The Magazine for ENERGY EFFICIENCY in Compressed Air, Pneumatics, Blower and Vacuum Systems

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October 2013

Food Processing

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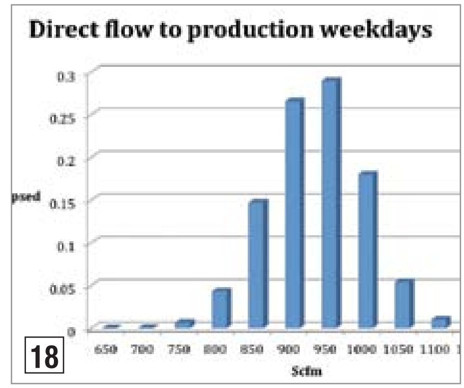

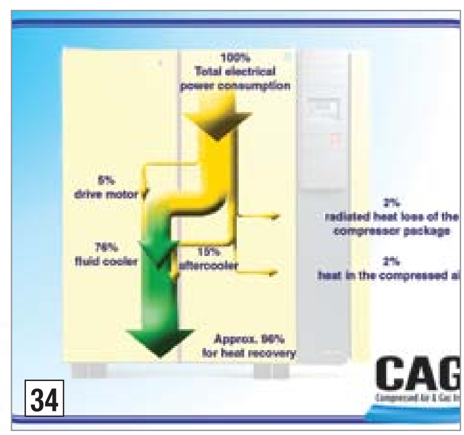

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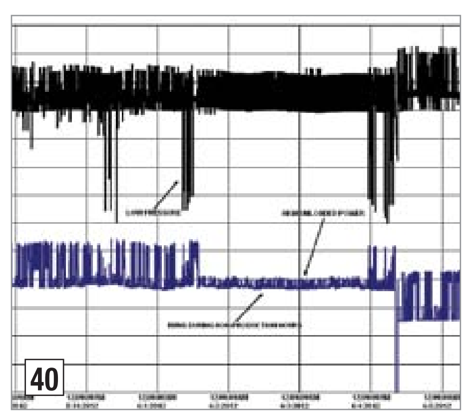

FROM THE EDITOR | Food Processing

Our first article is titled, "The Influence of System Pressure on Compressed Air Demand." The third article of his series on air system pressure, Mark Krisa from Ingersoll Rand provides an in-depth look at artificial demand. While reaffirming that lower system pressure can lead to energy conservation, this article also outlines some common calculation errors that can be made.

Our second article is a case study of a portion of a compressed air system assessment, done by James McAuley P.E., at a food processing plant. The article reviews compressed air users at the baggers, bag houses, CO_2 mold cleaning stations, and thermoformers.

A major brewery operates nine production lines: five bottle lines and four can lines. Annual plant electric costs for the compressed air system total $736,000. Don van Ormer, from Air Power USA, details five compressed air reduction projects.

The Compressed Air & Gas Institute (CAGI) offers our readers an interesting article on heat recovery. The heat generated by compressed air systems can be a very good source of energy savings. In fact, nearly all (96%) of the electrical energy used by an industrial air compressor is converted into heat. Too often, that heat is simply ejected into the ambient environment through the compressor cooling system. But here's the good news: nearly all this thermal energy can be recovered and put to useful work and significantly lower a facility's energy costs.

Ron Marshall, on behalf of the Compressed Air Challenge®, provides an article on how he studied the use of heated 30 psi compressed air to dry the ink used in flexible packaging printing machines. A common application in every food processing plant, efficiently matching supply with demand can be a challenge.

PROCESS EXPO 2013 will be held November 3-6 at McCormick Hall in Chicago. We are proud to be a *Supporting Publication* and hope you can visit the show. Please stop by the Compressed Air Best Practices® Magazine booth (#2852) and say hello!

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

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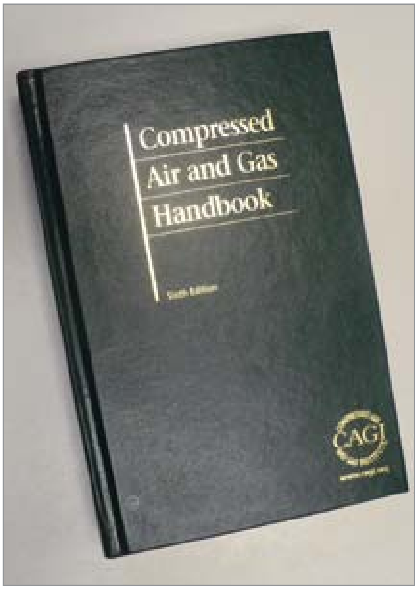
COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

Compressed Air and Gas Handbook Now Free Online

The Compressed Air and Gas Handbook, the authoritative and widely used reference manual for information about the proper installation, use and maintenance of compressors and pneumatic equipment, is now available online in PDF format. Formerly available only as a 750-page hardbound book for $70, the individual chapters are now available as free downloadable PDF documents on the CAGI website, www.cagi.org.

Published in 1947, the first edition of the Compressed Air and Gas Handbook was a joint effort of the CAGI Educational and Technical Committees. The original hardbound handbook consisted of five chapters and nearly 400 pages. Now in its sixth edition, the illustrated handbook contains engineering information from leading manufacturers and valuable reference data about compressed air systems. "The CAGI handbook is an excellent, comprehensive resource for compressed air professionals," said Paul Humphreys of CAGI. "Now, with its availability online, even more professionals can have access to this valuable information."



The handbook is still available for purchase as a hardbound book through the CAGI website.

About CAGI

For almost 100 years, the Compressed Air and Gas Institute (www.cagi.org) has been the leading source of manufacturer and product-neutral support for compressed air professionals. In addition to the Compressed Air and Gas Handbook, the CAGI website offers many resource materials such as selection guides, videos and online training.

Atlas Copco Acquires Edwards

Atlas Copco AB and Edwards Group Ltd. have entered into an agreement where Atlas Copco will acquire Edwards, a leading global supplier of vacuum and abatement solutions for an amount of up to BEUR 1.235 (BSEK 10.6). The company is headquartered in the United Kingdom and listed on the NASDAQ stock exchange in New York.

"Edwards is a technology leader with a well-developed structure and solid customer relationships in industries we know well. It is a great fit for Atlas Copco," said Ronnie Leten, President and CEO at Atlas Copco. *"The vacuum solutions market is growing and has similar characteristics to our existing industrial businesses."*

Edwards is a technology and market leader in sophisticated vacuum products and abatement solutions with more than 90 years' experience. The products and services are integral to manufacturing processes, such as for semiconductors and flat panel displays, and are used within an increasingly diverse range of industrial applications. The vacuum solutions market is estimated to be larger than BEUR 4.65 (BSEK 40). Edwards has more than 3,200 employees and is headquartered in Crawley, United Kingdom.

The acquisition of Edwards offers Atlas Copco an opportunity to expand into a growing business which serves industries that are well-known to Atlas Copco. There are several synergies between vacuum and compressed air solutions in sales, service and technology development.

"We recognize the strength Edwards has in its people and products as well as their excellence in technology and innovation. We are excited that this professional company will join our Group," said Ronnie Leten.

Edwards had revenues in 2012 of MEUR 746 (MSEK 6 400), of which more than half in Asia, with an adjusted EBITDA margin was 19.1%. The reported operating margin was 10.6%, including restructuring costs and amortization of the sellers' purchase price adjustments, corresponding to about 4 percentage points of revenues. The acquisition is an all-cash transaction utilizing Atlas Copco's existing own funds.

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The transaction, which will be completed by way of a merger, is subject to customary closing conditions including Edwards shareholder approval and antitrust clearance. It has been unanimously approved by the Boards of Directors of both companies. Further, the Board of Directors of Edwards unanimously recommends the offer to all Edwards shareholders. The transaction is expected to close in the first quarter of 2014. Edwards shareholders representing approximately 84% of the current shares outstanding have entered into voting agreements with Atlas Copco to vote in favor of the transaction. Edwards will be part of Atlas Copco's new Vacuum Solutions division within the Compressor Technique business area.

More information about Edwards on www.Edwardsvacuum.com.
Visit www.atlascopco.com for more information on Atlas Copco.

NYPA Saves Energy and Water

The New York Power Authority (NYPA) announced the completion of two energy efficiency projects at the Indian Brook Water Treatment Facility and the John-Paul Rodrigues Ossining Operations Center that will save the Village of Ossining $123,000 a year in energy and water costs.

More efficient fuel oil use will reduce greenhouse gas emissions from the operations center by more than 15 percent, while enhanced water-flow control will ensure that the amount of water being processed by the village is closely calibrated with the end-use needs of its residents.

NYPA provided $1 million in low-cost financing for the initiatives, commencing work in June 2012.

Indian Brook's three vertical turbine pumps were replaced and new motor drives were installed to control high-efficiency motors that allow for operating at variable speeds. At the John-Paul Rodrigues Operations Center, a new energy efficiency boiler was installed, along with steam traps that minimize heat loss.

"Under Governor Cuomo's leadership, NYPA is steadily ratcheting up its statewide efforts to improve the energy efficiency of public facilities like those in the Village of Ossining," Gil C. Quiniones, president and chief executive officer, NYPA, said. "We're responsive to the specialized needs of local and state governments in helping to manage their energy consumption, as we work toward lowering their monthly costs for utilities and their resource demands."

Every NYPA energy efficiency project results in savings that pay for the cost of the initiative. The total savings for each project exceed the cost of the upgrades over the lifespan of the improvements. Program participants repay the low-cost financing by sharing the savings with NYPA. After the costs have been repaid, participants retain all the savings.

"These NYPA energy efficiency programs provided the village with a cost-effective means to upgrade and improve our capital infrastructure, realizing immediate and future energy savings, and creating a healthier environment," said William R. Hanauer, mayor, Village of Ossining.

The village government's fuel-oil bills will be lowered by $19,000 a year. There will be another $104,000 a year in water-cost savings from the Indian Brook upgrades. The filtration plant produces an average of 3.6 million gallons of water each day for the village's 25,000 residents.

The plant has two sources of available water — a free source from the Ossining Reservoir, which is not enough to serve the entire village, and a supplemental source that is purchased from the Old Croton Reservoir owned by the City of New York. Older pumps at the filtration plant, operating at fixed speeds, could not be regulated. The new variable-speed controls ensure that the amounts of treated water closely match the actual use.

The previous boiler at the John-Paul Rodrigues Operations Center had an operating efficiency of approximately 75 percent. The heat energy emitted from the new high efficiency boiler supplies the same amount of energy as the older equipment but uses less fuel, at an efficiency rating of 83 percent. In addition, the replacement of 76 steam traps will result in reduced heating costs at the facility.

Visit www.nypa.gov

New Bioenergy Report from the European Environment Agency

Using biomass for energy is an important part of the renewable energy mix. However, bioenergy production should follow EU resource efficiency principles, according to a new report from the European Environment Agency (EEA). This means extracting more energy from the same material input, and avoiding negative environmental effects potentially caused by bioenergy production.

"Bioenergy" refers to energy uses of any kind of biomass, whether for heating, power generation or transport. The report, "EU bioenergy from a resource efficiency perspective", primarily looks at the potential for energy from agricultural land, although it includes forest and waste biomass in the overall analysis.

In 2010 bioenergy was the source of approximately 7.5 % of energy used in the EU. This is foreseen to rise to around 10 % by 2020,

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or approximately half of the projected renewable energy output, according to EU Member States' National Renewable Energy Plans.

Bioenergy should be produced in line with EU objectives to use resources more efficiently, the report says. This means reducing the land and other resources needed to produce each unit of bioenergy and avoiding environmental harm from bioenergy production. According to the EEA analysis, the most efficient energy use of biomass is for heating and electricity as well as advanced biofuels, also called "second generation" biofuels. First generation transport biofuels, for example, biodiesel based on oilseed rape or ethanol from wheat, are shown to be a far less efficient use of resources.

Building on previous analysis, the report shows that the current energy crop mix is not favorable to the environment. The report recommends a broader mix of crops to reduce environmental impacts. Specifically, this should include perennial crops, which are not harvested annually — for example energy grasses or short rotation willow plantations. This would enhance, rather than harm, "ecosystem services" provided by farmland — such as flood prevention and water filtration.

Bioenergy is often considered 'carbon neutral', as the carbon dioxide released in combustion is assumed to be compensated by the CO_2 absorbed during plant growth. However, as shown in this report, indirect land use change can negate any greenhouse gas savings from biofuel production based on energy crops. This is due to the displacement of crop production onto previously unused land, which can lead to the conversion of forests and savannah to agriculture. Such land use change harms biodiversity and increases greenhouse gas emissions.

Hans Bruyninckx, EEA Executive Director, said: "Bioenergy is an important component of our renewable energy mix, helping to ensure a stable energy supply. But this study highlights the fact that forest biomass and productive land are limited resources, and part of Europe's 'natural capital'. So it is essential that we consider how we can use existing resources efficiently before we impose additional demands on land for energy production."

Bioenergy in 2020 — exploring different options

The report develops three different "storylines" with varying technological, economic and policy assumptions. This helps explore different future options, illustrating which bioenergy types are most resource-efficient and which have the lowest environmental impact. The main conclusions of this analysis are next:

The EEA has revised its estimate of potential bioenergy production in the EU first published in 2006, reducing the estimate by approximately 40%. The estimate was revised due to changes in scientific understanding, the changed EU policy framework and accounting for economic factors.

Different biomass-to-energy conversion technologies vary significantly in their efficiency. For example, generating electricity by burning pure biomass is only approximately 30-35% efficient, while burning the same material to produce heat is usually more than 85% efficient. In general, using bioenergy for heat and power is a considerably more efficient way of reducing greenhouse gas emissions, compared to using bioenergy for transport fuel.

Different energy cropping systems can vary hugely in their productivity, as well as in environmental impacts. High-yielding systems with efficient conversion can deliver more than 20 times more energy compared to low-yielding inefficient systems using the same land area.

Current EU bioenergy policy only partially accounts for potentially adverse environmental effects connected to direct land-use effects, including changes in land management. Additional policies could help reduce these environmental impacts, particularly regarding water resources and farmland biodiversity.

The countries with the largest estimated agricultural bioenergy potential in 2020 are France, Germany, Spain, Italy, Poland and Romania, the report says.

Extensively using mature trees for energy purposes may have a negative effect on the climate, due to the long time it takes for the trees to regrow and re-capture the CO_2 that is released when wood is used for energy. This 'carbon debt' does not arise if bioenergy uses other forest biomass instead, for example branches left over from forest harvesting by-products or waste products from timber and paper production.

Using organic waste and agricultural or forestry residues as feedstock is more resource efficient than many other types of feedstock, as it does not add pressure on land and water resources and offers very high greenhouse gas savings.

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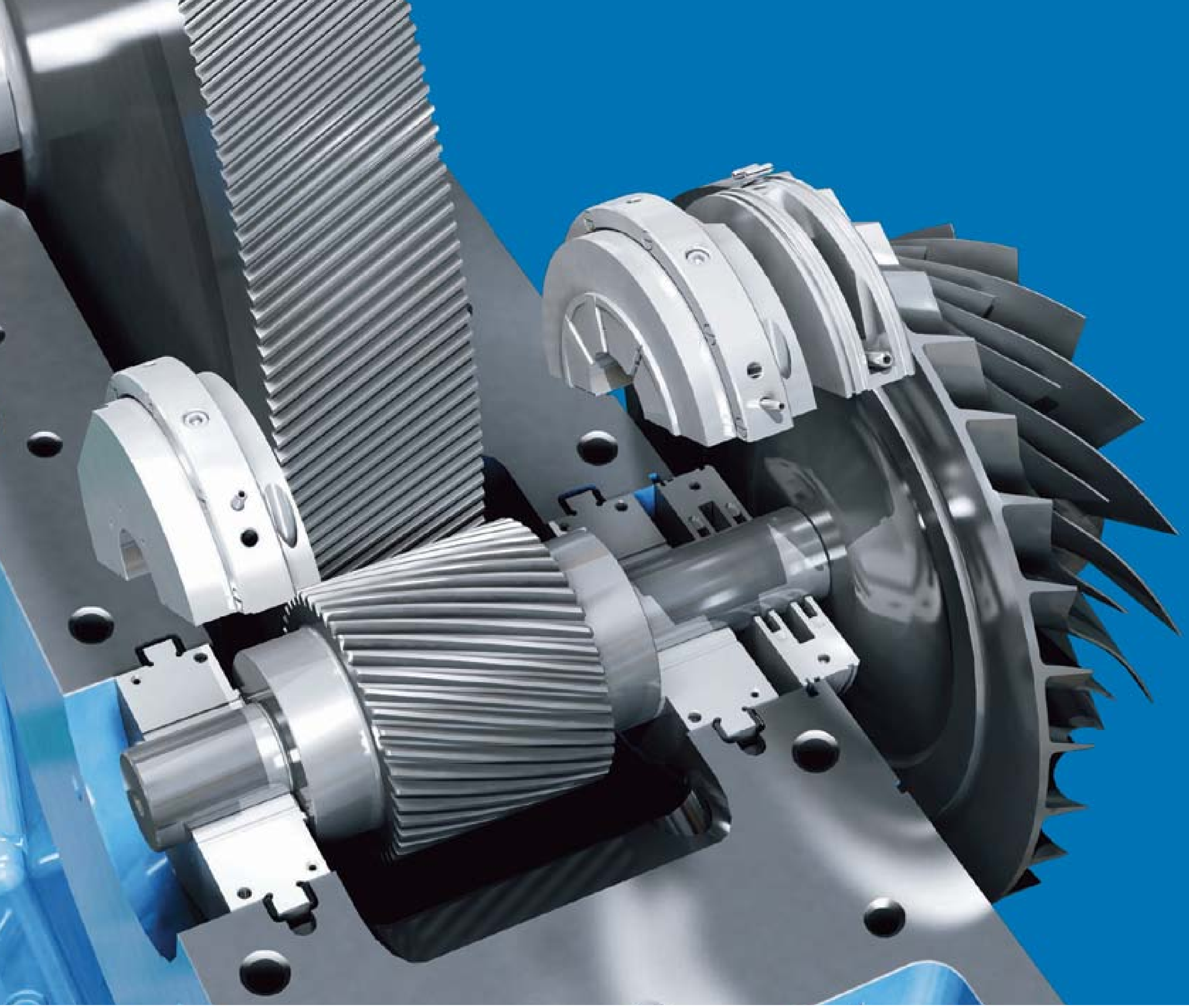

AIR SYSTEM PRESSURE INFLUENCES COMPRESSOR POWER

Part 3: The influence of system pressure on compressed air demand

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

Energy conservation measures (ECM) 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 corrective actions put forward to reduce compressed air energy consumption have been simplified with the goal of encouraging action. Although this is done with the best of intentions, sometimes simplifications and generalizations do not necessarily lead to positive results. One of the most common energy conservation measures for compressed air that leverages best practice calculations involves reducing system pressure. It is the objective of this series of articles to highlight some of the more common issues associated with estimating energy conservation resulting from changing system pressure.

Part 1 of this series identified issues with common methods used to calculate energy savings associated with the influence of system pressure on air compressor power. Part 2 focused specifically on centrifugal compressors to identify the relationship between pressure, capacity and power. This third and final article will focus on the influence of system pressure on compressed air demand.

The Influence of System Pressure on Compressed Air Demand

The relationship between compressed air demand and pressure is reasonably intuitive and can be easily observed by witnessing air escaping a balloon or turning down the pressure on a regulator ahead of an air tool or blow gun. The concept is simple, but accurately quantifying the impact of pressure across a network with hundreds of compressed air consumers can become complex. Simple rule-of-thumb calculations have been used by salespeople in the compressor industry for decades to estimate how much additional compressor supply capacity would be required to operate a system at an increased pressure.

As energy conservation through compressed air gained attention, so did the opportunity to reduce compressed air consumption by reducing pressure. The reduction in compressed air demand associated with reducing pressure is sometimes referred to as artificial demand. Although this term has been used by some to include all forms of compressed air waste, the original intent was to define a segment demand associated with operating at an elevated pressure. For simplicity, the amount (quantity) of compressed air associated with a change in pressure will be referred to as artificial demand for the balance of this article.

Calculating Artificial Demand

Artificial demand for most systems is a category of compressed air demand, consisting of several time-weighted values estimated as a function of load conditions or some other segmentation of compressed air demand relative to a change in pressures. Artificial demand is stated as a flow unit with respect to a target pressure. It is important to note that a change in operating pressure is required for artificial demand to exist. Artificial demand is typically estimated by applying one of the following three calculations for volume relative to pressure:

1. **Orifice Table Method:** The orifice table is a fundamental reference for many in the compressed air industry, listing volume of air in scfm for a range of orifices and pressures. Using an initial and proposed pressure for the artificial demand calculation, volumes from the table for matching pressures are divided to establish a correction factor that is applied to compressed air system demand.
2. **Air Density Ratio:** This method uses a table of compressed air density relative to gauge pressure as a source. The density of compressed air for the proposed pressure is divided by the density for the initial

pressures and factored against the initial demand to estimate the proposed demand.

3. **Absolute Pressure Ratio:** For this method, initial and proposed absolute pressures are divided and factored against the initial demand to estimate the proposed demand. This method will deliver the same results as the orifice chart provided the same standard conditions are used to correct from gauge to absolute pressure. The density method will also deliver very similar results. This is the most commonly used calculation for correcting volume relative to changes in pressure, because it does not require a table reference and can be used as a simple equation.

Since artificial demand is the difference in flow associated with operating at a different pressure, it has been stated using two equations to simplify interpretation of the calculation. Please note; volume in this context refers to the flow of air expressed as a volume with respect to time with V representing the demand in scfm and P representing gauge pressure in psig.

$$V\ final = V\ initial \times [(P\ final + 14.5) / (P\ initial + 14.5)]$$

$$V\ artificial = (V\ initial - V\ final) \times (\%\ influenced\ load)$$

Artificial Demand — Potential Calculation Errors

When calculating artificial demand, it is very important to segment load conditions and the associated pressures. For many systems, network pressure is highest when demand for compressed air is lowest. This is normally the case for a few reasons:

- For systems with multiple compressors using cascaded control set points, as fewer compressors are required the next trim compressor in the cascade will dictate the supply pressure using higher pressure values.
- With compressors using pneumatic inlet modulation controls, pressure increases as compressor supply is reduced. These machines use a subtractive pilot that operates using proportional logic, modulating the inlet valve as a function of the signal pressure.

AIR SYSTEM PRESSURE INFLUENCES COMPRESSOR POWER

- Pressure losses across filters and dryers are reduced as flow across the components becomes less. This applies to systems with multiple compressors connected to common purification equipment or when compressors have some form of supply reduction controls.
- Any pressure losses across the pipe network, sub-headers and shared point-of-use components will decrease as flow through the components is reduced. This will elevate pressure to some applications as demand decreases.

Since artificial demand is the additional volume of compressed air consumed relative to an initial operating pressure, it is imperative to use pressure values related to each load condition. This is a common error, and for some systems, can be significant depending on how much pressure and demand vary between load conditions. To assist with the explanation, the sample system from Part 1 of this series published in the July 2013 issue will be referenced as follows:

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

1. *Day shift, operating eight hours a day, 40 hours a 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.*
2. *Afternoon shift, operating eight hours a day, 40 hours a 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.*
3. *Night shift and weekends, operating 88 hours a 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.*
4. *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 around 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, a recommendation was made to 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, limiting pressure decay to less than 5 psi during the transition *from night to day shift. Proposed system would operate at an average pressure of 96 psig +/- 5 psi.*

The maximum recorded pressure of 123 psig from the sample system cannot be used to calculate artificial demand for all load conditions. Aside from the low-load period when demand averages 200 scfm, the other load conditions operate at lower pressures. Assuming a proposed operating pressure of 96 psig, a reduction in demand of almost 20 percent would be falsely estimated for all conditions by incorrectly using the maximum pressure value of 123 psig. During the day shift when demand is highest, average pressure is only 107 psig. Using this pressure, artificial demand would represent a potential 9 percent reduction in demand; less than half of the savings compared with the estimate using the maximum pressure.

The most common and significant error when calculating artificial demand is assuming that the relative changes in network or supply pressure will impact all compressed-air-consuming equipment. It is important to understand that compressed air demand consists of compressed air discharging to the atmosphere or some reduced pressure across an interface. Depending on the size of the system, there could be hundreds or thousands of individual points, each contributing to the total system demand. This could be air expanding to drive an assembly tool, air actuating a valve by filling a cylinder or air leaking through a blister in a hose. At some point for each individual consumer, there is an interface where pressure can influence air density, velocity and the volume flow rate. Depending on the system and how compressed air is consumed, a reduction in network pressure could directly impact the entire demand, a percentage of demand or have no impact at all. Some frequent artificial demand considerations are as follows:

AIR SYSTEM PRESSURE INFLUENCES COMPRESSOR POWER

- **Point-of-use regulators.** The majority of compressed air applications have one or several pressure regulators influencing point-of-use pressure. Depending on the design, size and regulator settings, pressure downstream may not decrease at all based on a reduction in network pressure. If pressure downstream of the regulator does not change, the demand associated with the application will not change. The percentage of compressed air demand that falls into this category will not have artificial demand associated with network pressure and this percentage of the system demand must be excluded from any artificial demand calculations. It is important to acknowledge that having a regulator installed does not necessarily isolate network pressure from the point-of-use. Many low-cost regulators will track with the upstream network pressure, causing pressure to decrease at the point of influence. Depending on the installation, artificial demand for the application relative to the change in network pressure could be a percentage of the estimated value or in some situations greater when regulated pressure is very low.

- **Sonic velocity.** Some applications will not be influenced by a reduction in network pressure, regardless of whether they are regulated or not. These are applications where air has reached a maximum internal velocity at some lower pressure. As long as the supplied pressure is above some critical value, demand will not change. It is not uncommon to find an application reach a velocity limit at 30 to 40 psig. The portion of compressed air demand operating in these conditions will not have artificial demand and must be excluded from the calculation.

- **Pressure independent control.** Some modern compressed-air-consuming equipment controls compressed air at the application based on a desired outcome. An example would be high-speed weaving machines where compressed air is used to move a thread across a defined path in a required time. Internal pressure requirements are low and the unit will automatically adjust internal pressure to achieve the required speed. If network pressure were reduced to this application, it would internally compensate for a change in network pressure, and compressed air demand would not change. This type of application does not have artificial demand, and the volume of total system demand associated with these applications must be excluded from any artificial demand estimations.

- **Compressed air leaks.** Some compressed air auditors assume 30 percent of compressed air demand is associated with leaks without any form of measurement or validation. The second assumption is that all leaks are unregulated and any reduction in system pressure will have an associated reduction in artificial demand. For most industrial systems with more than 200 horsepower of compressor supply, a significant percentage of overhead piping joints are welded and not very susceptible to developing leaks. If every mechanical joint used to connect hose, tube or pipe is considered a potential leak, the majority are typically located downstream of one or more regulators. Consequently it is not correct to assume 30 percent of the system demand is unregulated and directly influenced by a reduction in system pressure.

Correcting Artificial Demand at the Point-of-Use — Application Tuning

Many compressed air components are installed with a filter-regulator-lubricator (FRL) without detailed expectations regarding application pressure. Air cylinders are a great example of an application that can potentially have artificial demand. It is not uncommon to find regulators set at 90 to 100 psi for a cylinder that will deliver sufficient force and speed at a significantly lower pressure. During installation and tuning of the installed equipment, the cylinder speed is reduced by increasing back pressure on the exhaust metering valve instead of lowering the pressure. The net result for example, is 95 psig supply with 55 psig back pressure. Unless the 95 psig is required to deliver a specified force after the cylinder is fully extended, this same cylinder could be tuned to operate at close to 40 psig by adjusting the regulator and exhaust valve, reducing the required volume of compressed air 49 percent. The higher regulated pressure may also be required to compensate for undersized components causing excessive pressure drop while the cylinder is extending. This can often be seen by watching the pressure gauge when the cylinder strokes. When friction (pressure drop) ahead of the cylinder or the regulator itself is the issue, the gauge reading will initially drop while the cylinder is extending and then recover after the cylinder has completed the designated task. After the cylinder is fully extended, the required work has been done and air is flowing to the cylinder for no purpose other than to raise the pressure unnecessarily, increasing the consumed volume of air. After the cylinder is fully extended, the rate of flow will decrease, along with the pressure drop as pressure increases in the cylinder until flow has stopped. It is not uncommon to see 30 to 50 psi deflection that can be corrected to reduce demand. Although this action may not be as glamorous as a demand expander with a segmented valve and PID control, it can be implemented with almost no capital investment and can deliver significant results for many systems. A facility could reduce total compressed air consumption 20 to 40 percent by diligently tuning point-of-use applications.

Energy Conservation and Artificial Demand

It is important to reaffirm that artificial demand is a reduction in demand, not energy. Assuming the pressure at the discharge of the compressor does not change and network pressure was reduced using some type of pressure-reducing device, the energy reduction will be based on how the installed compressors reduce consumed power relative to the reduction in supply requirements. A best-in-class system will reduce power almost directly proportionate to the change in demand. Other systems will deliver a reduction in power that is a percentage of the demand reduction with the extreme being a system with centrifugal compressors that have no more throttle capability and are discharging excess air to the atmosphere in an effort to control pressure. For this type of system, a reduction in demand will have no impact on power.

Closing Comments

Although efforts to reduce compressed air pressure can potentially deliver significant energy savings with an attractive rate of return, topics discussed in all three parts of this series identify issues that can erode some or all of the assumed savings. Simple rule-of-thumb estimates are an easy way to quickly assess an opportunity to determine if more detailed analysis is warranted but more detail is required for investment grade projects. The sample system referenced in this series of articles illustrates how energy savings estimates associated with artificial demand and compressor power could vary from more than 50 percent to less than 3 percent depending on calculation method, compressor design and how compressed air is consumed. For larger systems or projects that require validated results, the experience and capabilities of the individuals assessing the system becomes more significant. Contracting credible resources with a reference list of implemented systems becomes an investment as the costs for corrective actions and risks associated with overestimating savings become substantial. BP

About the Author

Mark Krisa is director of 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 has authored several papers and speaks regularly at conferences and training events across the Americas. You can contact Krisa with questions or comments at mark_krisa@irco.com.

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THE COMPRESSED AIR SYSTEM ASSESSMENT

Reviewing Compressed Air Demand at a Food Processor

By James G. McAuley P.E.

This article reviews portions of an audit report of a compressed air system in a food industry factory located in the U.S. Although the audit explored different supply-side options the client should consider to improve dynamic efficiency, we will focus on the demand side of the system for this article.

The Compressed Air System

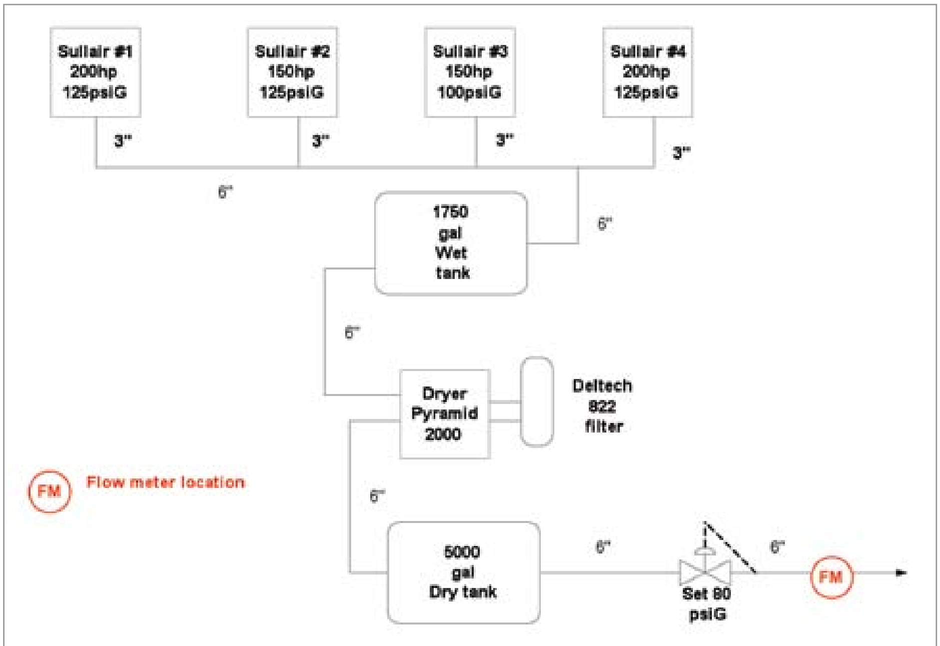
This plant is currently served by four rotary screw air compressors providing compressed air at 105 psig average plant pressure. The four air compressors are at the end of their expected life cycle although they are still operating well. They send compressed air, at one point of entry, to a 1750-gallon "wet tank". There is a single refrigerant dryer with a cold coalescing filter and an after-filter providing compressed air treatment. The compressed air then goes into a 5000 gallon "dry tank".

The system normally operates with two compressors running in MASTER mode through the sequencer. One is fully loaded and the other loads and unloads to maintain the target pressure in the dry storage tank. The demand side is regulated down at 80 psig through the flow control valve.

Measurement

During the course of the audit, compressed air flow was directly measured after the pressure regulation valve set at 80 psig as it exited the compressor room.

We also monitored compressor motor amperage on all operating compressors and common header pressure throughout the plant. This allows us to measure the performance of the system in terms of Dynamic Efficiency (DE). Dynamic efficiency is defined as Scfm per Kw. Dynamic Efficiency is a key indicator of system performance and is a readily and easily repeatable measurement. We use this audit measurement as a key benchmark to guarantee and measure improvement in system performance.



Pactiv Bakersfield Existing Simplified One line Diagram
Compressed Air

> "Leaks were estimated at about 25% of flow. This is typical for an existing plant with lots of motion and heat."
>
> — James G. McAuley P.E.

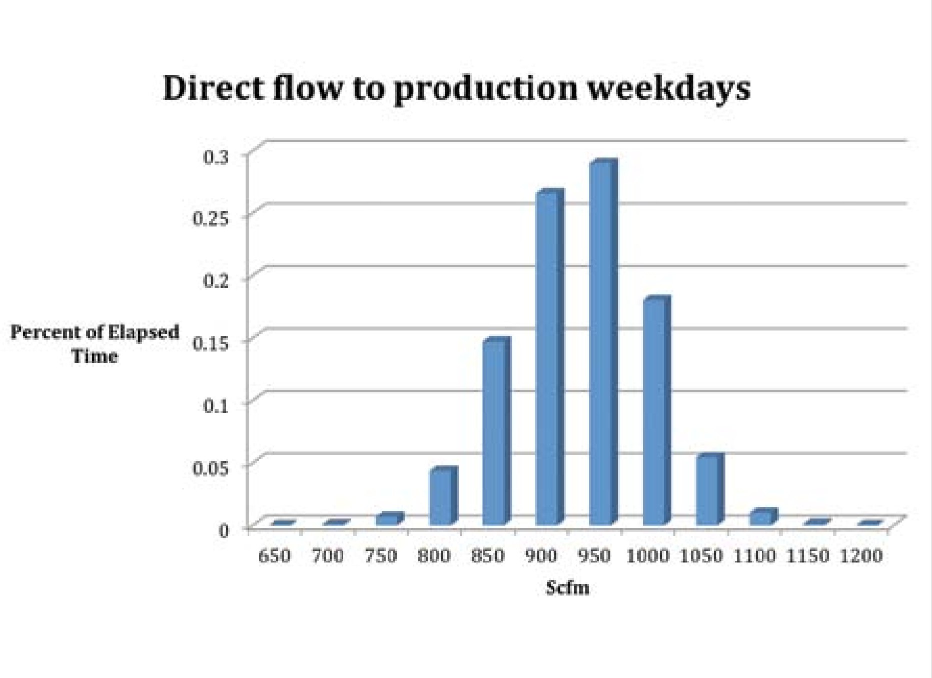
We measured the compressed air flow out to the users in twelve second intervals and continuously measured the compressor power in 12 second intervals for one week. We then compiled a frequency analysis of total system flow in 50 Scfm increments.

To the right is a histogram representing the actually measured demand side flow data.

We directly measured this flow from Monday morning until Thursday afternoon. From Thursday afternoon until Monday morning we collected amp data only on the operating compressors. This data indicated the flow was slightly less during the remainder of the week. We recorded -4% power on the lagging compressor (loading and unloading) and +0.6% power on the leading compressor (fully loaded). This indicates that the weekly demand profile shifted slightly to the *left* from the data directly observed above. The net result is that the annual cost data extrapolated maybe slightly inflated. For our purposes here I consider this to be irrelevant. We will use the direct flow profile we measure for four days to model the annual system operating cost.

In order to model the annual power required by the compressed air system we measured both the flow out to the plant and the average amperage on each compressor over the course of the data collection period. We then extrapolate this data over a year. The spreadsheet in the appendix details the **actual demand** BASELINE annual cost of electricity for the compressed air system based upon an entire year of production (8760 hours) and electricity cost of 8.7 cents per Kwh.

The audit result showed a poor compressed air system Dynamic Efficiency (DE) measurement of 4.36 scfm/kW and an extrapolated annual energy cost of $162,000.



THE COMPRESSED AIR SYSTEM ASSESSMENT | Reviewing Compressed Air Demand at a Food Processor

Allocated Unit Costs for Compressed Air

The *allocated* unit cost for compressed air at this plant is $1.99 per hour of operation per 100 Scfm of usage. This number is derived from the total cost of compressed air operations, the average demand side flow rate observed in the system (930 Scfm), and the total hours per year (8760). It is a useful number when comparing costs.

The allocation of unit cost will allow plant management to estimate the financial impact of various management decisions including the operating cost associated with new equipment and the efficacy of better (more) intense maintenance practices. Caution: It is not the marginal cost of the next 100 scfm of use nor the savings derived from the last 100 scfm of use eliminated. This number is average for a facility of this type and size in the United States.

95 ˚F AMBIENT INLET TEMP	COMP 1	COMP 2	COMP 3	COMP 4
Inlet filter		97 ˚F	98˚F	
After-Cooler compressed air inlet		201 ˚F	217 ˚F	
After-Cooler compressed air discharge		115 ˚F	120 ˚F	
Water in		105 ˚F	106 ˚F	
Water out		127 ˚F	131 ˚F	

Cooler Performance Evaluation

During the audit period, air compressor cooler performance was measured and all appeared to be functioning well and not fouled.

Water-in temperature of 105 ˚F indicates the cooling tower is not functioning properly. We estimate about 45 tons of cooling is required for compressed air and about 17 tons for the new improved vacuum system.

Excessive temperature is the enemy of compressors. These types of maintenance failures can be identified early and often remedied inexpensively before an emergency breakdown. Discharge temperature should be logged every shift and provisions made to correct elevated temperature situations as soon as they arise.

During the course of the evaluation we observed the water-cooled 2000 Scfm PYRAMID dryer stop working at least twice. We never determined why it stopped working or how it began working again. It is thought that high cooling water temperature may cause these shutdowns.

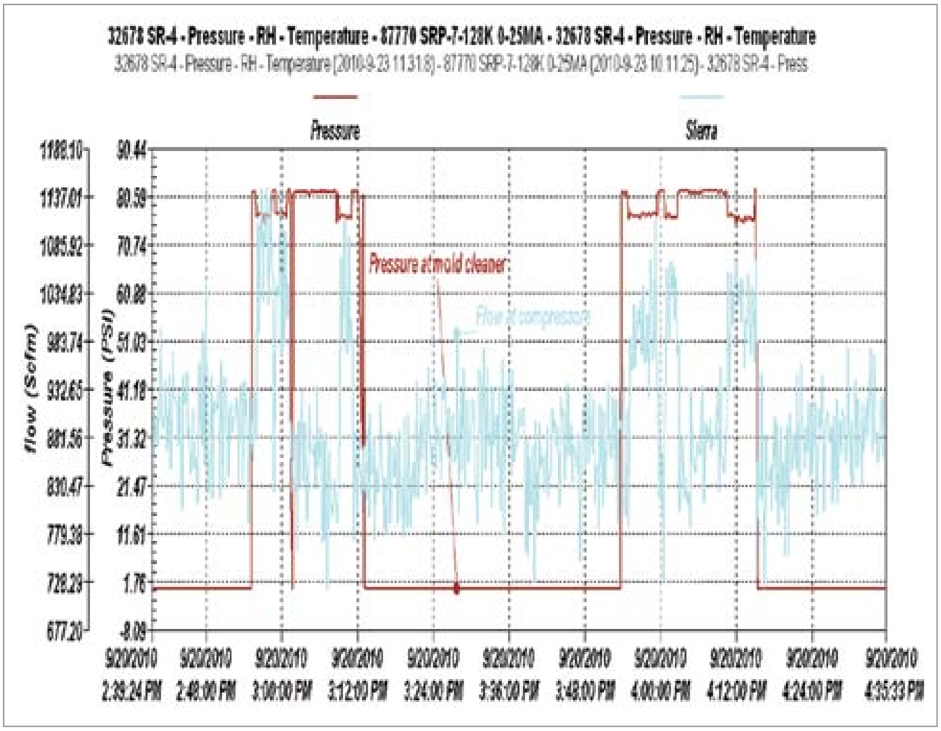
Vacuum System Operations

We were asked to collect data on the vacuum systems with an eye toward improvement. We measured common vacuum header and found the system not working nearly where it should be.

We observed the vacuum header in the 7-10 inch mercury range. Normally these systems operate at about 18-20 inches. We observed three 25 hp vacuum pumps. Two operated and one repeatedly overheated and shut down. We believe the plant needs additional vacuum capacity and as much as 100 hp more to adequately meet the needs of the plant. This includes migrating ten splicers from compressed air generated vacuum to this central vacuum system. This estimate will be confirmed through vacuum system experts and relayed to the plant.

"Wet Tank" Piping

The wet tank has the air going in and out near the bottom on the tank. The proper way to pipe a wet tank for moisture removal is in the bottom and out the top. This will inevitable cause moisture to drop out of the air stream and will reduce the load on the dryer and all downstream drainage equipment. The audit recommends the plant pre-plumb the required section of pipe and during the next shutdown reconfigure the wet tank for its intended purpose.



THE COMPRESSED AIR SYSTEM ASSESSMENT | Reviewing Compressed Air Demand at a Food Processor

Potentially Inappropriate Uses of Compressed Air

Because compressed air is ubiquitous in most industrial settings, and since it is a highly adaptable energy source, it tends to be the first choice for power at remote locations even when it is clearly not the most efficient choice. We surveyed the entire plant looking for potentially inappropriate uses of compressed air.

It is worth repeating here this indisputable fact; 85% of the input *purchased* energy used to drive an air compressor is immediately dissipated in the heat of compression and lost forever. Only 15% of the *purchased* energy is actually imparted to the fluid (the compressed air) to later go out and do useful work in the plant. If it can be done with electricity it is automatically 8 times more efficient than with compressed air.

We surveyed the entire plant with an ultrasonic detector and identified only one open blowing application that could be modified.

- On the Rennco baggers a quarter inch open blow is used to close the open end of the bag prior to tie wrapping the end. This has been modified such that it is intermittent. I observed approximately 25% on time for this application. Assuming 6000 hours per year for each and six in operation at 20 Scfm full flow and our $1.99 per hour per hundred Allocated Cost model, this use is costing the plant about $3600 per year.

(20/1000) x .25 x1.99 x 6000 hours x 6 baggers = $3582/year

- Even though a blower would use only 30% of this energy it would have to stay on 100% of the time, thus there are no net savings using a blower here.
- The 15 bag houses on the roof are all well controlled via differential pressure and not on time. This has dramatically reduced the compressed air cost here from over 350 Scfm estimated in 1999 to less than 30 Scfm now. I observed only a few firings while surveying the equipment on the roof over a ten minute period.
- We also looked at the CO_2 mold cleaning operations. We wanted to be sure they were not dragging down the local header pressure at the mold cleaning operations. They were not, at least not at the normal mold cleaning station. We observed that the mold cleaning

operation used about 200 Scfm for less than ten minutes. This is about 33 cents worth of compressed air for each cleaning operation.

200/100 x .165 hours x 1.99 $/hr/100 Scfm = 33 cents

- The compressed air use appears efficient and effective in this application. Here is a flow tracing of a typical CO_2 mold cleaning operation.
- Ten Thermoformers (TF) are equipped with Airvac (Milford Ct) compressed air vacuum generators. These use 0.41 Scfm each. There are twelve on each TF. We estimate they use 65 Scfm or 15 Kw of power (65/4.36). Vacuum pumps are estimated to do this at 30% of the power of compressed air or for a net savings of $7545 per year.

(65/100) x $1.99 x .7 x 6000 hours per year = $7545

Effective Leak Management Processes

Leaks were estimated at **about 25%** of flow. This is typical for a existing plant with lots of motion and heat. We noted many normal leak modes including push pull connectors, connections subjected to excessive heat and vibration (behind the safety fence) and many final connections to applications including unions, pipe clamps, and FRL.

We recommend the plant invest in an ultrasonic United Electric Ultraprobe 3000 hand held detector and recruit a Plant Champion to identify and fix leaks on a regular basis . This monthly shift task, with the Ultrasonic detector, can ultimately achieve reduction in leak loss level to 15%. In this plant, this could be responsible for up to $16,000 in yearly savings using our allocated cost model.

930 Scfm x (.25-.15) x 1.99 $/100Scfm x 8760 hr/yr =$16,212

We'd like to highlight, at Extruder 504, a very large long-term leak at the MAC solenoid manifold.

Summary

The compressed air system at this food processing plant is not now operating near peak performance. In fact, it runs at a combined dynamic efficiency (DE) of about 4.36 Scfm/Kw. We believe we can boost this dynamic efficiency to 5.69 by modifying the supply side situation and addressing the demand side issues outlined in this article. BP

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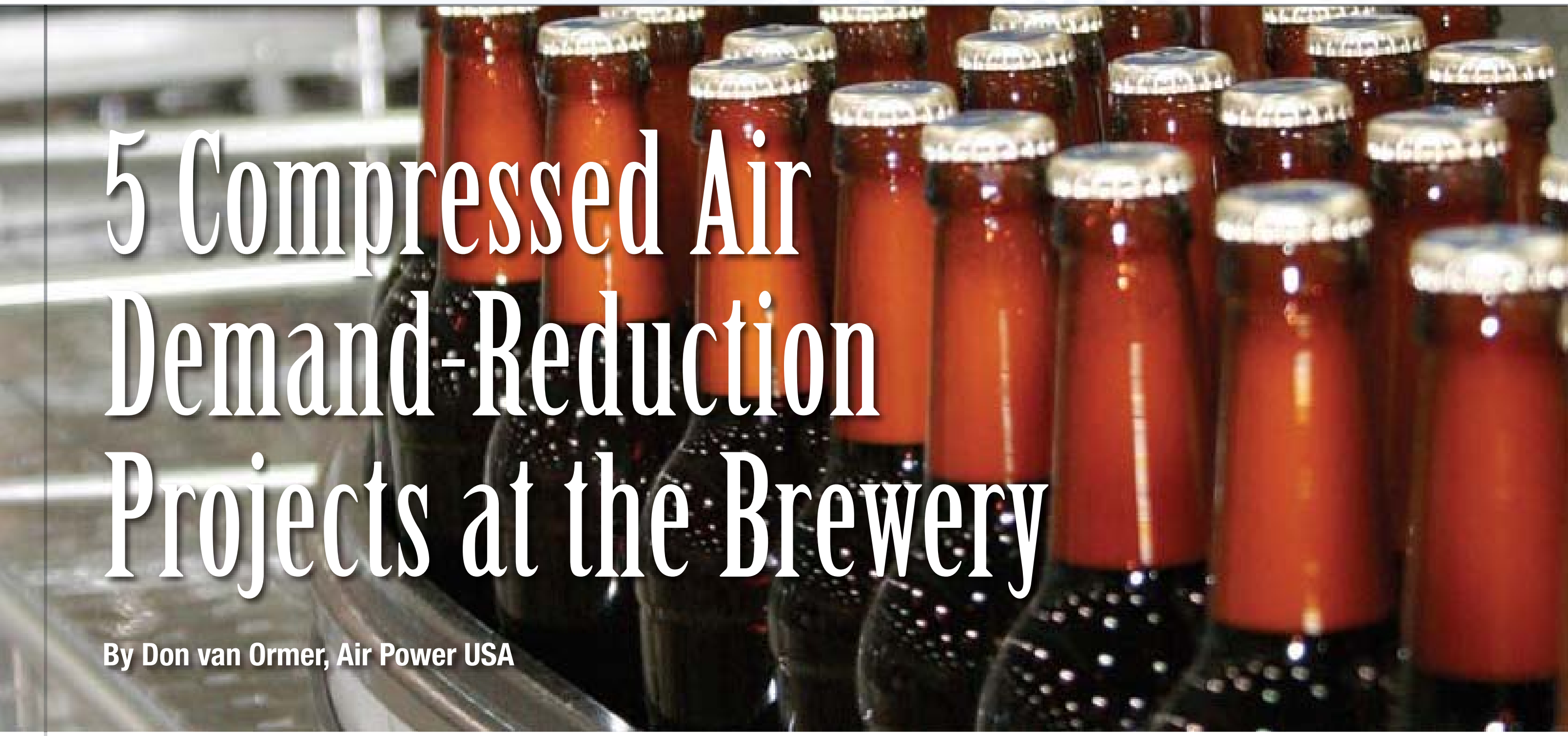


5 Compressed Air Demand-Reduction Projects at the Brewery

By Don van Ormer, Air Power USA

This brewery is a relatively large operation with nine production lines plus a keg line. There are five bottle lines and four can lines. Operations in the plant include palletizing de-palletizing, filling, packaging operations, and brewing.

Annual plant electric costs for compressed air production, as operating today, are $693,161 per year. If the electric costs of $43,016 per year associated with operating ancillary equipment such as the blower purge dryers are included, the total electric costs for operating the air system are $736,177 per year. These estimates are based upon a blended electric rate of $0.06/kWh.

This was a complete supply and demand-side system assessment. Although the leak audit yielded 930 cfm in demand reductions, this article will focus on some lesser-known project areas where a plant can reduce compressed air consumption.

The Current Compressed Air System

The air system operates 8,760 hours per year. The load profile or air demand of this system is relatively stable during all shifts. Overall system flow ranges from 4,000 scfm during production to 5,000 scfm. The system pressure runs from 68 to 73 psig in the headers during production.

The compressed air system is supplied compressed air by several generations of mostly Joy (Cooper Cameron) centrifugal compressors and two 1995 era Ingersoll Rand 300 hp class units. The Joy units include two 1975 era, 500 hp class machines, two 1985 era, 450 hp class machines, and one 2000 vintage 200 hp compressor. These compressors are well applied and apparently very well maintained and monitored on their central data acquisition 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
First Shift: Operating at 88-98 psig discharge pressure for 8,760 hours							
7	Joy TA18	389	2,015	100%	389	100%	2,015
6	Joy TA17V	369	1,900	98%	363	90%	1,710
5	Joy TA22	396	2,200	OFF			
8	Joy TA18	369	1,986	38%	140.9	Unloaded	0
9	IR CV15M2	280	1,343	OFF			
10	IR CV15M2*	280	1,343	100%	331	100%	1,343
11	Joy TA2000	174.6	1,099	54%	94.9	Unloaded	0
			TOTAL (Actual):		1,319 kW		5,068 scfm

During our site visit, the units performed very well, spending very little, if any, time in blow-off. There are seven air compressors and usually three units carry the plant load — two are at idle and two are not running, waiting to come on in the auto hot start "ready" mode.

The compressed air goes through water-cooled after-coolers and then goes to four blower purge dryers. During our site visit, all the dryers were working well with their dewpoint demand controls engaged and working. Pressure dewpoints were always at a consistent -40 °F.

The plant runs 24 hours a day, 7 days a week, almost all 365 days a year. There are two planned shutdown days every year. For calculating usage, we have agreed to use 8,760 hours per year. The new negotiated power cost from the plant's utility provider is 6 cents per kWh.

Project #1: Automatic Equipment Shut-Offs

Shutting off the air supply to machinery when not in use can often minimize some of the most significant air leaks. When such air users are found, there are usually some very economical and easy methods to switch off air automatically as machinery is shut off.

Slow-acting, electric-operated automatic ball valves that can be installed in the main feed line to a piece of equipment and wired so it will open and close whenever the machine is powered up or shut off.

The system assessment identified Filtech laser coolers as using compressed air when not in operation. The table below lists locations where automatic shut-off valves may be of use, either as individual machine shut-offs or as zone valves, in front of the laser coolers.

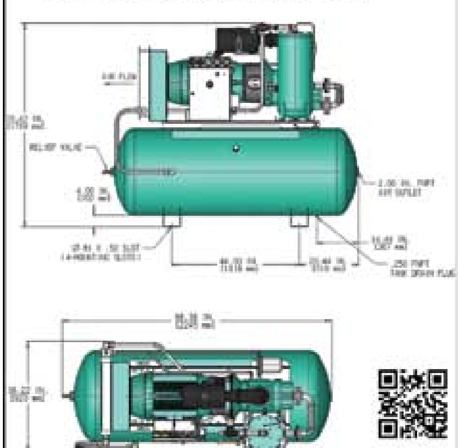
Current peak demand with 15 units x 20 cfm is 300 cfm at 80% usage or 240 cfm average demand. According to plant personnel, these units were running even when the line was down for cooling. If we consider a normal operation of the Packer or a device or part of the line, depending on the product being packaged (6 pack, 12 pack, case, etc.), the estimate of average usage is 30% of the Packager.

When shut off cooling air flow when process is off, the utilization factor will go from 80% to 30%. Air demand will go from an average flow of 240 cfm to an average of 90 cfm, making a net average savings of 150 cfm. We recommend a 10 minute delay after shutdown for additional cooling. This should be reviewed by staff engineering.

Filtech Laser Cooler Locations and Compressed Air Consumption

Line 64	12-12	Packer	20+ cfm
Line 63		Packer	20+ cfm
Line 65		Packer	20+ cfm
Line 66		3 Packers	60 cfm

	LOCATION	DESCRIPTION	SIZE (CFM)	USAGE (%)	NET SAVINGS (AVG CFM)
#1	All Filtech Laser Coolers	Cooling for laser	300	50%	150 cfm
TOTAL			300 cfm	—	150 cfm



5 COMPRESSED AIR DEMAND-REDUCTION PROJECTS AT THE BREWERY

Cfm savings	150 cfm
Cost per cfm	$129.18 cfm/yr
Total savings	$19,377 /year
Estimated cost of project (solenoid/timer)	$300 each
Total cost (15 units x $300)	$4,500

Project #2: Replace Freon-based Refrigeration Cabinet Coolers

During our site visit, we counted somewhat over forty 4,000 Btu/hr refrigeration-type (Freon) cabinet coolers similar to the Hoffman CR2902 units.

Freon based refrigeration units can lower the ambient air temperature about 15 to 16 °F each pass. For more cooling drop the refrigeration action is cumulative as long as there is enough capacity. This limits their usage to *ambient temperatures no higher than about 125 °F.*

The refrigeration units mount on the side of the cabinet and continue to cool the same air in the cabinet over and over until they reach the desired internal temperature. The units usually run constant speed but when there is enough refrigeration capacity these may be controlled to shut off with a temperature switch. In practice they usually run most the time because they are being controlled by the hot gas bypass valve. There is no electrical energy savings in the HGBV control model.

- Refrigeration units have a practical limitation of 115 °F to 125 °F ambient without significant over sizing.
- Avoid installations exposed to machine vibrations.
- Refrigeration units generally run full time.
- The electrical energy operating cost is usually the highest of any type except open blows.
- You can and should apply them to only run when the cabinet is active if possible.
- Of all the types available, these probably require more general maintenance and shorter overall life, particularly in hotter environments.

A heat pipe consists of a sealed aluminum or copper container whose inner surfaces have a capillary wicking material. Inside the container is a liquid (usually alcohol) under its own pressure that enters the pores of the capillary material, wetting all internal surfaces. Applying heat at any point along the surface of the heat pipe causes the liquid at that point to boil and enter a vapor state. When that happens, the gas picks up the latent heat of vaporization — the gas — which then has a higher pressure, moves inside the sealed container to a colder location where it condenses. Thus, the latent heat of vaporization moves heat from the input to the output end of the heat pipe. This process takes place at great speed, reaching over 500 MPH.

The core material selected for use in the heat tube cabinet cooler is copper tubing and aluminum fins. This combination of materials is readily available and has been in use for many decades in refrigeration coils, steam heating coils, radiators, etc.

The fans are designed to be an easily change replacement part and two axial fans are usually selected as the standard fans for heat pipe cabinet coolers.

The annual maintenance on these units would be to clean or replace the filter elements and the fans as required.

The "heat tubes" will not cool below ambient. The water-cooled units will cool below ambient temperature. These are relatively simple and can use most process or cooling water and will not significantly raise the temperature. These units perform very well and no water enters the cabinet. The air-cooled units are limited to about 3,500 Btu/hr heat loads. Water-cooled units go up to about 60,000 Btu/hr.

The lowest electrical energy cost ambient cooler after the fan is the heat pipe — air cooled units can only cool to *almost ambient temperature.* When the ambient temperature around the box is higher than the desired inside temperature — *it will not work! Water-cooled will work very effectively.*

> **"Since well-applied Vortex tubes cool quickly and have no moving parts, they can shut on and off as often as required to save air flow."**
>
> — Don van Ormer, Air Power USA

We recommend replacing these coolers with a Noren Model CC3060, Type 22 or equal heat pipe with cooling water assist. The cooling water does not enter the cabinet. The Noren CC3060 with water assist is rated to handle 9,300 Btu/hr of cooling, so it will only be 67% loaded at 4,000 Btu/year. Comparative specifications:

	HEAT PIPE/WATER ASSIST	4,000 BTU/HR FREON REFRIGERATION
Cooling capacity	9,300 Btu/hr	4,000 Btu/hr
Weight	13 lbs	98 lbs
Estimated life	10 years (+)	5 years
Duty cycle	57%	100%
Operating energy cost	35 watts	1.7 kW

Energy cost per unit (1.7 kW x $0.06 x 8,760 hrs)	$894 /yr
Annual energy cost for 40 units	$35,740 /yr
Energy required per heat pipe-type cabinet cooler (35 ÷ 1,000)	0.035 kW
Annual kW cost: 40 heat pipe units (.035 x 40 x $0.06 x 8,760 hrs)	$735.84 /yr
Net savings ($35,740.80 - $735.84)	$35,004 /yr
Estimated purchase cost (including freight and installation)	$45,000

Project #3: Control Compressed Air Vortex Tube Cabinet Coolers with Thermostat-controlled Solenoid

Compressed air vortex tube cabinet coolers behave in a very predictable and controllable way. When compressed air is released into the tube through the Vortex generator, hot air blows out of one end of the tube and cold air out of the other.

The Vortex flow generator — an interchangeable, stationary part — regulates the volume of compressed air, allowing the plant to alter the air flows and temperature ranges that can be produced with the tube on some models.

Everything else equal as the inlet pressure rises, the cold air temperature drops (within performance limits). Colder air may be delivered if the installation minimizes pressure loss to the inlet of the Vortex tube cooler. A compressed air temperature drop up to 90 °F is available.

Back-pressure on the cold end will reduce the ratios across the tube and raise the cold end temperature. There is usually a relief valve in the Vortex tube cooler assembly venting the cabinet air, not allowing back pressure to build up, and exchange hot air for cold air.

Since well-applied Vortex tubes **cool quickly** and have no moving parts, they can shut on and off as often as required to save air flow.

Vortex tube coolers should **always** be controlled by a thermostat sensing the inside cabinet air and an electric solenoid to shut the air on and off with the signal.

5 COMPRESSED AIR DEMAND-REDUCTION PROJECTS AT THE BREWERY

There are twelve vortex cabinet coolers installed on the labeling lines.				
Line 06	Domino Vortex 701	100%	2 units	15 cfm each
Line 06	Labeler Vortex 701	100%	3 units	15 cfm each
Line 05	Vortex Cooler Case Packer		2 units	15 cfm each
				Total 105 cfm
Line 08 Domino Printer				
• Three Vortex 701 units run continuously when line is on and go off when line is off. • 70% utilization (15 cfm each or 11 cfm average each). • 50% savings when controlled auto shut off — 33 cfm or savings of 16.5 cfm.				
Line 04 Domino Printer				
• Two Vortex 701 units run whenever the line is on and are running with the door open. • 100% utilization (15 x 2) or 30 cfm • Savings is 15 cfm total.				

All the vortex coolers were not running cool enough, probably due to low pressure and possibly dirt or a ring seal failure. None of the units have auto shut off controls. Add auto shut off to all the vortex units and raise the pressure 75 80 psi. Estimated minimum flow savings with an auto thermostat shut off with 80 psi inlet is 72 cfm.

Total number of coolers observed	12
Total peak scfm	180 scfm
Total average current scfm	144 scfm
Total peak cfm savings	180 scfm
Total average scfm saved (minimum)	72 scfm
Cost per scfm	$129.18 scfm/yr
Total savings	$11,897 /yr

Project #4: Control Air Use of Vacuum Generators

The system assessment identified 52 vacuum generators using 215 scfm of compressed air. We estimate that 62 scfm of use can be eliminated if automatic compressed air shut-off controls are used when the generators are not functioning.

Vacuum generators are selected for more localized or "point-of-use" vacuum applications that require smaller volumes and faster local response times. Manufacturers of production machinery often supply them as standard equipment. There are two basic types of ejector pumps: single-stage vacuum generators and multi-stage vacuum generators.

Single-stage vacuum generators use compressed air by accelerating the air through the restrictor tube to create a Venturi effect to evacuate the required volume of air. These single-stage Venturi generators are somewhat limited in their ability to fit many applications efficiently, since their basic design is set to accommodate either the highest flow or highest volume requirement. Typically, this type of vacuum generator has a ratio of compressed air consumption (scfm) to vacuum flow (the rate at which atmospheric pressure is removed from a system) of no better than 1:1 and sometimes as high as 2:1 or 3:1.

Multi-stage vacuum generators were developed to improve this efficiency for many applications. The multi-stage units use a series of ejectors and nozzles that allow compressed air to expand in controlled stages. This usually improves the ratio of compressed air consumption to vacuum flow to a level of up to 1:2 or more. Multi-stage units are also quieter.

The compressed air (1) exits the smaller first pump nozzle (2) creating a low pressure area at that stage. This low pressure creates a Venturi, pulling in the evacuation air through the ports (3). This evacuated air is mixed into the compressed air flow. This action continues over succeeding stages. The flapper valve allows the compressed air to flow through the pump nozzles and not back into the vacuum (4).

Recommended Actions on Vacuum Generators

On the 63 212 Packer, change the solenoid to air side instead of vacuum on cam. When the unit is on, it runs 100% (12 cfm x 2) at 90% utilization — demand is 22 cfm. Change air reduction at least 50%. Savings is 12 cfm.

On the 65 Lift Case, the generator runs 100% of the time with the vacuum shut off solenoid on the vacuum line which stops the vacuum but the air continues to flow even when not running boxes. Installing the solenoid on the air line will stop the air flow and vacuum and reduce the air flow 70%.

VORTEX TUBE CABINET COOLING TYPICAL COMPRESSED AIR REQUIREMENTS	
BTU/HR	APPROXIMATE CFM REQUIREMENTS
600	12 cfm
1100	15 cfm
1800	25 cfm
2500	35 cfm
5000	70 cfm

CURRENT APPLICATION VENTURI VACUUM GENERATORS IN USE								
LOCATION	BRAND	QTY	MODEL SIZE	OPERATING PSIG	CA SCFM FLOW	EVAC AIR FLOW	% UTILIZATION	AVG CA USE (CFM)
212 Packer	PIAB	2	M1006-63		12 x 2	1:1	90%	22
63 / 64 / 65 Depal	NA	3			10-12	1:1	60%	21
63 / 64 / 65 Debag	NA	3			10-12	1:1	20%	7
63 / 64 / 65 Flap Up	PIAB	3	M100L	72 out of control	12	1:1	50%	24
65 List Case	PIAB		M100L	72 out of control	12	1:1	100%	12
Lid Depal 65 / 64 / 63	PIAB	8	2 x 4					
M100L		12	1:1	80%	40			
64 end load	PIAB		M100L		12		40%	5
Line 66 2-12	PIAB	3			12		50%	18
Line 6 Targeteer #1	PIAB	3			12	Were off at visit	30%	12
Line 6 Targeteer #2	PIAB	3			12	Were off at visit	30%	12
Line 07 Case Packer #1	PIAB	1			12	12	20%	2
Line 07 Case Packer #2	PIAB	1			12	12	20%	2
Line 66 Jones Multistack	PIAB	1	Solenoid valve on vac not on air side		12	12	80%	10
Palletizer 18 Labeler 18	PIAB	18				1	100%	18
Line 4 Case Packer	PIAB	1			12		80%	10

Debaggers 63 / 64 /65 are also breaking only the vacuum line, which is not on air side. Demand is 24 cfm and moving the shutoff solenoid to the air line will generate 12 cfm average of compressed air savings.

The lid debagger has two units running the same as above with only breaking the vacuum lines not on the compressed air side. These units run at 50% utilization. Demand is 40 cfm for a savings of 50%. The compressed air savings is 20 cfm.

Line 66 Jones Stacker is running vacuum at 50% utilization with the breaking vacuum only in the vacuum line not on the air side. Demand is 10 cfm and the solenoid should be moved. Air savings is 5 cfm.

Review Line 6 Targeter after the system is running.

The Line 4 Case Packer unit is also breaking vacuum instead of air side. Move solenoid. Savings is 5 cfm.

5 COMPRESSED AIR DEMAND-REDUCTION PROJECTS AT THE BREWERY

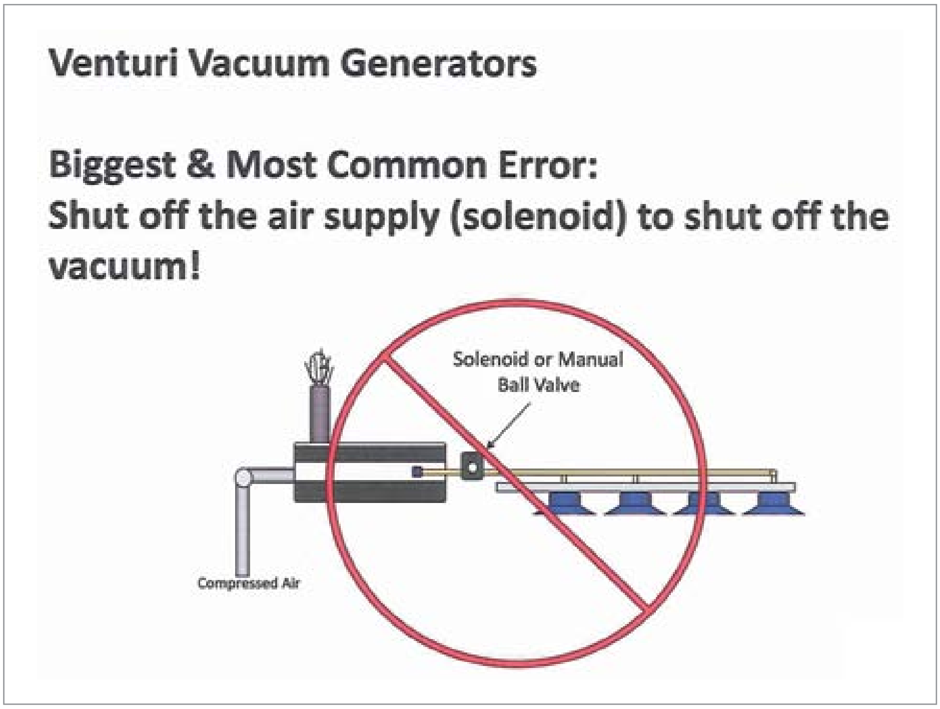
The Palletizer could easily have small central vacuum system installed, but the Labeler uses very little air.

The Depalletizer area has the Lid line running continuously. Investigate this situation further since the paper is very think and auto shut-off system may not be a good fit. This system may also use a central vacuum system. These are both Phase 2 recommendations.

Most of the Packaging machines had vacuum breaks on the vacuum line and not on the compressed air side, which when shut off stops the air flow and the vacuum. In many cases, the Packers were not on during our site visit. It would be a good idea to evaluate the rest of the vacuum generators after those listed are modified.

When the vacuum capacity to product lifted is appropriate, add venturi generator with built-in automatic on/off controls. For example: a vacuum generator which uses *60 scfm* at 90 psig and can pull a *20" vacuum in 0.25 seconds*. If the vacuum generator is shut off at 20" of mercury vacuum pressure, total air demand will be about *0.25 scfm (1/16 hp) vs. 60 scfm (15 hp)*.

Estimated flow of Venturi vacuum without auto shut off	12 cfm each
Number of Venturi units	52
Total air flow in current system / peak flow	215 cfm
Minimum air flow reduction with auto shut-off	30%
Air flow savings with auto shut-off	62 cfm
Recoverable energy savings	$129.18 / cfm yr
Annual estimated energy savings	$8,009 /year



5 COMPRESSED AIR DEMAND-REDUCTION PROJECTS AT THE BREWERY

PNEUMATIC BOOSTERS LOCATED IN FACILITY

LOCATION	QTY	BRAND	LOCATION	QTY	BRAND
Brewing	6	Haskall Model 58981 30-40 spm Stackhouse	Line 4	2	Haskall
Debagger Can Lines	4	MPS 36-40 spm	Line 6 Capper	1	Haskall
Video Jet Line 63	3	MPS	Line 6 After Labeler	1	MPS
Video Jet Line 64	2	XXXX	XXXX	XX	XX
Video Jet Line 65	1	Haskall	Line 6 67 Capper	1	Haskall
Video Jet Line 63 before filler	1	MPS	Line 6 65 Capper Video Jet	1	MPS
Video Jet Line 63 Debagger	1	MPS			

Project #5: Eliminate Pneumatic Air Amplifiers (Boosters)

When the plant lowered its pressure on a continuing basis to the current 72 psig target, many good things happened, particularly when the plant processes received a stable operating pressure. However, in some cases, the lowered pressure apparently had a negative impact on production and quality and these pneumatic amplifiers were installed to deliver higher pressure to these locations.

Discussions with various plant operating personnel indicate that at system pressure (80 psig), none of these amplifiers would be needed. We observed the Haskall MPS pneumatic booster at the following locations.

There are currently at least 24 pneumatic boosters in use throughout the plant at the locations shown in the table above. Most of these units are the 20 cfm size. This means they deliver 20 cfm at twice the intake pressure, but will require a total of 40 cfm to run.

At least half of these units are not operating at full speed, and will therefore, use somewhat less air. To estimate the impact of this project on the air system, we will use an average of 15 cfm delivered to drive the booster on 24 units (24 x 15 cfm) or 360 cfm reduction.

Compressed air saved by removing 18 pneumatic boosters (30 x 18)	360 cfm
Value of recoverable energy for each cfm of reduction	$129.18 cfm/yr
Electrical energy saved by implementing this project	$46,505 /year
Cost of project	$3,000

This project should be done after system pressure has been raised enough to operate most of the processes. We believe the system pressure should be raised to 80 psig. Many of these units are currently running at a system pressure 70 psig or lower.

Since the air supply is from Centrifugal compressors lowering or raising the pressure does not have any significant impact on the input kW according to the operating performance curves. Raising the pressure enough to eliminate the pneumatic boosters will then reduce the flow somewhat but not enough to cause another unit to run.

COMPRESSED AIR SYSTEM CHARACTERISTICS — PROPOSED SYSTEM*

MEASURE	BASELINE - EXISTING SYSTEM	OPTION A - DEMAND REDUCTION PROJECTS WITH EXISTING AIR COMPRESSORS**
Average System Flow	5,068 scfm	3,111 scfm
Avg Compressor Disch Press	88-98 psig	85 psig
Average System Pressure	72 psig	80 psig
Input Electric Power	1,319 kW	602 kW
Operating Hours of Air System	8,760 hrs	8,760 hrs
Specific Power	3.84 scfm/kW	5.166 scfm/kW
Electric Cost for Air /Unit of Flow	$136.79 /cfm yr	$101.74 /cfm yr
Annual Electric Cost for Compressed	$693,161 /year	$316,411 /year

*Based upon a blended electric rate of $0.06 per kWh and 8,760 hours/year.

** A Scenario B was also proposed with a new air compressor that reduced energy consumption to $240,000 per year.

Conclusion

The system assessment at this brewery realized significant demand-side reduction opportunities. Average system flow was reduced from 5,068 to 3,111 scfm. While much attention is appropriately given to compressed air leaks (they totaled 930 cfm at this job), it is important to find the other areas of inappropriate compressed air uses in the plant. BP

For more information contact Don van Ormer, Air Power USA, tel: 740-862-4112, email: don@airpowerusainc.com, www.airpowerusainc.com

To read more ***System Assessment*** articles, visit www.airbestpractices.com/system-assessments

A COMPRESSED AIR & GAS INSTITUTE Q&A SESSION
HEAT RECOVERY FROM INDUSTRIAL COMPRESSED

By Compressed Air Best Practices® Magazine

The rise in energy prices is an unwelcome reality in today's manufacturing and business environment. And while the rate of price increases for natural gas, heating oil and electricity may vary from year to year, the upward trajectory is clear. Energy cost reduction strategies are vital to staying competitive. Compressed Air Best Practices® Magazine recently discussed heat recovery, from industrial compressed air systems, with the Compressed Air and Gas Institute's (CAGI) Technical Director, Rick Stasyshan and with CAGI member — Werner Rauer of Kaeser Compressor. Their inputs should provide you with some insight in energy-saving technology.

Can you provide some background on this topic?

While energy reduction strategies are vital, related considerations are protection of the environment and the focus on sustainable growth. Some industries are under increasing pressure to reduce their carbon footprint, while many companies are proactively taking steps to do so.

With manufacturing plants and other facilities doing what they can to streamline their operations and improve efficiencies, facility engineers face the challenges of optimizing the energy efficiency of their operations and extracting as much productivity out of every unit of energy consumed and paid for.

How can compressed air be a potential plant energy source?

One important way operational efficiencies can be increased is by harnessing heat from compressed air systems, which make up a significant share of industrial energy consumption.

The law of thermodynamics and the principle of the conservation of energy tell us that energy isn't created or destroyed; it can only change form. The air that enters a compressor at atmospheric pressure has a base level of energy content. After the compression process

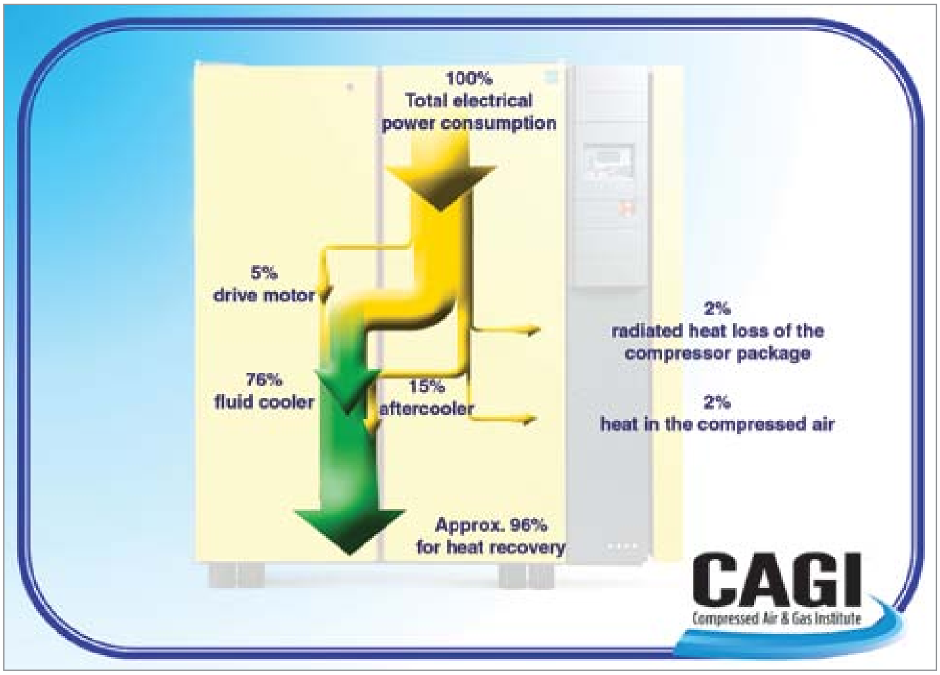


Figure 1: Highlights the opportunity available for heat recovery

> "While the rate of price increases for natural gas, heating oil and electricity may vary from year to year, the upward trajectory is clear. Energy cost reduction strategies are vital to staying competitive."

AIR SYSTEMS

increases the air pressure and raises its temperature, the energy becomes available for transfer. The heat must be removed to maintain proper compressor operating temperatures and to cool the compressed air to make it suitable for plant use.

The heat generated by compressed air systems can be a very good source of energy savings. In fact, nearly all (96%) of the electrical energy used by an industrial air compressor is converted into heat. The balance remains in the compressed air or radiates from the compressor into the immediate surroundings. **(Figure 1)**

Too often, that heat is simply ejected into the ambient environment through the compressor cooling system. But here's the good news: Nearly all this thermal energy can be recovered and put to useful work and significantly lower a facility's energy costs.

Can you give our readers some examples on how to use this energy source?

Some uses of recovered energy from compressed air systems:

- Supplemental space heating
- Makeup air heating
- Boiler makeup water preheating
- Industrial process heating
- Water heating for showers, bathrooms, etc.
- Heating process fluids
- Heating food and beverage products
- Heat-driven chillers

With the popularity of rotary screw air compressors, is this an opportunity?

One of the more common pieces of equipment found in manufacturing plants is the air-cooled, lubricated rotary screw air compressor. The amount of heat recovered using these systems will vary if the compressor has a variable load. But in general, very good results will be achieved when the primary air compressor package is an oil-injected rotary screw type design.

Oil-less rotary screw compressors are also well suited for heat recovery activities. As with other compressor systems, the input electrical energy is converted into heat. Because they operate at

HEAT RECOVERY FROM INDUSTRIAL COMPRESSED AIR SYSTEMS

much higher internal temperatures than fluid injected compressors, they produce greater discharge temperatures (as high as 300 ˚F or even greater). **(Figure 2)**

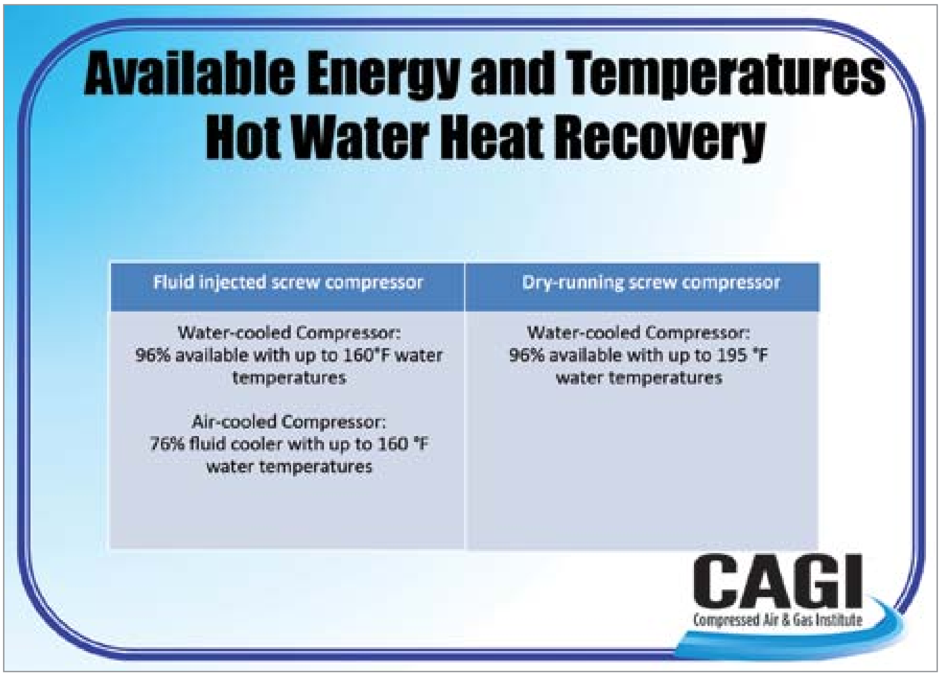


Figure 2: Demonstrates the Available energy & temperatures from screw compressors

Let's discuss warm air applications.

Capturing warm air is easily accomplished by ducting the air from the compressor package to an area that requires heating. The air is heated by passing it across the compressor's aftercooler and lubricant cooler. This extracts heat from the compressed air as well as the lubricant, improving both air quality and extending lubricant life.

By integrating standard HVAC ductwork and controls, warm exhaust air from compressors can be channeled to remove or provide heat in the compressor room and adjacent areas. Typical uses include: **(Figure 3)**

- Heating for warehouses or storerooms
- Heating for production areas and workshops
- Drying air for paint spraying
- Air curtains pre-heating combustion air to improve efficiency

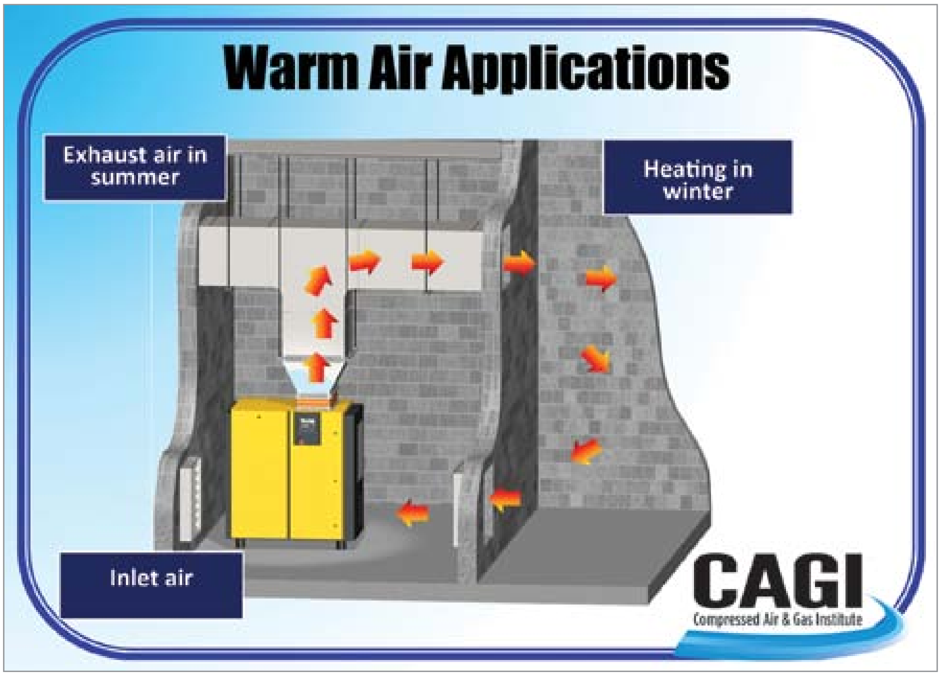


Figure 3: Shows typical and relatively easy way to harness some of the heat of compression in an installation

A majority of the current compressors models being purchased have cabinets that channel airflow through the compressor, and many current designs exhaust warm out the top of the unit. This simplifies adapting compressors for space heating to the installation of ducting and sometimes a supplemental fan to handle duct loading and eliminate backpressure on the compressor-cooling fan.

Space heating can be regulated easily using thermostatically controlled, motorized louver flaps for venting, thereby maintaining consistent room temperature by making continuous adjustments to the heating air flow. This also means that when heating is not required, the hot air can be ducted outside the building to reduce cooling costs.

Can you expand on some of the other opportunities using heat of compression?

Water/Fluid Heating

The key to heat recovery effectiveness with water-cooled compressors is attaining a "thermal match" between the heat being recovered and the heat that is needed on a regular (hourly) basis.

Plate heat exchangers offer a cost-effective way to capture heat from the rotary screw compressor and utilize it to heat water for diverse processes such as electroplating, chemical processing and laundry services.

Fail-safe heat exchangers provide additional protection against contamination of process water or fluids by the compressor cooling fluid. This makes them more suitable for heating applications in the food and pharmaceutical industry sectors — as well as for heating potable water.

Some compressor manufacturers offer built-in heat recovery heat exchangers as options. In some cases, they are fully integrated inside the compressor cabinet and require very little onsite engineering.

Beyond the energy savings, what are some of the other benefits and potential paybacks?

Most process applications in production facilities can benefit from heat recovery from compressed air systems throughout the year, not just during the cold-weather months. In most space heating applications heat is required during three seasons. And during the warmer months, removing the heat of compression will make the compressor room temperatures much more comfortable.

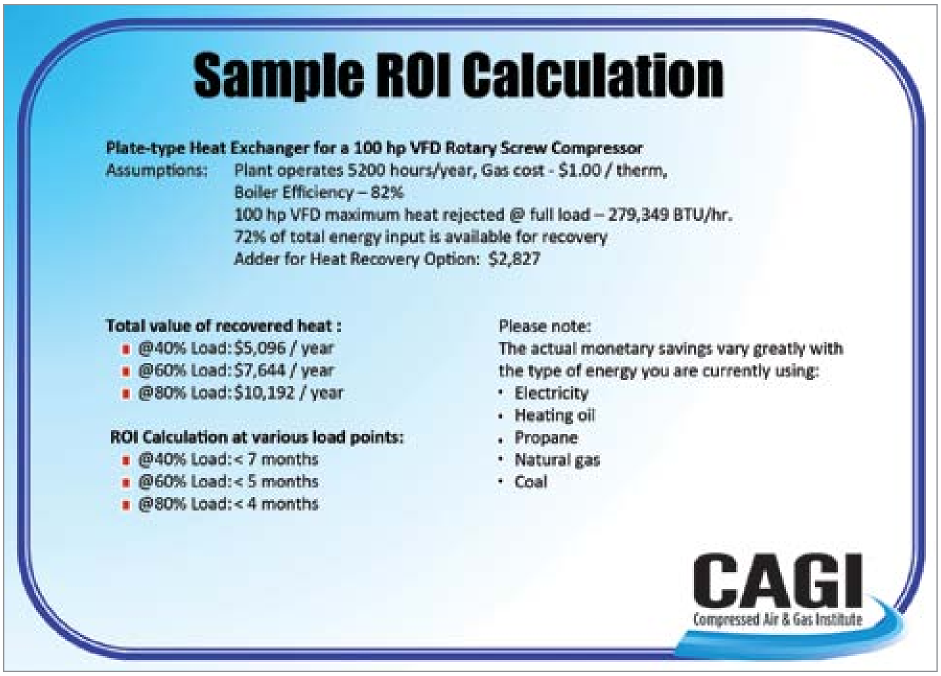


Figure 4: Shows ROI payback in a typical screw compressor installation

HEAT RECOVERY FROM INDUSTRIAL COMPRESSED AIR SYSTEMS

Figure 5: Things to consider

Maintaining proper ambient conditions will also improve compressor efficiency and facilitate air treatment. Moreover, controlling operating temperatures will extend compressor air equipment life.

Current energy costs make an investment in heat recovery systems highly attractive. However, when attempting to calculate energy savings and payback periods for heat recovery efforts, it's important to compare heat recovery with the current source of energy for generating thermal energy, such as relatively lower-cost natural gas.

Generally, the larger the system the faster the payback, but payback on heat recovery also depends on the amount of rejected heat that can be used, and the cost of the alternative energy source. After factoring in the installation cost, it's possible that smaller systems will not provide enough recoverable BTUs of energy to make the investment worthwhile. **(Figure 4)**

Rejected heat can also be used to heat water or other process fluids. It can be done with either air-cooled or water-cooled compressors, although the best efficiencies are usually obtained from water-cooled compressor installations where discharge cooling water is connected directly to a continuous process heating application such as a heating boiler's return circuit for year-round energy savings.

Naturally, higher energy savings will be realized when the alternative-heating source is an older, less efficient technology. Investing in newer, more efficient equipment may be more cost effective. Many heaters are now operating at ~85% efficiency or better, and thus compressor heat recovery activities will result in relatively less annual energy savings.

Beyond energy savings, an important argument can also be made that heat recovery activities benefit the environment. After all, substantial energy savings also mean a reduction in the carbon footprint of a plant. As energy policies and regulations continue to evolve in the United States and other countries, these considerations are only expected to become more important.

Can you give our readers some points to think about when considering this topic?

Figure 5 highlights additional things to consider for your application. A compressed air system audit by a trained and qualified compressor system expert will assist you in determining the best options and opportunities available for your facility. BP

For more information, visit the CAGI web site at www.cagi.org

For more ***CAGI*** articles, visit www.airbestpractices.com/standards/iso-cagi

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.

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

AUDIT OF LOW PRESSURE DRYER SAVES ENERGY

By Ron Marshall for the Compressed Air Challenge®

Compressed air audits are valuable exercises on significant energy users in a plant. Often done on main compressed air systems, these studies are also valuable on secondary systems, like dedicated low pressure circuits that feed production machinery. An audit of such a system turned up some surprising results on a process that was initially thought to be very efficient.

A common accessory to flexible packaging printing machines is an electrically powered nozzle system utilizing heated low pressure (30 psi) compressed air. The hot pressurized air is precisely directed through a compact arrangement of nozzles at a web of just printed material which causes the ink to dry quickly. This operation not only speeds up the printer throughput, but requires substantially less supply and exhaust air volumes over standard natural gas fan powered drying systems. Reported energy savings for this type of drying system is in the order of 25 to 50% over the gas type. These dryers require a supply of clean and dry 30 psi air from an external source. One such source is low pressure lubricant free screw compressors.

On request by the customer, as part of basic customer service, the local power utility, Manitoba Hydro, undertook an analysis of one of these drying systems which was installed at a large Winnipeg based plastics product manufacturer. The dryer was supplied compressed air from a dedicated 150 HP air-cooled lubricant-free single-stage screw compressor capable of producing 1050 cfm of continuous 2.5 bar (38 psi) compressed air.

Initial spot check readings were taken on the air compressor which was operating in load/unload mode. The hour meters on the local control showed the compressor had been running 51,500 hours, yet showed the unit was loaded only 9,400 hours of the total. In all, the compressor duty cycle calculated to only 18% over the life of the unit. Power measurements showed the compressor consumed 128kW fully loaded and 84 kW unloaded. A check of the manufacturer's specifications for this unit showed something was wrong, the loaded kW reading was higher than normal and the unloaded kW was much higher than the expected 20 to 30% of full load.

Hour meter readings and kW measurements can be very important indicators of compressed air system efficiency issues. In this case, it would appear that internal compressor problems and a mismatch in compressor capacity may be greatly reducing the overall efficiency of the system. Fully loaded this compressor could produce a flow of 38 psi compressed air at a specific power of 11.2 kW per 100 cfm. The unit was actually consuming power at a rate of 34.5 kW per 100 cfm, even higher than an efficient compressed air system would run at 125 psi. The initial readings showed that about 75% of the compressor's total power was consumed when the unit was unloaded and producing no air.

Data loggers were placed on the system and a load profile was developed (Chart 1). During the data logging the compressor was repaired which immediately reduced the power consumption in both the loaded and unloaded

Fundamentals of Compressed Air Systems WE (web-edition)

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Join Compressed Air Challenge for the next session of ***Fundamentals of Compressed Air Systems WE*** (web-edition) coming in November of 2013. Led by our experienced instructors, this web-based version of the popular *Fundamentals of Compressed Air Systems* training uses an interactive format that enables the instructor to diagram examples, give pop quizzes and answer student questions in real time. Participation is limited to 25 students. Please visit www.compressedairchallenge.org, to access online registration and for more information about the training.

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AUDIT OF LOW PRESSURE DRYER SAVES ENERGY

condition to the manufacturer's rated power levels of 118 kW loaded and 51 kW unloaded. This also eliminated periods of low pressure that were being experienced. It was interesting to note that these low pressures did not affect production activities.

The data logging showed that while the drying system was operating 22 percent of the time the compressor was only loaded 12 percent of the time. Further to this, the compressor ran unloaded the remaining 78% of the time, including during non-production hours on the weekend. These wasted unloaded operating hours not only consumed significant energy, but also accumulated machine maintenance hours, which caused unnecessary expensive maintenance and repair costs.

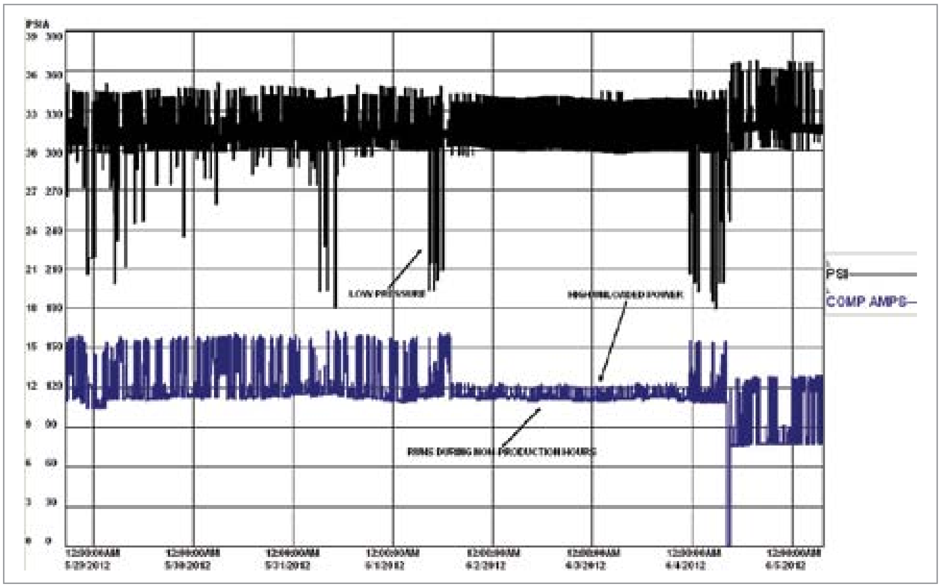

Chart 1: Typical production week profile showing significant time spent unloaded.

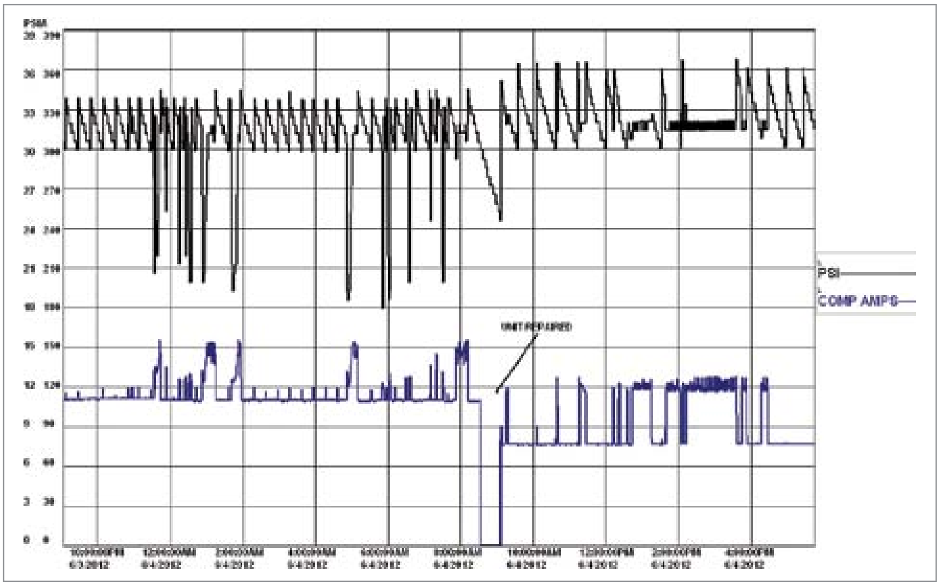

Chart 2: Compressor repairs immediately reduced the loaded and unloaded power consumption and improved the pressure.

The compressor and heaters were consuming just over 1,000,000 kWh per year. The compressor repairs immediately saved about 30% of the compressor consumption or 260,000 kWh per year.

The low compressor duty cycle during actual production, the compressor was only loaded 54% of the time (12/22 hours), showed that the compressor is too large for the current production capacity, in fact the unit had been purchased for two presses, but only one was actually implemented.

The object of the whole drying system is to get heated compressed air to the material to be dried. This is somewhat at odds with the way the compressor is designed. The unit chosen was an air cooled unit that had an after-cooler installed. The purpose of the after cooler in a normal system is to lower the temperature of the compressed air so as not to negatively affect the compressed air user. In this case the compressed air user needed air temperatures higher than that produced by the air compressor. In essence the after cooler was removing heat of compression that could be used to benefit the dryer system rather than using directly powered electric heating elements. This compressor heat was then removed from the compressor and blown directly outdoors, even in winter months when natural gas heating was required in the building.

A number of proposed energy measures were developed that, if implemented, could save additional electrical energy and displace natural gas used for building heating:

- The operating hours of the compressed air system could be reduced by turning the compressor off on weekends and during evening non-production hours. Investigation revealed that the compressor has remote control inputs that

AUDIT OF LOW PRESSURE DRYER SAVES ENERGY

could be used to turn off the compressor when the press is off and low pressure air was not required.

- Heat of compression can be used for both drying and building heat. Main compressor ventilation can be outfitted with automatic dampers that direct the substantial heat of compression indoors in winter months to supplement building heat. The after cooler of the compressor (air cooling only) can be bypassed to keep the heat of compression and supplement the main drying operation, reducing the need for electric heating.

- The system pressure can be lowered for some savings. Investigation revealed that the nozzles required only 22 psi compressed air rather than the 29 psi average pressure. At low pressure the rule of thumb stating 1 % energy reduction for every 2 psi reduction typically used for compressed air energy reduction does not apply. At the current system pressure this 7 psi energy reduction would reduce the compressor loaded power by about 14%.

- Should the compressor need replacing in the future, the customer should consider right sizing the compressor to more closely match the actual flows required by the drying nozzles. Variable speed drive controlled compressors are available that could better match the compressed air requirements, eliminating wasteful unloaded run time, while keeping a constant lower air pressure, reducing the specific power of the system.

The potential savings by addressing these measures are estimated at 61% of the existing compressor operation or 610,000 kWh. Further to this a reduction of dryer heater power of 22% is expected saving about 7,000 addition kWh per year. Heat recovery potential is estimated at 9,700 cubic meters of natural gas.

This study illustrates the value of assessing compressed air systems of every kind for potential savings opportunities. In this case the customer was unaware of the energy this system was wasting and the internal compressor problems that were causing increased power consumption.

CAC Training Available

Projects like this can be yours for the taking; the secret is to apply some knowledge gained from a CAC training seminar and do some measuring. There are pre-qualified instructors available now to help you host your own seminar. More information on CAC's many instructors is at http://www.compressedairchallenge.org/training/instructors/ BP

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> "The potential savings by addressing these measures are estimated at 61% of the existing compressor operation or 610,000 kWh."
>
> — Ron Marshall

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

New Kaeser SFC 37-45S VFD Models

Kaeser Compressors, Inc. announces their new generation of 37 and 45 kW variable frequency drive rotary screw compressors.

With pressures up to 217 psig, these new SFC 37 and 45S models deliver the "built-for-a-lifetime" reliability, simple maintenance, and sustainable energy savings you expect from the Kaeser name. The SFC 37 has a flow range of 54 - 240 cfm at 125 psig, while the SFC 45S has a flow range of 60 - 273 cfm at 125 psig. Both models feature the latest in Siemens drive technology.

Kaeser has further enhanced the SFC series' energy efficiency through a combination of true direct drive design, premium efficiency motors, lower internal pressure differential, and optimized airends. Specific power is improved by up to 6%. In addition, built-in heat recovery options bring the energy savings potential to the next level.

New features include an enhanced cooling design, eco-friendly filter element, integral moisture separator with drain, and an Electronic Thermal Management system. These compressors also come standard with Sigma Control 2. This intelligent controller offers unsurpassed compressor control and monitoring with enhanced communications capabilities for seamless integration into plant control/monitoring systems. SFC models are also available with an integrated dryer for premium compressed air quality.

To learn more about the new SFC 37-45S, visit www.kaesernews.com/SFC37_45S. To be connected to your local representative for additional information, please call 877-586-2691

New Atlas Copco ZH Centrifugal Compressor Range

Delivered as a plug-and-run package, the new Atlas Copco's ZH 355+ — 900+ oil-free centrifugal compressor range employs advanced aerodynamics to reduce energy consumption in the core. Coupled with this, all the components of the package are designed based on *Computational Flow Dynamic (CFD) analysis* to drastically reduce pressure drops in the package. The result is a reduction of specific energy up to 7% at full load compared to the previous model. Inlet guide vanes (IGVs), which are part of Atlas Copco's standard scope of supply, further reduce energy cost by 9% at part loads as compared to a throttle valve control. As energy consumption constitutes about 80% of the life cycle cost of a compressor, users will benefit from day one, reducing the overall total cost of ownership.

Other than energy efficiency, reliability is a very important aspect. To ensure continuous production for the users ZH centrifugal compressors from Atlas Copco employ high-end features to ensure maximum uptime. Milled impellers and servo controlled inlet guide vanes (IGV) are only two examples of the entire list that contributes to a trouble free performance and high lifetimes.

The third aspect is the Class 0 certified quality of air. A fail-safe and unique sealing system prevents the possibility of contamination of the air with oil, without the need of any external buffer air. Oil fumes from the gear box are captured by a motorized demister, thus eliminating the risk of ingestion of oil fumes along with the intake air. This safeguards the end product of the customers against oil contamination.

"The existing range of ZH turbo compressors is already considered a benchmark for energy efficiency and reliability. The introduction of the new range raises the bar even higher" says Chris Lybaert, President of Atlas Copco's Oil-free Air Division. "Atlas Copco is committed to sustainable productivity and it is our ongoing endeavor to bring to market the most energy efficient solutions year after year."

Learn more at www.atlascopco.com

ASCO Introduces High-Pressure Solenoid Valve for CNG Dispensing Applications

ASCO Numatics, the world leader in fluid automation solutions and controls for fuel dispensing applications, has introduced in North America the ASCO 291 Series of high-pressure solenoid valves for compressed natural gas (CNG) dispensing applications.

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

"As CNG becomes a popular fuel in commercial fleets and personal vehicles, the demand for fueling stations is expected to rise dramatically," said Robert W. Kemple, Jr., executive vice president, sales and marketing — Americas, ASCO Numatics. "The Series 291 valve is specifically designed for CNG dispensing equipment in North America. Few valves on the market have the high flow and pressure ratings, plus the low power consumption, that are critical to design engineers at CNG station packagers and dispensing manufacturers."

Solenoid valves play a key role controlling CNG flow in dispensing equipment. The 291 Series' rugged construction and unique internal design are tailored to meet the industry's unique requirements for solenoid valves. It safely withstands pressures of over 5,000 psi, provides superior flow rates, and consumes only 12 watts of power.

"Dispensing equipment manufacturers will benefit from our CNG valve line's small size, great fit, and low power consumption, plus the high quality that only ASCO can provide," said Kemple. "Station packagers will value our high flow rate that permits faster vehicle fueling and exceptional reliability that reduces maintenance and down time."

The 291 Series valves are offered in three pipe sizes — 3/8 inch, 1/2 inch, and 1 inch — plus three-station and six-station manifold versions.

Customers can access Emerson ASCO's worldwide technical and application support through its distributors, field sales representatives, and the company's technical support center via phone and the Web.

The ASCO 291 Series CNG valves can be ordered from ASCO distributors or directly from the company in the U.S., Canada, and Mexico. For more information, contact ASCO at 800-972-ASCO, by e-mail at info-valve@asco.com, or visit http://www.ascovalve.com/CNG

PowerScout 3 Plus Meter Receives BTL Acceptance

DENT Instruments, a global leader in the design and manufacture of power and energy measurement instruments, announces that the PowerScout 3 Plus Power Meter has been certified by independent testing labs to have met or exceeded equipment interoperability guidelines of one of the industry's leading standards agencies, BACnet Testing Laboratory (BTL).

"We recognize that the BTL mark is becoming an increasingly common requirement," says Christopher Dent, President of DENT Instruments. "We are very excited to announce that the PowerScout 3 Plus has passed rigorous BTL testing. Our customers in the building automation market, including system integrators, can be confident that the PowerScout 3 Plus is fully interoperable with third-party BACnet devices."

Ideal for new construction or building recommissioning, the PowerScout 3 Plus instruments are dependable single-point submeters for precise energy measurement. Paired with flexible and easy-to-mount RoCoil CTs or traditional split-core style CTs, the DENT PowerScout provides accurate and cost-effective energy measurement for a wide range of building submetering projects.

DENT Instruments is a leading supplier of an array of precision measurement instrumentation and analytical software in the field of energy management.

www.dentinstruments.com

Festo VTOC Valve Manifold for Semiconductor Industry

Festo said today its high density/small footprint VTOC pilot gas valve manifold delivers the ideal solution for space-limited semiconductor gas box applications. The VTOC valve manifold can be ordered in wide range of configurations from 2 to 24 valve positions, giving OEMs the flexibility to order a manifold best suited to available gas box real estate.

These manifolds are designed for 2 x 3/2 valves, enabling a compact 24 valve position manifold to accommodate up to 48 solenoid coils. Valve airflow is 10 normal liters (Nl)/minute. An online configuration tool helps OEMs quickly select the best option for the gas box application. All units are tested and ready to install on delivery.

VTOC options include: configurable manifold rails (pneumatic and electric connections), multi-pin plug connection with sub-D plug

TECHNOLOGY PICKS

or flat ribbon cable, valve with non-detenting manual override, and choices of pneumatic outlets — push-in connectors, straight, or angled. Also optional are individual contacts for each coil — separate commons — and diodes to ensure the current is in only one direction. This can be used to increase safety in user circuits.

"The VTOC was designed for the OEM looking for a valve manifold with the highest density and smallest footprint possible," said Frank Latino, product manager, valve terminals and electronics, Festo. "The VTOC does that and more through ease of ordering, wide choice of options, and ready to install tested units. It is an excellent example of the type of innovations Festo is delivering to the semiconductor industry."

Read about the VTOC and see the online configurator. For additional sales information, call Festo at 800-993-3786 and visit www.festo.com/us

Klüber Lubrication Promotes Food Industry Products

Klüber Lubrication, a worldwide manufacturer of specialty lubricants, will display its latest NSF H1-registered lubricants for the packaging and processing industry at PACK EXPO, Sept. 23-25 at the Las Vegas Convention Center. Klüber will exhibit at booth S7046 and have representatives available to discuss the company's products, services and expertise with PACK EXPO attendees. Products from Klüber provide efficient solutions for increasing productivity in extreme applications, such as ovens, freezers and high friction points in conveyors, proofers and palletizers. Klüber will showcase the following products and services at PACK EXPO:

The ALLPLEX FMG Series of greases are multi-purpose, NSF H1 registered products for the food processing, beverage and pharmaceutical industries. ALLPLEX is specifically designed for use in applications where incidental food contact is possible. The special additive package provides for excellent anti-wear and extreme pressure protection from corrosion. Equipment in wash-down environments benefits from the aluminum complex thickener system, which provides excellent water resistance in addition to a broad temperature range. ALLPLEX is available in multiple standard packaging options from drums to cartridges, and can be used as a single point lubricator. Klüber has also included ALLPLEX with its innovative Klübermatic system, a single point lubricator option that improves process efficiencies, as well as safety in the workplace.

Klüberfood NH1 CH 2-220 is the premier oil for lubricating high-temperature chains in both baking and beverage can manufacturing applications. This fully synthetic, ester-based lubricant can operate at extreme temperatures for longer periods of time and without residue build-up, all while protecting chain components from increased wear. Users benefit from dramatically reduced consumption, cleaner operations, reduced noise and no smoking when applying oil. The can manufacturing environment presents significant challenges for proper lubrication of chains, including high temperatures, high and low speeds, potential ingredient contamination, increasing wear and more. Klüberfood NH1 CH 2-220 is an NSF H1-registered lubricant that not only keeps food safe from incidental contact, but solves each of the aforementioned challenges as well.

Spraying Systems

Klüber Lubrication, in collaboration with Spraying Systems Co., tested and qualified a solution for pin-chain applications for beverage can manufacturing. The combination of the AccuJet® Electrostatic Lube System with Klüberfood NH1 CH 2-220 provides complete and optimum lubrication of DECO oven pin-chains. As a result, users reduce oil consumption, increase chain life and, due to the elimination of oil mist, create a safer work environment for operators while decreasing chances of contamination.

Klüberfood NK1 Z 8-001 Spray is a cleaner and de-greasing spray for the food-processing and pharmaceutical industries. This spray has been formulated to aid in the rapid and thorough removal of oils, greases, waxes and resin residues. Klüberfood NK1 Z 8-001 Spray is an organic solvent cleaning agent that is registered NSF K1 and K3, which helps promote safety in non-food processing areas.

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Michell Instruments Oxygen Analyzer

Michell Instruments has extended its range of oxygen analyzers with the introduction of the compact and cost-effective XZR200, which offers a great blend of price and performance. It is capable of measuring percent oxygen content to better than 1% of span. The XZR200 is easy to install and integrate into existing systems as no special software is required. Its RS232 output can be directly accessed by a PC.

The analyzer offers four configuration options with two choices of probe length and two temperature ranges. The lower temperature range of up to +250°C is suitable for relatively low-temperature applications such as food and beverage packaging, while the higher temperature range of up to +400°C serves combustion control and metal treating applications.

Depending on the application, the XZR200 may also be configured to measure in either 0-25% or 0-100% oxygen concentrations. The first configuration gives the highest accuracy of 0.5% O2 in the combustion process range. In the 0-100% range the accuracy is 1% O2.

A key feature of the XZR200 is a 3.3 V DC logic output which is used to monitor the sensor for diagnostic purposes. It's a way of listening to the sensor's 'heartbeat' and enables the operator to check on the health of the sensor, providing a warning when if there is a fault with the sensor. The lifespan of the zirconium dioxide sensor is between 1 and 7 years, depending on the temperature and type of gas measured.

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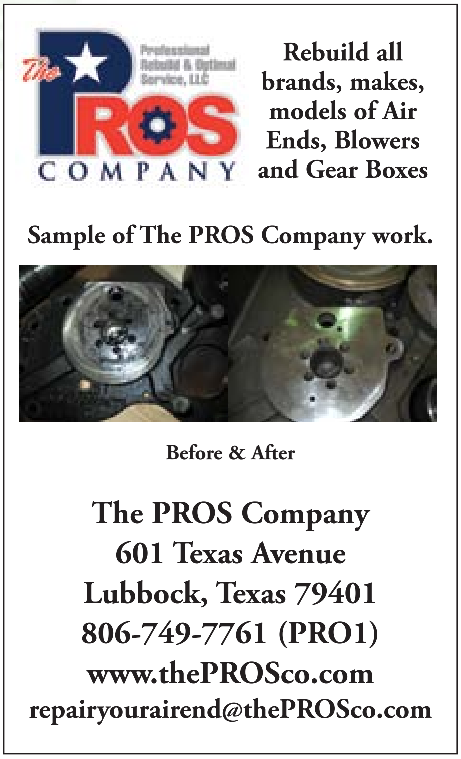

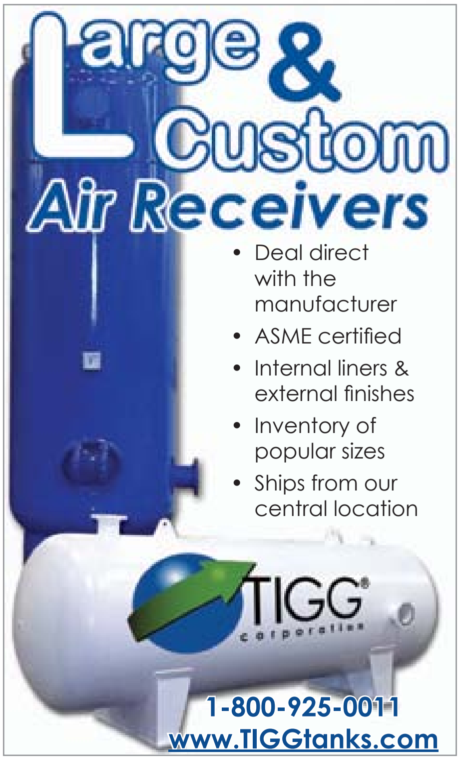

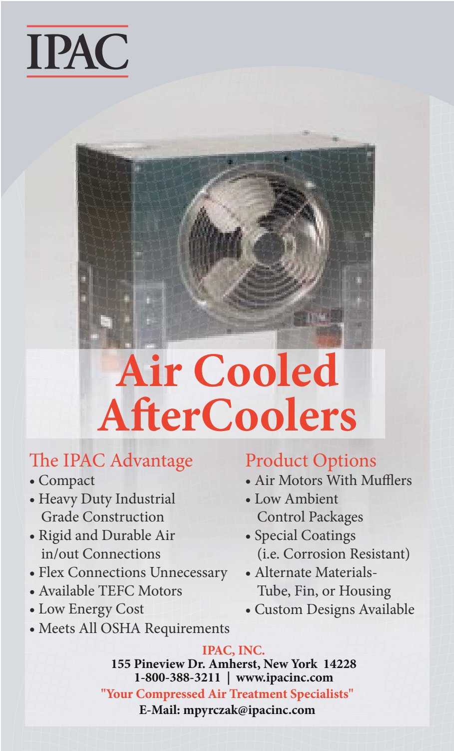

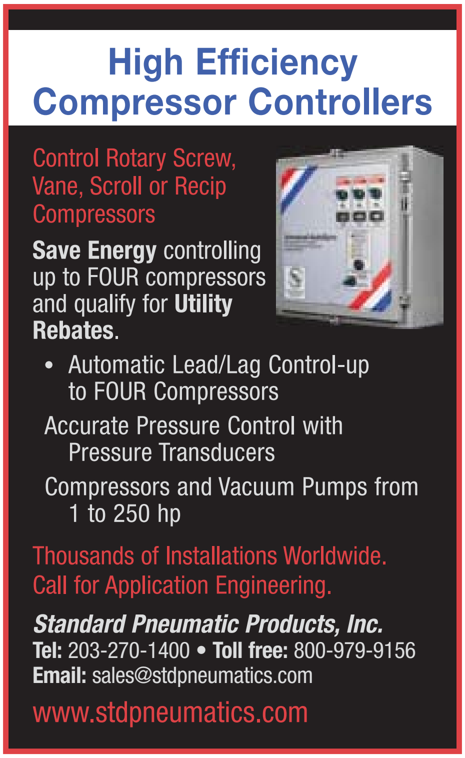

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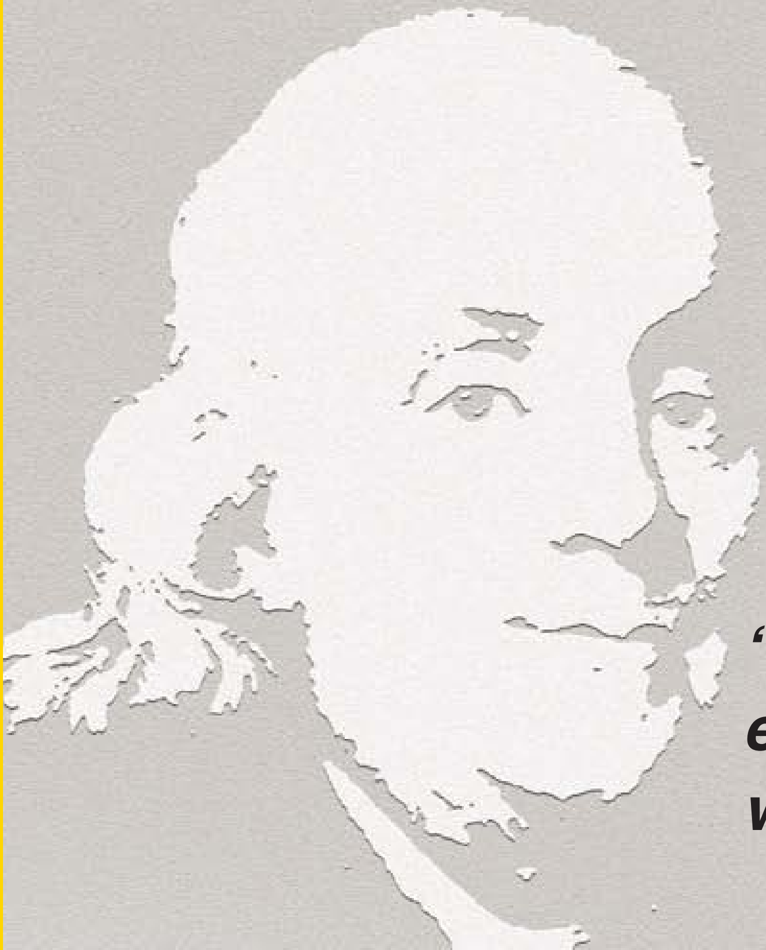

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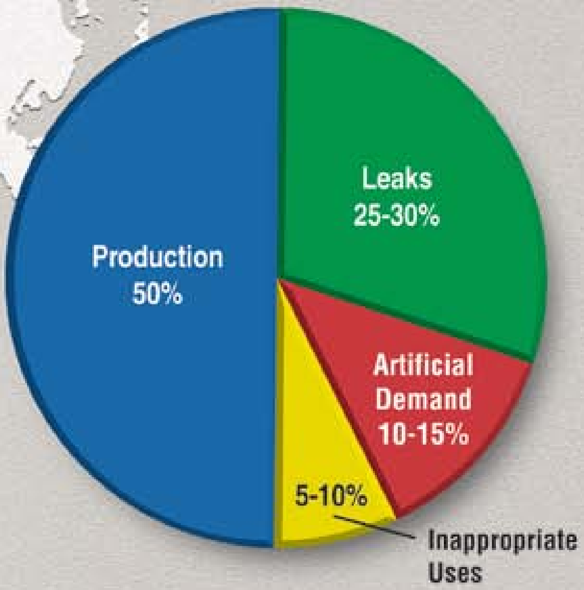

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