion product lines. The broad range of rotary screw, rotary vane and reciprocating air compressor technology they have available is impressive. Good to see industry veterans like Dean Chew still telling jokes! CompAir told me they continue their traditional focus on supporting the air compressor distributor sales channel.

Elgi Compressors has certainly made some noise this year by acquiring Patton’s Inc. and followed it up with a big booth at the AICD. It was great to see Gary Valvo and Hannu Heinonen again after all these years. Elgi has assembled a veteran team of compressor people, in the U.S., and all they talk about is “uptime”! The Managing Director for ELGI, Mr. Varadaraj, was present and he explained their engineers have always designed for durability so there is never any “downtime”. ELGI designs their rotary screw compressors, for example, to withstand 115 °F ambient temperatures and claim to use the largest airends in the world on specific models. They run the compressors at low rotational speeds of 1800 rpm, on average,

and have announced an innovative “Lifetime Warranty” on their patented rotary screw airends.

FS-Curtis and FS-Elliott had a strong presence at the AICD with a nice double-sized booth. I had a good chance to talk to Brent Becker, the President of FS-Curtis, who said, “We’ve been talking to attendees about how the FS-Curtis, FS-Elliott, and ALMiG brands are working together to provide distributors the opportunities to focus on their customer’s needs.” It is interesting to see how these two historic U.S. brands have come together to offer one powerful lineup of rotary screw, reciprocating, and centrifugal air compressor technologies.

Hankison SPX reported excellent progress with their high-capacity, energy-saving HES Series refrigerated dryers for flow capacities from 3750 to 12,500 scfm. Now just over one year after launch, Sales Manager Ray Brahm reports a solid sales volume has been experienced and that the multi-station technology is working well.

JORC continues their exclusive focus on condensate management. President Eugene White said that business continues strong with both OEM and distribution sales channels. Their non-electric zero air-loss drain is seeing a lot of success as are their oil-water separators. I have always particularly liked their Air-Saver lock-down valves designed to prevent air leaks when the system is down during shut-down periods. One distributor, at the show, told me of an installation using 20+ Air-Saver lock-down valves that has saved their client a lot of energy. This big plant had a lot of leaks in the piping and these valves isolated those areas of the plant and only allowed compressed air into them when it was needed. A simple way to keep the air compressors from turning on at night!

Parker had a great island booth consolidating the multiple technologies they offer into one large booth including Parker Transair piping and Parker nitrogen generators. Parker domnick hunter is launching the new DNC Series non-cycling refrigerated air dryers for flows from 10-1200 cfm. I really liked the instrumentation on the unit as it’s made for refrigeration technicians with a suction pressure gauge and alarms for high and low refrigeration pressure. The units have a “4 in 1” aluminum heat exchanger featuring an extremely low pressure drop of only 2 psi. The units are sold standard with a 1 micron pre-filter. Parker Finite is also launching the new HX Series filter line. It has a unique end-cap to protect aftermarket and a “low clearance profile” minimizing the space required to remove the bowl to change the element. Marketing Services Manager Jane Sexton showed me their new online “Click to Chat” and “Talk to an Engineer”



Ray Brahm and Roger Michael at the SPX Hankison booth.



Dale Zimmerman, Robin Viviano, Mike Sims, Rob Lear, and Jane Sexton at the Parker booth.



Mike Wlodarski, Bruce Williams, and Bill Kiker at the Hydrothrift booth.

THE 2013 AICD MEMBERSHIP MEETING & EXHIBITION



Tony Hergert, Nick Herrig, Mark Lauterwasser, Kent Reddington, Johnny Smith, David Peters and Todd Allison at the Nano Purification Solutions booth.



Stefano Gaggero and Joe Burke at the Aircom booth.



David Dieterle, Megan Ginelli, Michael Sano, and James Morrel at the Porocel booth.

chat features allowing clients to ask customer service center or product related questions directly online and receive instant answers.

HITACHI America has grown their oil-free air compressor division significantly in the U.S. After having moved into a significantly larger facility in the Charlotte area, U.S. Senior Manager, Nitin Shanbhag, reports they continue to hire new employees and recruit new distributors. The company recently unveiled their new NEXT campaign including a new oil-free rotary screw compressor line, a new air treatment line-up and master control and compressor sequencing technologies. They reported that their niche campaign has also worked well to sign up distributors for their line of oil-less scroll air compressor ranging from 1.5 to 16.5 kW.

Nano Purification Solutions continues to steam ahead. Their veteran team, led by Nick Herrig and David Peters, reports high acceptance levels of their new D-Series desiccant dryers featuring a patented combined filter and desiccant cartridge allowing users to eliminate external pre- and after-filters (although they do recommend an oil coalescer prefilter if the compressor is lubricated). The company is also introducing a truly new drying technology, called the AMT Series, of extruded activated alumina tubes. This exciting new technology has significant potential to displace many traditional drying technologies — particularly in lower-flow applications in these early stages of the technology.

Hydrothrift Corporation and Thermal Transfer Products both had excellent booths talking about their cooling system products. It's great to see such a wide array of heat exchanger options for the diverse cooling system requirements out there. One thing I hear about, from end users, is a need for more engineering advice to help them reduce the energy and water consumption requirements of their systems.

Conclusion

Once again, the AICD was a very entertaining and educational event. It's amazing how well Cheryl Kiker organizes and runs the whole thing. For anyone wanting more information on membership or exhibiting at the AICD, please contact Cheryl Kiker at aicd@aicd.org or visit www.aicd.org. **BP**

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CAGI PERFORMANCE VERIFICATION PROGRAM FOR AIR COMPRESSOR AND DRYER SELECTION

By the Compressed Air & Gas Institute

► Introduction

Plant engineers do not purchase air compressors or compressed air dryers on a regular basis. There may be decades between purchases, and with today's more reliable and durable compressed air equipment, the interval between purchasing decisions grows ever longer. This lack of purchasing frequency, coupled with the significant investment in productivity that compressors and dryers represent, means it is important to make the right decision.

Compressed air system equipment manufacturers offer a wide variety of equipment and features to meet every need. Purchasers must weigh the costs and benefits of different options while evaluating the many variables that must be considered

when purchasing a compressor or dryer. The following list starts to scratch the surface: current system layout (if there is one), end use requirements, control strategies, future expansion plans, available resources (power, water, financial, infrastructure, etc.), site conditions, intermittent end uses, available storage, etc.

The Performance Verification Program

The Compressed Air & Gas Institute (CAGI) has developed a Performance Verification Program for rotary compressors and refrigerated air dryers to help purchasers address one key decision: which equipment will provide the compressed air needed to meet demand in the most efficient way. CAGI and its members have devoted great effort to establish the Performance Verification

Program. Development of well accepted international standards for measuring performance, ISO 1217 for compressors and ISO 7183 for dryers, and adoption of a common, standardized means of reporting performance, the CAGI datasheets, took many years of hard work.

Performance standards and standardized datasheets are critical decision making tools. They offer key points of comparison for purchasers, but is the data reliable? The manufacturers provide the performance data. Can purchasers trust the data?

To ease possible concerns about the reliability of stated performance data, CAGI members that manufacture rotary compressors and refrigerated air dryers took an additional step. They contracted with an independent third party to verify their stated performance data.

The third party administrator of the program is Intertek Testing Services, a respected 127 year-old testing company. Intertek first determines a participating manufacturer's stated performance by obtaining datasheets on the participant's public website. Intertek then selects a sample for testing, ships it to the Intertek lab, and tests the equipment to the relevant standard test procedure. The outcome of the Intertek test is compared to the participant's stated performance claims, and

The Compressed Air & Gas Institute (CAGI) is an association of manufacturers of compressed air system equipment: compressors, blowers, air drying and filtration, and pneumatic tools. Links to member websites are provided on the CAGI site. The members' representatives are readily available to assist users in recommending the proper equipment to meet your compressed air needs. CAGI's mission is to be the united voice of the compressed air industry, serving as the unbiased authority on technical, educational, promotional, and other matters that affect the compressed air and gas industry.

Currently, the Performance Verification Program covers lubricated rotary compressors from 5 to 200 horsepower and dryers from 200 to 1000 scfm, CAGI has expanded the scope of the program since its inception, and future expansion is expected.

The CAGI Performance Verification Program for Rotary Compressors and Refrigerated Air Dryers is based on ISO standards and CAGI Datasheets. For further information about the standards, the datasheets, and the program, visit the CAGI website: <http://www.cagi.org/performance-verification/>. In addition to the Performance Verification Program, there are additional resources, including e-learning coursework on the SmartSite, selection guides and data sheets, videos and CDs, and the Compressed Air & Gas Handbook available through CAGI.



CAGI PERFORMANCE VERIFICATION PROGRAM FOR AIR COMPRESSOR AND DRYER SELECTION

COMPRESSOR DATA SHEET			
Rotary Compressor: Fixed Speed			
MODEL DATA - FOR COMPRESSED AIR			
1	Manufacturer:		
2	Model Number:		Date:
	° Air-cooled ° Water-cooled	Type:	
	° Oil-injected ° Oil-free	# of Stages:	
3*	Rated Capacity at Full Load Operating Pressure ^{a, e}		acfm ^{a, e}
4	Full Load Operating Pressure ^b		psig ^b
5	Maximum Full Flow Operating Pressure ^c		psig ^c
6	Drive Motor Nominal Rating		hp
7	Drive Motor Nominal Efficiency		percent
8	Fan Motor Nominal Rating (if applicable)		hp
9	Fan Motor Nominal Efficiency		percent
10*	Total Package Input Power at Zero Flow ^e		kW ^e
11	Total Package Input Power at Rated Capacity and Full Load Operating Pressure ^d		kW ^d
12*	Specific Package Input Power at Rated Capacity and Full Load Operating Pressure ^e		kW/100 cfm ^e

Partial View of the Fixed-Speed Rotary Air Compressor CAGI Datasheet

the results are published in a directory on the CAGI website.

Participation in the CAGI Performance Verification Program is voluntary, and not easy. Aside from the time and money expended to develop the program, the participating manufacturers devote additional time and financial resources to meet ongoing program demands. Participating companies see a value in providing unbiased, third party confirmation of their performance claims. They see a benefit to reassuring potential customers that they will receive the performance that was promised. Participating companies are confident that they have conducted the necessary design and testing to ensure their stated performance is accurate.

CAGI Datasheets

Only participants in the CAGI Performance Verification Program are permitted to use the CAGI datasheets. So how can the datasheets and the verified data they contain help? As

we stated previously, many factors must be considered when selecting compressed air system equipment, and the totality of proper selection of compressed air system equipment is beyond the scope of this article; however, the program and datasheets do address one facet of the selection process: determination of power consumption per unit volume of air and the relative efficiencies of different models.

First, match the requirements of your system with the basic information on the datasheets. Refer to the sample datasheets that appear nearby. For compressors, be sure the flow and pressure provided by the models being evaluated match the flow and pressure requirements of your system. To compare compressors rated at different pressures, corrections have to be made, typically around 1% increase in power for every 2% increase in pressure (psi). For more specific data, contact the manufacturer for a datasheet at the pressure you are evaluating if such a sheet is not available online. Similarly for dryers,

be sure the flow and pressure dew point of the models being evaluated meet your system requirements.

From the available universe of models that meet basic requirements, the next step is straightforward. *All other things being equal*, the compressor that has the lowest specific package input power is more efficient and is the better choice. For dryers, again *with all other things being equal*, the model with the lowest pressure drop and the lowest specific package power is the most efficient and is the better choice.

While this sounds simple, the key phrase, "all other things being equal", must be considered. In actuality, all other things will rarely be equal. Durability, reputation, service, other features, etc., will probably vary widely. There will likely be tradeoffs and compromises, but this is normal when purchasing anything, from a camera to an automobile. The datasheets and performance verification program do not provide all of the answers to selection questions. They were designed to assist in providing reliable information about one key piece of the selection process.

Using the CAGI Datasheets

The information on the datasheets will also help users understand how much it will cost to operate their equipment. Use the following formula to determine the amount of electricity required to operate your equipment:

Electricity (kWh) = (Flow (cfm) X specific package power (from CAGI datasheet) x hours of operation)/100.

The result can be multiplied by the cost of electricity in your area to arrive at a good estimate of the cost of operation over a given period.

For example, a fixed speed compressor providing 500 scfm with a specific package

DRYER DATA SHEET

Refrigerant Dryers


MODEL DATA				
1	Manufacturer			
2	Date			
3	Model Number			
4	Cycling/Non-Cycling			
5	Refrigerant Type			
	DESCRIPTION	FULL FLOW	10% FLOW	UNITS
6	Tested Flow			scfm ^b
7	Outlet Pressure Dewpoint			°F
8	Pressure Drop			psi(d)
9	Total Dryer Input Power			kW
10	Specific Package Power ^c			kW/100 scfm

Partial View of the Refrigerated Compressed Air Dryer CAGI Datasheet

power of 18.9 as stated on a CAGI datasheet
and operated for 60 hours a week will require

$(500 \times 18.9 \times 60) / 100 = 5,670$ kWh for one week of operation. With a \$.06 per kWh cost of electricity, cost of operation is \$340.20 per week. For ease of calculation, if the compressor is operated for 52 weeks at the same level, annual cost of operation would be $\$340.20 \times 52 = \$17,690.40$.

CAGI members recognize the importance of making the right decision when purchasing compressed air system equipment. The institute has made it easier for purchasers to make energy efficiency comparisons by developing standards and datasheets. Participants in the CAGI Performance Verification Program

have gone further by having performance claims independently verified. Given the choice between purchasing equipment from a participant in the CAGI program or a non-participant, why choose the non-participant? Support those manufacturers of compressed air equipment that care enough about the industry and the users of compressed air equipment to belong to CAGI and to participate in the CAGI Performance Verification Program. 

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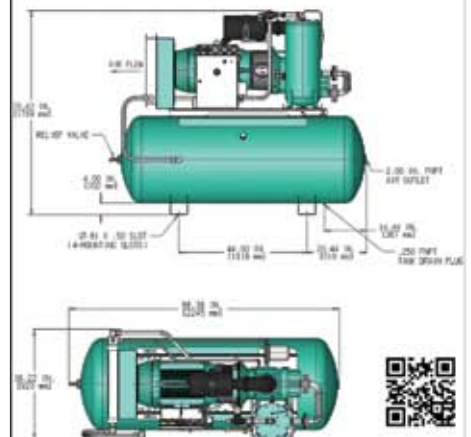
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USING KPI'S FOR PEAK EFFICIENCY

By Ron Marshall for the
Compressed Air Challenge®



► For many industrial sites the only indicator of compressed air performance is the big old pressure gauge right outside the maintenance manager's office. Over the years someone may have penciled a red line on the gauge, and if the pressure falls below the line the manager will start shouting. This is an example of the saying "What gets measured, gets managed", definitely the plant pressure in a facility is a very important indicator of adequate compressed air system operation, but is it the only parameter that needs to be monitored? This article explores some important compressed air KPI's and provides some examples of how they can be collected and used.

What are KPI's

Key Performance Indicators are widely used in business and finance to track important aspects of the performance of something. They can be defined as "A set of quantifiable measures that a company or industry uses to gauge or compare performance in terms of meeting their strategic and operational goals. KPIs vary between companies and industries, depending on their priorities or performance criteria." (Source Investopedia.com). As business processes get leaner and input costs get higher it has become more and more important to keep track of how important parts of your business are performing.

A compressed air system is no different than any other cost center in an organization, its performance has an impact on production quality, plant efficiency, operating costs and ultimately profitability. Proper attention to the key aspects of the compressed air system can go a long way in solving production problems and reducing waste. Recent advances in the quality, availability and affordability of data collection

equipment has made the monitoring of key compressed air performance indicators (KPI's) even more possible now than ever before.

How KPI's can be used

The collection and analysis of key performance indicators is important to ensuring efficient and effective performance of a system. Some uses of KPI's with regard to energy and system performance:

- Determining system efficiency and setting a baseline before improvement projects are started
- Helping justify improvement projects and providing data to receive utility incentives
- Proving the results of improvement projects
- Ensuring the savings gained from projects are maintained
- Monitoring the levels of waste and triggering corrective actions
- Detecting impending operational and equipment performance problems

Compressed Air KPI's

With regard to the performance of compressed air powered compressed air equipment the most important indicator is definitely system pressure. But other aspects of the system are important as well. Knowing the cost of producing the air is important too, especially with rising electricity rates. This means the power consumption of compressors and associated equipment is an important factor. So too is a measurement of the compressed air flow produced by the air production equipment.

Fundamentals of Compressed Air Systems WE (web-edition)



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Once power input and output flow are measured system specific power can be calculated which is an indicator of how efficiently your equipment produces air for a given energy unit input. And also important, the compressed air must be produced to an adequate level of quality with regard to contaminants and water content (dewpoint) in order to keep air powered machines operating without problems and to keep product from becoming contaminated.

There are other less common performance indicators that are important to keep up on, like ambient and compressed air discharge temperature, compressed air leakage and in some cases the compressed air cost per unit production.

Pressure

The red line drawn on the gauge at the manager's office was one example of the use of pressure monitoring to trigger action. But low plant pressure is not the only pressure related indicator important to system performance. Since screw compressor power consumption increases $\frac{1}{2}$ % with each psi in discharge pressure, and unregulated compressed air flows increase by almost 1% for every psi, the manager should also be concerned about having average pressure levels that are too high. And, although it seems like he is always at his desk, he may not be attentive enough to know or around during the times where the system goes unstable due to control problems and causes production shutdowns.

Pressure differential measurements across filters and air dryers is also an important indicator of system efficiency and is a maintenance related condition.

If the plant has a pressure/flow controller the plant pressure may not be a true indicator of the pressure at which the compressed air is actually being produced. For these reasons it is important to monitor discharge pressure, pressure after the cleanup equipment and one or more points within the plant.

Power

Compressed air production equipment power consumption is the least commonly measured parameter in a compressed air system. With the exception of flow and power, the local instrumentation on typical air compressors provides all other important parameters. The actual power

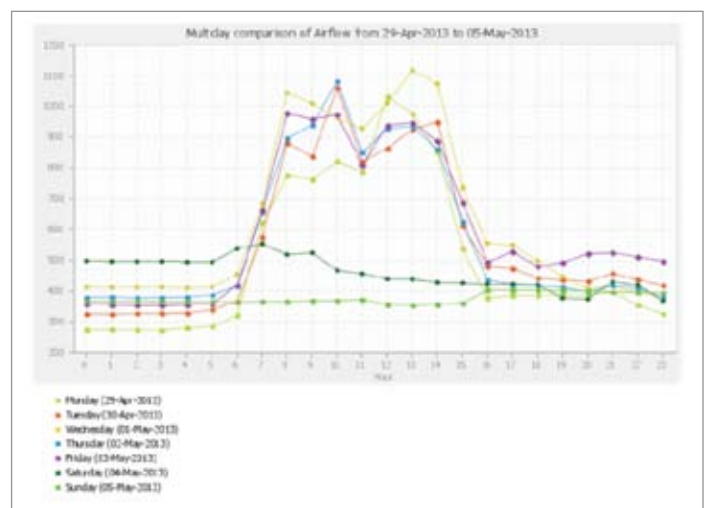


Chart A — Attention to flows during non production times can help track waste.
(Source Air Power Analytics)

USING KPI'S FOR PEAK EFFICIENCY

consumption of a compressor is often a complete surprise to the system operator. For example a recent measurement revealed a set of 55 kW rated air-cooled screw compressors at an industrial site were consuming 70 kW each at full load and rated pressure. Still another 75 kW compressor was consuming 92 kW under the same conditions, and was consuming far more power than rated in the unloaded condition. This information was very useful to the customer as they previously assumed that the units would be consuming no more than nameplate rating like other similar electrical equipment.

Installation of power measurement meters on each air compressor and dryer can be used to calculate the electrical operating cost of the system and to detect system problems. These readings can be used in conjunction with flow measurement to keep track of system efficiency in terms of specific power.

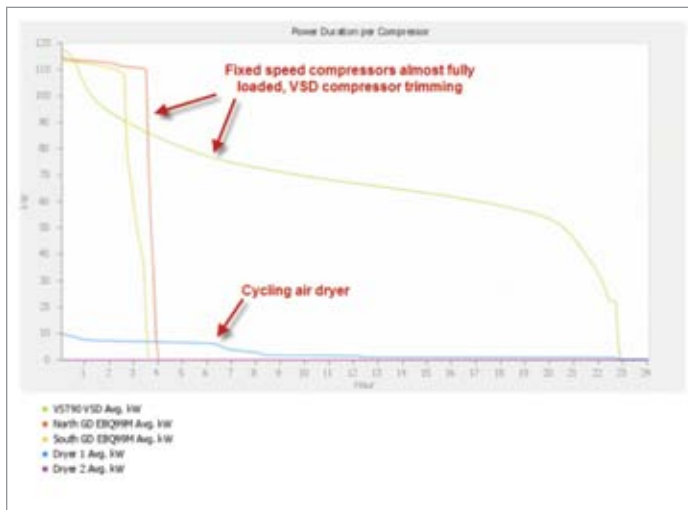


Chart 2 — Power duration (power sorted highest to lowest) shows compressors and dryers operating efficiently. (Source Air Power Analytics)

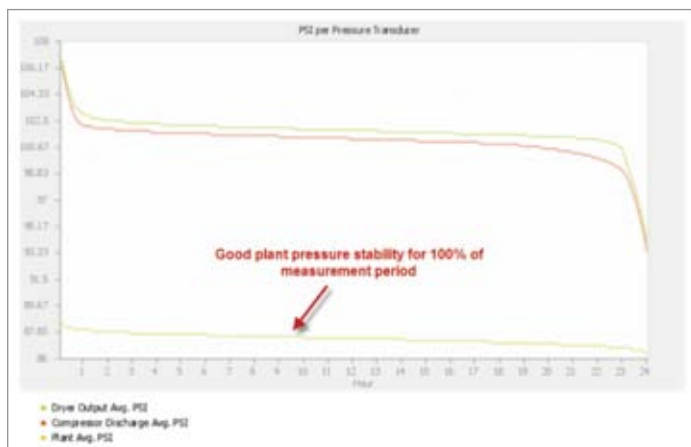


Chart 3 — Pressure readings sorted highest to lowest shows good pressure stability. (Source Air Power Analytics)

The use of energy meters that record energy (kWh) is also desirable as the readouts of these meters can be useful even if a system does not log kW or if the logging system fails at some points.

Flow

The measurement and logging of compressed air flow is very important to ensuring a compressed air system is performing efficiently. It is often very difficult to accurately estimate the amount of compressed air a particular compressor is producing, especially units that modulate, blow off or have complex variable capacity controls. In the past the measurement of flow was an inaccurate and very expensive exercise. But recent changes to flow measurement technology has made thermal mass flow measurement very affordable and very easy to install for any organization, even for small systems.

Flow measurement can track other items besides compressor output. The performance of air dryers that consume purge air or nitrogen systems that consume compressed air and output a smaller amount of nitrogen can be tracked using strategically located flow meters.

While the total accumulated air volume is important, the instantaneous flows tracked over time can reveal some system problems that can cause system performance deficiencies. For example, in a shift oriented plant with minimal weekend production the air flow at midnight on a Saturday might be a good indicator of system waste due to leakage and abandoned production machinery left to consume air when the machine is turned off.

Dewpoint

Tracking the dewpoint of compressed air is a good way of ensuring the air drying equipment is operating normally and that the quality of the compressed air is at required levels. Tracking dew point over time can reveal transient problems related to higher than desired dryer inlet temperatures or the impending failure of the dryer onboard dryer control system.

Specific Power

In the past few years most compressor manufacturers in North America have been publishing CAGI data sheets relating to the efficiency of rotary screw compressors. These data sheets are very helpful in determining what an air compressor system should be consuming if it is operating efficiently. For example, a large air-cooled rotary screw compressor might be rated at a specific power of 18 kW per 100 cfm of air output. Measurement instruments might detect a system using a number of these compressors as having an

average power consumption of 435 kW while producing an average of 1500 cfm of compressed air. Doing the math on this reveals a specific power of 29 kW per 100 cfm which compared to the rated specific power might suggest some issues with compressor control, and some good potential for energy savings.

Leakage

But a specific power is not always completely relevant if the appropriateness of the compressed air usage is not known. A super efficient system could be producing low cost compressed air for a facility that is wasting 50% or more of the output due to system leaks. Often compressed air reading can be taken to determine flows at specific times of the week. If it is known that the flow at that particular time is only compressed air waste then this can be tracked and trigger points set. Once a threshold is exceeded leak repair efforts can be initiated by maintenance.

Temperature

Often air quality problems due to water condensation are not the result of the failure of the dryer but due to excessive compressor room temperatures leading to higher than desired discharge temperatures. Monitoring ambient temperatures and compressed air temperatures is desired if this is a continual problem for a system.

Annual Carbon Emissions

Knowing the energy consumption of the system and the characteristics of your power provider can allow you to calculate and track your equivalent annual carbon emissions and your savings if improvements are made. This may be an important parameter for your corporate energy management personnel to track.

Best Practices for Compressed Air Systems Second Edition



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

DAILY AVERAGE CFM CONSUMPTION BASED ON 7 DAY TOTAL								
% OF MAX. CFM	HOURS	AVERAGE CFM	AVERAGE KW	SPECIFIC POWER	DAILY KWH	DAILY COST	ANNUAL KWH	ANNUAL COST
70	0.1	1,286.37	219.81	17.09	21.98	\$1.19	7,693	\$415
65	0.2	1,183.84	212.95	17.99	42.59	\$2.30	14,907	\$805
60	0.5	1,109.92	204.09	18.39	102.05	\$5.51	35,716	\$1,929
55	1.0	1,021.13	188.80	18.49	188.80	\$10.19	66,079	\$3,568
50	1.3	930.60	178.42	19.17	231.95	\$12.53	81,183	\$4,384
45	1.3	843.07	168.96	20.04	219.65	\$11.86	76,877	\$4,151
40	0.9	750.75	155.83	20.76	140.24	\$7.57	49,085	\$2,651
35	0.8	648.55	121.19	18.69	96.95	\$5.24	33,933	\$1,832
30	2.0	551.67	93.26	16.91	186.53	\$10.07	65,285	\$3,525
25	5.7	460.06	77.72	16.89	443.00	\$23.92	155,051	\$8,373
20	7.4	373.21	70.87	18.99	524.41	\$28.32	183,543	\$9,911
15	2.5	296.93	68.89	23.20	172.22	\$9.30	60,277	\$3,255
10	0.3	198.66	70.70	35.59	21.21	\$1.15	7,423	\$401
Totals	24	530.54	99.66	18.78	2,391.58	\$129.15	837,051	\$45,201
Annual carbon cost for 7-day period: 695 tons of CO ₂ . Leak load: 369 cfm								

Chart 4 — Table showing key performance indicators of a weekly sample of data. (Source Air Power Analytics)

Cost per production output

Often there are production related KPI's being tracked in a plant. It is sometimes useful to see how compressed air costs track seasonal and/or production level variations. These numbers can be compared between similar factories in companies with multiple production facilities. Often some outliers are detected where one factory is consuming considerably more compressed air costs than other similar plants, or in some cases considerably less. This can

drive innovation across the corporation if one or more efficiency changes can be replicated across all production facilities.

Example System

Manitoba Hydro has implemented some permanent compressed air efficiency monitoring installations in a number of large facilities that have received significant utility incentives to support efficiency projects in the last 10 years. This was done to ensure the

USING KPI'S FOR PEAK EFFICIENCY

SAMPLE PERIOD COMPARISON FOR SUPPLY NEW COMP PACKAGE BASED ON 7-DAY TOTAL									
SAMPLE PERIOD	START DATE	AVERAGE CFM	DAILY KWH	DAILY COST	ANNUAL KWH	ANNUAL COST	SPECIFIC POWER	LEAK LOAD (CFM)	ANNUAL CO ₂ EMISSIONS ¹
Aug 30-Sep 5, 2012	08/30/2012	638	3,163.04	\$170.83	1,107,065	\$59,782	20.65	451.5	833,575 kg
Sep 4-10, 2012	09/04/2012	714	3,636.24	\$196.36	1,272,685	\$68,725	21.16	552.0	958,280 kg
Sep 11-17, 2012	09/11/2012	662	3,381.41	\$182.60	1,183,492	\$63,909	21.19	448.5	891,121 kg
Sep 17-23, 2012	09/17/2012	639	3,453.89	\$186.53	1,208,862	\$65,279	22.53	412.5	910,224 kg
Sep 25-Oct 1, 2012	09/25/2012	795	3,714.23	\$200.56	1,299,979	\$70,199	19.41	502.5	978,831 kg
Mar 04-10, 2013	03/04/2013	506	2,406.47	\$129.95	842,264	\$45,482	19.82	326.9	634,190 kg
Mar 11-17, 2013	03/11/2013	519	2,496.87	\$134.82	873,903	\$47,191	19.99	372.6	658,014 kg
Mar 18-24, 2013	03/18/2013	503	2,434.42	\$131.47	852,047	\$46,011	20.16	338.2	641,557 kg
Mar 25-31, 2013	03/25/2013	458	2,122.76	\$114.63	742,966	\$40,120	19.33	285.7	559,423 kg
Apr 01-07, 2013	04/01/2013	527	2,355.77	\$127.19	824,520	\$44,524	18.61	327.1	620,830 kg
Apr 08-14, 2013	04/08/2013	546	2,507.74	\$135.41	877,707	\$47,396	19.14	388.0	660,878 kg
Apr 15-21, 2013	04/15/2013	518	2,308.09	\$124.64	807,833	\$43,623	18.58	314.4	608,265 kg
Apr 26-May 02, 2013	04/26/2013	499	2,609.83	\$140.94	913,441	\$49,326	21.80	316.4	687,784 kg
Apr 29-May 05, 2013	04/29/2013	531	2,391.58	\$129.15	837,051	\$45,201	18.78	368.6	630,266 kg
May 06-12, 2013	05/06/2013	549	2,473.53	\$133.57	865,736	\$46,750	18.78	366.8	651,864 kg

Chart 5 — Comparison chart showing key performance indicators for selected weeks showing efficiency and leakage improvement. (Source Air Power Analytics)

ongoing sustainability of the project savings, especially where compressor control systems or leakage management was part of the efficiency measures.

One example system is from a transportation products manufacturer who upgraded their system from a system of four load/unload screw compressors to a system using two fixed speed compressors and one VSD controlled compressor. Power monitors were placed on each compressor and two air dryers. Pressure monitors were installed to measure compressor discharge, air dryer output and the output of the pressure/flow controller. A flow monitor measures total plant flow.

Data is collected by a dedicated measurement system uploading the data to a cloud database. Weekly reports are then generated that show the KPI's of the system in an understandable format available without further processing.

Chart A is an example of the air flow comparisons on a weekly basis. The subsequent charts and tables show efficiency related parameters that can be used to

determine if the system is operating normally and how it compares week on week.

Energy Management Systems Certification

Those plants wanting to meet the ISO 50001 Energy Management Systems certification may require some sort of monitoring of their compressed air system if it is a significant energy user. Permanent systems can be used for both baselining and verification of projects. Temporary system installed by qualified compressed air system auditors following the ANSI EA-4 Compressed Air Assessment standard may also provide adequate indication of a system's KPI's.

KPI's without installing instruments

If budgets are tight and you can't afford instrumentation or qualified experts, in some cases, measurement and calculation of key performance indicators can be done manually using the available instrumentation. Compressor outputs can be estimated using loaded and unload hours if the hours are logged by personnel on a regular basis.

Using compressor ratings the approximate power and flow can be calculated, and an approximate specific power. Additional manual measurements can be made using a stopwatch during off production hours to assess leakage levels. As long as the personnel know at what level action needs to be initiated this can serve as an excellent tracking system.

Also, some compressor control systems have internal calculation algorithms that can calculate KPI's and generate reports to track the health of your system.

In general keeping track of the key compressed air system performance indicators is a good way of making sure you are aware of how well your system is operating. Have a look at your parameters and assess if it is worthwhile to initiate improvement measures to reduce your operating costs and improve system parameters. **BP**

For more information visit
www.compressedairchallenge.org

To read more **Measurement** articles, visit
www.airbestpractices.com/technology/instrumentation

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Atlas Copco Compressors New Compact Oil-Injected Rotary Screw Compressor Reduces Energy Consumption by up to 50 Percent

New Variable Speed Drive Compressor Features Patented Vertically Aligned Motor Design

New Atlas Copco GA VSD+ with Patented Vertically Aligned Motor Design

Atlas Copco has launched the new GA VSD+. The new GA VSD+ range of compact, oil-injected rotary screw compressors can reduce energy consumption by 50 percent compared to a traditional load/unload compressor of the same type. The new 7-15 kW (10-20 hp) GA VSD+ range, including a full feature version with an integrated dryer,



is also 15 percent more efficient than the previous generation and offers a 12 percent improvement in free air delivery.

“Reflective of Atlas Copco’s drive for innovation, the new GA VSD+ is the next evolution in energy-efficient compressor technology,” said Robert Eshelman, vice president, Atlas Copco’s Industrial Air Division in the United States. “We have achieved many significant milestones during the past 19 years in rotary screw technology and our new design with patented features represents one of the largest and most innovative changes to the technology since 1994.”

The new range was designed with energy efficiency and customer needs in mind, with a motor that significantly exceeds the latest NEMA Premium efficiency requirements. Built upwards, like a mini skyscraper, the motor and drive train share a single-drive shaft and are vertically aligned, reducing the total footprint by up to 55% compared to other compressors on the market. In addition, the motor drive train is completely enclosed, resulting in a NEMA 4 rating for protection against dust, debris and water. A single closed oil-circuit cools the motor and lubricates the element and bearings, resulting in a very reliable and compact compressor that is also extremely quiet (down to 62 dBA).

The result is a revolutionary air compressor that saves space and energy while simultaneously achieving higher air capacities. Additional improvements include a more efficient fan, a robust air intake

system that eliminates blow-off losses and advanced electronic components.

“The new GA VSD+ achieves better performances at full load than a comparable load/unload compressor, allowing customers in most industries to switch to a variable speed drive compressor for virtually any application, ultimately reducing energy costs and contributing to a more sustainable industry,” added Eshelman.

The new 7-15 kW (10-20 hp) GA VSD+ range, including a full feature version with an integrated dryer, is available now and stocked in the United States at Atlas Copco’s state-of-the-art 150,000 sq-ft. North American Service Center in Charlotte, N.C. The new 18-37 kW (25-50 hp) GA VSD+ models will be available in November 2013.

Visit www.atlascopco.com

Ultrachem Introduces Chemlube® Plus Series Synthetic Compressor Lubricants

Ultrachem has developed a new line of high-performance synthetic lubricants — the Chemlube® Plus Series — designed to be used in a wide variety of rotary screw and rotary vane compressors. True universal lubricants, the Chemlube Plus Series is fully compatible with most OEM Rotary Screw compressor oils and can be used to top off and replace existing fluids.

The Chemlube Plus Series lubricants are made with a very thermally and oxidatively stable polyol ester (POE) blend. These oils

TECHNOLOGY PICKS



were designed to take advantage of superior lubricating properties inherent in polyol esters, and yet be economical, by combining them with less expensive synthetics.

These fully synthetic premium lubricants are formulated to form less varnish under high temperature applications and to be more resistant to acidic intake air than the polyalkylene glycol (PAG) coolants. Under normal operating conditions users can expect to obtain up to 11,000 hours of lubricant service life in rotary screw compressors. The line is available in ISO grades 32, 46 and 68.

Typical industrial applications for the Chemlube Plus Series include: rotary screw compressors, rotary vane compressors, centrifugal compressors, and vacuum pumps. Chemlube Plus Series lubricants offer these performance benefits:

- Outstanding thermal and oxidative stability
- Extended drain intervals reduces oil disposal
- Wide operating temperature range

- Excellent anti-wear protection
- Compatibility with most compressor oils
- Improved safety — high flash point

Visit www.ultracheminc.com

New Bosch Rexroth Advanced Valve AV03 System

Technical designers always try to position pneumatic valves as close to actuators as possible, because shorter tubing lengths reduce the required compressed air by up to 20 percent. However, common valves are usually too large and heavy for handling applications. With Rexroth's new generation of extremely compact and lightweight Advanced Valve AV03 valve systems, engineers now have a lot more freedom and can arrange pneumatics decentrally, thus increasing efficiency.

Compared to the market standard, Rexroth has halved the weight of the new valves by using resistant high-performance polymers and reducing the number of parts. A further plus: The required space has also been cut by 45 percent. How did they do it? Developers arranged the valve components at an angle and optimized the supply and exhaust channels, thus reducing flow losses. Users profit from a flow improvement of 40 percent, allowing them to substantially lower the supply pressure and boosting their energy efficiency. The new valve system also fulfills engineers' demands for customized

automation solutions. With 25-pin D-sub connection, manifolds can be configured in increments of 1 after the second valve position, and after the fourth valve position with 44-pin D-sub and Field bus connections. The new AV03 can control up to 24 coils with 25-pin D-sub connection, up to 40 coils with 44-pin D-sub connection, and up to 128 coils with Field bus connection. Nowadays, more and more users also implement different pressure zones in a single valve system to achieve further savings. The new valve systems allow up to ten supply plates for this exact purpose. In addition to improving the energy efficiency, the new AV03 also fulfills expectations for simple engineering. Users can connect the valve systems electrically using multipole or fieldbus connections, with integrated I/O modules, depending on their configuration. Thanks to the option of directly connecting sensors to the valve electronics, fewer cables have to be fed back to the control cabinet.

Visit www.advanced-valve.com/en/index.html



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Sage BASIC[™] Thermal Mass Flow Meter



Sage Metering announces — Sage Basic[™] — the affordable choice for thermal mass flow measurement. The Basic provides an accurate and reliable mass flow measurement at a very economical price, while maintaining the high level of performance and self-calibration check that Sage mass flow meters are known for. Featuring low power consumption, the Basic can be used for any gas. The all stainless steel probe or in-line sensor provides durable construction. Both a 4-20 mA signal and a pulse output are provided.

Visit www.sagemetering.com

Siemens Introduces Matched Motor/Drive Combination Package

Integrated drive system provides OEMs and end-users cost-effective Simotics motor and Sinamics drive packages from single source; backed by three-year warranty

Siemens Industry, Inc. announces the release of combination motor/drive packages, allowing an OEM or end-user the option to select the optimum solution for a variety of heavy-duty industrial motion control applications from a single source, backed by a full three-year warranty. Choosing from a pre-determined list of motor/drive combinations, the customer simply makes the selection best suited to the application. The



motor and drive are packaged on a single pallet, shipped and invoiced together.

The motor and drive combinations are power-matched for 480V high-overload operation through a 20 hp range, with I²T protection from thermal damage provided as a standard in both the motor and the drive components. The Siemens Intelligent Operator Panel (IOP) is included with these packages, allowing easy step-by-step drive start-up.

Application macros are provided in the Sinamics G120C drive for easy installation and wiring; the terminals are pre-assigned at the factory and the parameters are automatically set. The SIMOTICS SD100 motors are rugged cast-iron with inverter duty ratings in a 4:1 speed range for constant torque and 20:1 speed range for variable torque. Simotics SD100 units are severe-duty TEFC motors that meet NEMA Premium[®] efficiency.

Communications selections on these matched motor/drive combinations include RS485 with USS and Modbus protocols. A Profibus variant is also offered for a Totally Integrated Automation (TIA) solution. TIA is the proprietary Siemens solution for achieving optimum performance, energy efficiency and sustainability within a machine or manufacturing environment. Standard pricing has been established for a wide variety of motor/drive combinations from 1–20 hp and is included in the available literature on this new Siemens service.

Visit www.usa.siemens.com/drives

FIPA Compact Ejector with Blow-off Boost

Ultra-fast cycle times, compact design: The new ejector from FIPA is a vacuum generator that uses suction cups for highly dynamic handling tasks. Its blow-off flow is supplied not only via the compressed air line, but also from ambient air, lowering the consumption of compressed air. “The patented blow-off boost of our newest ejector makes precisely depositing work pieces in milliseconds economically feasible,” says Rainer Mehrer, President and Owner of FIPA.

TECHNOLOGY PICKS

Common fields of application include Delta robots in the packaging industry, electronics production or micro assembly. The new ejector with blow-off boost at a glance:

- **Fast Blow-off:** Work pieces are placed precisely and cautiously
- **High Process Dynamics:** Lightweight and very fast vacuum build up and dissipation allow quick gripping and placing
- **Compact Design:** Each suction cup can be supplied with its own ejector, even in large gripper systems
- **Robust & Durable:** Solenoid valve withstands over 100 million switching operations
- **Extremely Short Cycle Time:** Ideal for robotic applications, such as Delta robots
- **High Precision:** Grippers with one ejector per suction cup prevent lateral work piece swinging due to different blow-off speeds

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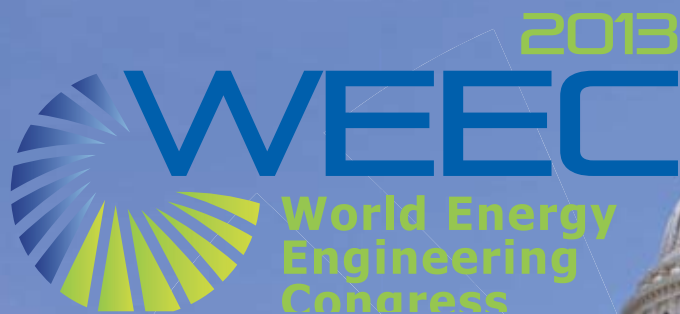
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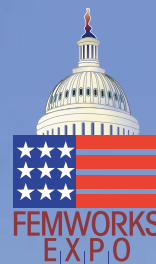


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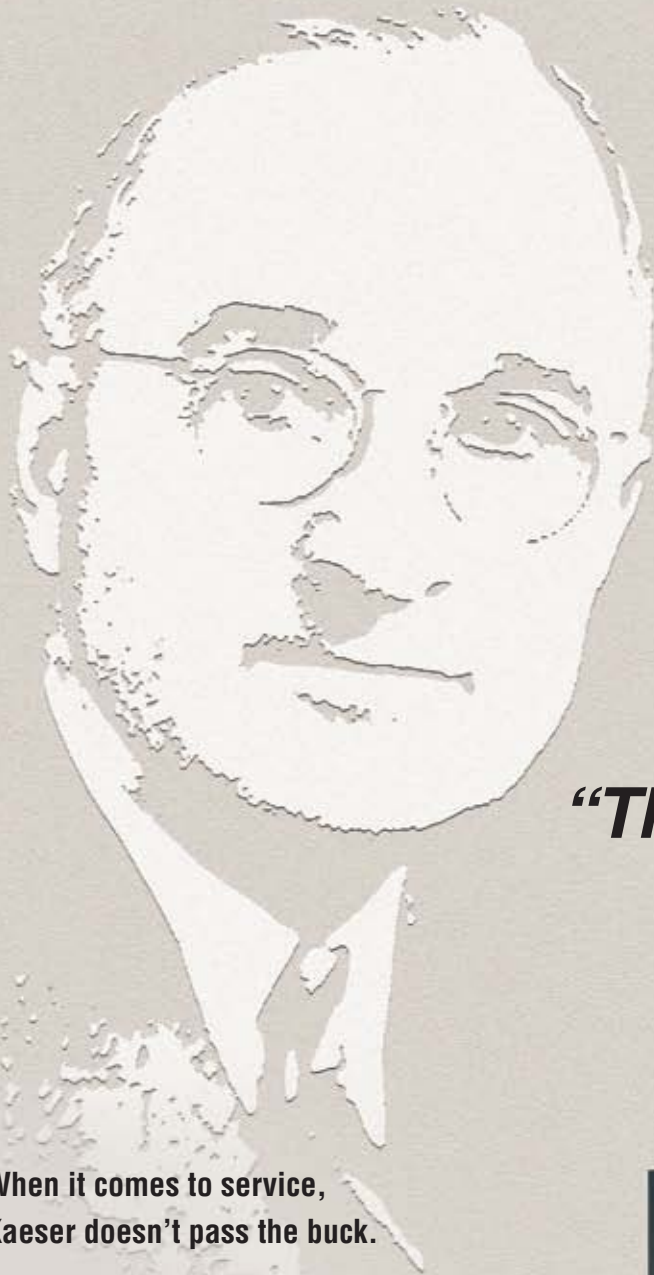


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