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

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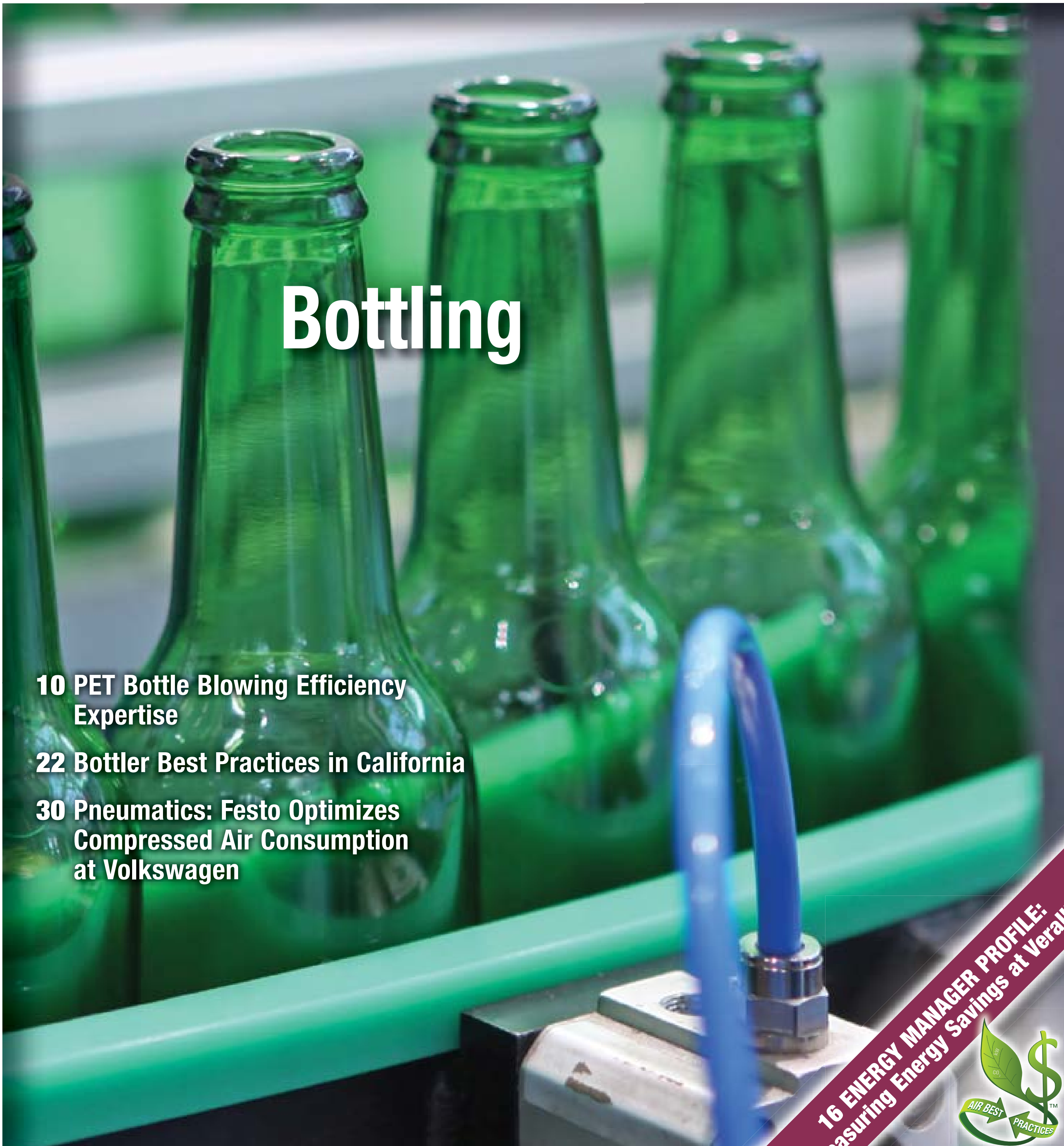
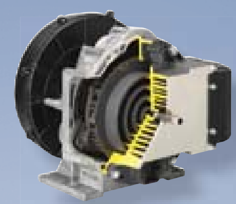
January/February 2012



Bottling

Hitachi SRL Series Oil-Free Air Compressors

Innovation • 100% Oil-Less Design • Superior Sound Quality



SRL Series Simplex
(Single Motor/Single Scroll Configuration)

SRL Series Features

- Patented Labyrinth Lap for extended life and reliability
- World's Largest Unitary Scroll (7.5HP)
- Microprocessor standard with Control Cycle Logic for compressor longevity
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- Highest Air Purity
- Environmentally Friendly
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(Multiple Motor/Multiple Scroll Configuration)

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Hitachi's history of success and proven experience in scroll technologies has enabled Worldwide Innovation of producing the World's First Scroll for air compression. With over 20+ years experience in scroll compression, the SRL Series of Oil Free Compressors represents our alignment of value for the discriminating air user.

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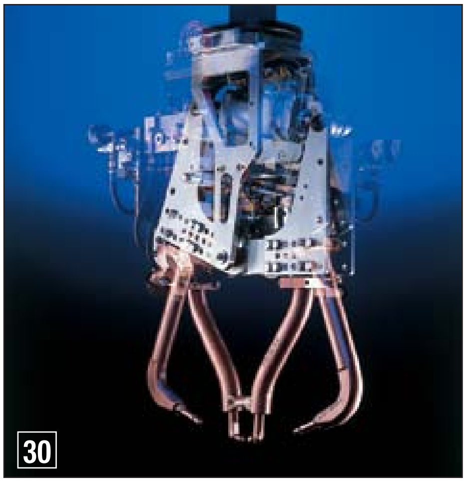
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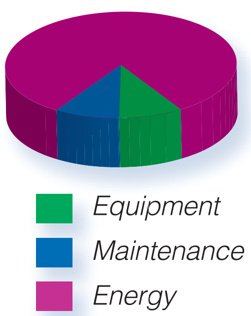
Sullair Compressors with EES Yield Quantum Cold Weather Savings

Did you know . . .

Today's energy costs represent 82% of the expense of compressor ownership.



Save on Energy Costs

The Sullair compressors with Energy Efficiency System (EES) heat recovery were developed to produce the most cost-effective compressed air solution in the marketplace. The Sullair EES recovers the heat of compression and re-circulates it for comfort heating in plants for cold weather operations during winter months, or provides pre-heated air for boilers or processes. When not in use, the thermostatic controls exhausts heated air to the outside. This 100 hp compressor generates 1,649,000 BTUs per year. Annual energy savings from the EES alone may reach $10,993.00*, with a payback period of 7 months as a result of the energy savings.

Additional energy savings may be achieved by combining the EES with Variable Capacity Control** and Variable Speed Drive**, which provide flexibility to vary both capacity and pressure to match system demand, and result in maximum effectiveness in reducing total life cycle costs. Part load capacity and efficiency benefits can produce additional energy savings up to 17 percent.

** Calculations are based on climate conditions for Chicago, IL and natural gas at $0.50/therm (subject to market fluctuations).*

*** Not available on all configurations.*

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FROM THE EDITOR

A New Year Means a New, Positive Chapter

Happy New Year 2012 to everybody! Each New Year brings, all of us, the opportunity to write a new, **positive,** chapter in our personal and professional lives. I'd like to take this reflective moment to thank you, our readers, for your support and encouragement over the past six years since we started the publication in 2006. You have made it possible for us to realize our goal to publish **positive news** about the "Best Practice" work realized by industry to improve energy efficiency in a profitable manner.

An example of an exciting new chapter for us, we are pleased to announce the formation of an Editorial Board for Compressed Air Best Practices® Magazine. Our Board Members (listed on this page) are Energy Managers from a diverse group of end user industries. These individuals have the responsibility to improve the energy efficiencies of their operations. Board members are also executives working for a diverse group of "Technology Providers" – companies that provide the products and knowledge to implement projects that will improve energy efficiency. The Board's guidance will center on helping us achieve our main mission – that is to help create awareness of profitable, energy-efficiency projects related to compressed air, pneumatics, blower, and vacuum systems.

An Editorial Board Member, Brad Runda from Saint Gobain, helped us create a valuable article you can read in this month's edition. Brad's group manages energy consumption across 140 factories in North America and realized energy-use reductions (over a two year period) equal to the amount of energy required for them to produce 1.1 billion glass containers! Brad introduced me to Gregory Rhames, a site Energy Manager for Verallia – a division of Saint Gobain. In this article, Greg shares his acquired expertise on **flow measurement and pneumatics** on OEM production equipment – expertise that has led to significant increases in energy efficiencies and the establishment of "Best Practices" flow rates for individual pieces of production equipment.

We are also pleased to announce the continuation, in 2012, of our 5+ year collaboration agreement with the **Association of Energy Engineers** and a new agreement in place with the **Association of Facilities Engineers.** It is an honor to work with both of these prestigious engineering associations as we mutually support one another's goals to attract more members and subscribers.

Our goal is to focus on the positive work being done every day by people, like you, who get their hands dirty and get the job done with profitable energy efficiency projects. That is why we focus on publishing the case studies supplied by our readers. Thank you for being a part of this effort and we wish you the best in 2012.

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

Atlas Copco announced the acquisition of Houston Service Industries. HSI had revenues in the last 12 months of $37 million and 123 employees. The company is a leading manufacturer of multistage centrifugal blowers, a traditional low pressure technology. It has recently introduced high-speed drive turbo blowers, which is an innovative and energy-efficient technology.

"This acquisition fits very well with our ambition to develop a globally leading position in the market for low pressure equipment, extending our offering to blowers of nearly all sizes," says Stephan Kuhn, Business Area President, Atlas Copco Compressor Technique. "We see especially good growth opportunities in wastewater treatment, where there is great demand for more energy efficient products."

Houston Service Industries will be part of the Oil-free Air division within the Compressor Technique business area. The company will continue operating under the HSI brand. www.hsiblowers.com

Parker announced that the Purification, Dehydration and Filtration Division (PDF) will change its name to Finite Airtek Filtration (FAF) Division. With global customers using its various compressed air and gas treatment products, the division is changing its name to better reflect the breadth of its portfolio.

"Today's name change to Finite Airtek Filtration Division marks a significant milestone for our division. The PDF name no longer adequately represented our business, our products and solutions, or expertise and our position as the leader in compressed air and gas treatment solutions," explained Denis Williams, General Manager. "The Finite Airtek Filtration name embodies our ability and our commitment to continue to provide innovative solutions and premier customer service to our customers."

Williams added, "We remain firm in our commitment to the Airtek, domnick hunter, Finite and Zander brands along with their respective distributor organizations. The new name ensures that our image and name accurately reflects what we do and we will continue to serve the market's needs for industry leading compressed air and gas treatment products utilizing the distinct distribution channels that have contributed to the divisions success." www.parker.com/faf

SPX Corporation and Shanghai Electric announced the formation of a new strategic joint venture to supply industry-leading products to the power sector in China and select global opportunities. The joint venture agreement is between Shanghai Electric Group and an SPX subsidiary in China.

With 2010 revenue of $9.5 billion, Shanghai Electric is one of China's leading diversified heavy equipment manufacturing groups, providing power equipment, electromechanical equipment, heavy machinery, transportation equipment and environmental systems. The company has more than 28,000 employees.

Under the terms of the agreement, the joint venture will be called Shanghai Electric-SPX Engineering & Technologies Co., Ltd. and will be headquartered in Shanghai, China with a branch office in Beijing. Shanghai Electric will own a majority 55 percent of the joint venture and an SPX company the remaining 45 percent. A jointly appointed management team will run the joint venture. www.spx.com

Gardner Denver reported that on December 15, 2011 it completed the previously announced acquisition of Robuschi S.p.A. ("Robuschi") for approximately EUR 152 million ($200 million). Based in Parma, Italy, Robuschi is a market leading manufacturer of blowers and pumps with annual revenues of approximately EUR 70 million ($92 million). www.gardnerdenver.com

Chicago Pneumatic Compressors and Pneumatech jointly announced the appointment of Ellen Steck as President of both organizations. Steck will be based out of Chicago Pneumatic's Rock Hill, S.C. office, and will be responsible for delivering both organizations' renowned customer service and product offerings across the North American compressor and quality air markets. Chicago Pneumatic Compressors produces

Ellen Steck

a comprehensive range of compressed air solutions including the RCP piston and QRS rotary screw compressors, air drying solutions and quality air accessories. Pneumatech is an established and innovative manufacturer in the compressed air system engineering market with unparalleled custom-design capabilities. Both companies have production facilities located within the continental United States.

Steck joins the Chicago Pneumatic and Pneumatech teams after more than a decade in other leadership roles with parent company Atlas Copco. Steck previously served as the Vice President, Communication & Branding – Compressor Technique for the Atlas Copco Group out of its Antwerp, Belgium office, where she was responsible for driving customer loyalty in over 60 countries and creating communication structures across 23 brands in more than 170 markets. Prior to that, Steck served as the Vice-President of Marketing for Prime and RSC Equipment Rental, then wholly-owned subsidiaries of the Atlas Copco Group. At RSC, Steck led the marketing and eBusiness efforts for the more than 400 location $1.5B USD commercial equipment rental company. www.cp.com

Chicago Pneumatic

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PET BOTTLE BLOWING Efficiency Expertise

An Interview with Dean Smith

BY COMPRESSED AIR BEST PRACTICES® MAGAZINE

Compressed Air Best Practices® interviewed Dean Smith of iZ Systems. Mr. Smith has over 20 years experience as a compressed air energy efficiency and productivity consultant to the PET bottle blowing industry.

Good morning Dean. With stretch blow molders using PET, what are the typical energy costs associated with compressed air?

Good morning. The PET industry is in a state of flux right now. A number of new bottle blowing facilities are being brought on-line. They are in the "discovery" phase right now as they realize how challenging the required compressed air systems are to manage — from an energy efficiency standpoint. The average high-volume stretch blow molder (SBM) working with PET usually has 2,000 to 4,000 horsepower of installed air compressors with the related energy costs running between $1 to $4 million per year. This typically represents 35-40% of the facilities' total energy bill.

What are the challenges to compressed air energy efficiency?

Rotary reheat stretch blow molding (RSBM) machines, from all the leading manufacturers like KRONES and SIDEL, provide challenges to the efficiency of compressed air systems. These challenges include:

- Significant pressure drops in the RSBM machine
- Large instantaneous air demand swings (2000-3000 scfm)
- Very large horsepower sizes for individual compressors (400-1200 HP)
- High historical pressure requirements (600+psig)
- Multiple pressure requirements in one facility

Our experience is that 15% energy savings are possible on the supply side with another 15% achievable by focusing in on the pressure drops within the blow molding machinery.

Please describe the pressure drops in the blow molding machines.

Stabilizing air pressure is our primary objective. We find that pressure is fluctuating 50-60 psi in most stretch machines and is significantly lower than expected. Correcting this can lead to increases in productivity and reduced air consumption.

We first recommend that blow molders understand the air pressure requirements of their blow molding machines. For example, the blow process consumes as much as 60% of the air. The remaining pneumatic applications, using 40% of the air for control components and packaging or decorating, will typically lower pressures. We recommend that the blow molder install a dedicated piping system to the blow air circuits.

PET BOTTLE BLOWING EFFICIENCY EXPERTISE

An Interview with Dean Smith

> "There is a real need for an air compressor manufacturer to optimize a 425 psi machine for CSD applications."
>
> — Dean Smith

The second step is to modify the pneumatic circuits on the blow molding machinery which is typically sized, by the manufacturer, based on average air demand rather than peak air demand. The pneumatic circuit on the molding machines consists of solenoids, regulators, and tubing which when undersized, creates pressure drops during the blow cycle. The pressure drop is really a lag in the flow of compressed air, which slows inflation and subsequent cooling of the container. Pressure drops in these pneumatic circuits can be as high as 50 to 75 psig! If sized appropriately to match the peak air demand by examining the Cv (critical velocity) of the components, we can minimize the pressure drop, increase productivity and reduce plant air pressure — which also saves energy.

The key component, in the pneumatic circuit, is the regulator. A carefully selected pressure flow control valve will always stay partially open and simply modify flow and pressure as demanded. This creates the pressure required to maximize efficiency. Regulators are designed for continuous flow and simply cannot keep up with the rapidly changing, pulsing demand requirements of RSBM.

We recently went through this process at one of the nations' largest blow molding facilities. The blow molding machines were actually able to increase output, at the lower pressure, because the pressure inside the mold was stabilized.

How do you manage multiple pressures in one plant?

There is no one "right answer" to this question. Each facility has to be evaluated individually. You can have two to four pressures in one plant. The way PET is going, virtually all RSBM can actually run below 500 psi (34 bar) in he air header in the blow. In fact, the carbonated soft drink (CSD)

Pressure drops in the pneumatic circuits of blow molding machines can be as high as 50 to 75 psig. Some manufacturers, like Sidel, design circuits to effectively manage this issue.

containers (cold fill) are now running below 400 psi (27 bar) and represent a very large portion of the industry's air demand. Meanwhile, the pre-forms need pressures from 150 to 250 psi but can also run at significantly lower pressures if modified.

Ideally, for every pressure you need to run, you'd generate compressed air at that pressure. An air compressor designed to run at 600 psi is not as efficient as another one designed to manufacture air at 300 psi. After ten years of pretty dramatic changes in pressure requirements, there's a real need for an air compressor manufacturer to optimize a 425 psi machine for CSD applications. Today, the industry is forced to use a 600 psi design machine that is then regulated down.

In theory, you'd have optimally designed equipment and distribution for each pressure in the system. The pitfalls are the increased capital requirements on the supply side and the second limiting factor is you would end up with a lot of piping for the different machines. In the real world, we have to take the compressors we have and work with them to optimize the system's efficiency.

What are your thoughts on supply-side equipment?

Compressor and dryer selection is the first step in the efficiency challenge but the proper application of systemic principals is more important in than in most compressed air systems because of the unique requirements of PET listed above. The basic offerings are:

- Large reciprocating compressors
- Large centrifugal compressors with unique control requirements
- New VSD offerings which have to be applied appropriately to gain the value of the VSD
- Drying technology

PET BOTTLE BLOWING EFFICIENCY EXPERTISE

An Interview with Dean Smith

While the full load efficiencies of these compressor technologies are similar, it is not reasonable to think that any single technology is appropriate for all high-pressure air systems considering how different the compressors are and how widely varying the system's needs will be. For example, the proper application of the new high-pressure VSD offerings is different depending upon the size of the facility. A smaller facility can operate well with the low-pressure compressor supplying the high pressure booster directly — but in a larger facility the need for a common low pressure system supporting the plant needs as well as the booster requirements becomes critical to maximum efficiency. Improperly applying this in one major facility, which we worked on, was wasting more than $300,000 per year in energy.

High-pressure centrifugal compressor offerings can be utilized to lower long-term system operating costs — but only if properly sized and managed based on the system's need for turndown relative to its normal variations in sustained production loads. Using automation to coordinate the use of the high-pressure centrifugals, we have been able to extend maintenance intervals and lower those costs by more than 30% in some facilities.

Reciprocating compressors can provide excellent trim capability due to their ability to start and generate air quickly - but only if the compressors are properly sized for the instantaneous variation in air demand. Otherwise, you will end up with multiple compressors running with very high unloaded hours and wasted energy. A system we are currently working on is running more than 40% unloaded time on a set of five reciprocating compressors - obviously wasting a lot of energy AND increasing maintenance costs by that amount.

What is the most often over-looked compressed air system component?

The systemic principles which are most overlooked that sacrifice efficiency are automation and controls, storage, and monitoring pressure drop especially at the blow machines. Additionally, in larger facilities, we recommend significant data acquisition to monitor compressor and system performance because the annual energy costs for a typical individual high-pressure compressor will exceed $250,000 — so it is critical to know when that machine is not performing to its full capability.

In all larger, multiple compressor air systems, coordinating the operation of the compressors relative to the variations in air demand requires some form of automation to maintain a reasonable level of efficiency. This is particularly the case, in PET systems, because of the variations in compressor technology and the variations in air demand so typical in these systems. Maximizing the value of these controls requires a proper system design including storage, storage pressure differential, and pressure flow control valves. Normally, we start with an audit so that we can record and fully appreciate the needs of the individual system. There are a lot of common principles applicable in this industry — but in order to minimize the capital costs of modifications and/or upgrades to the system, an audit can be very helpful. For example, at these elevated pressures, unnecessarily over-sizing the air headers or a single storage tank pays for an audit many times over.

When it comes to high-pressure storage, the general principles we outlined in the original Compressed Air Challenge® technical materials can be applied, but the elevated costs of the tanks due to pressure ratings makes it important to size these vessels with as much care as possible. Our approach is to maximize the storage differential with the minimal amount of compressor power possible. This allows us to minimize the tank size (and capital requirements) and yet still achieve the required total stored air to support air demand swings and properly manage air compressor cycling. BP

Thank you for your insights.

For more information please contact Dean Smith at iZ Systems at tel: 678-355-1192, email: dsmith@izsystems.com

To read more ***Plastics Industry*** articles,
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THE ENERGY MANAGER

Measuring Energy Savings at Verallia

BY ROD SMITH, COMPRESSED AIR BEST PRACTICES® MAGAZINE

Compressed Air Best Practices® interviewed Gregory Rhames, Asset Reliability Manager/Energy Manager at Verallia.

Good afternoon. Please describe Verallia's operations here in Madera, California.

Good afternoon. As background, Verallia is the packaging division of Saint-Gobain. Verallia employs 15,500 people globally and makes about 25 billion glass bottles and jars each year. We employ 350 people at Madera where we produce about 1 million wine, champagne and sake bottles per day. Our company is dedicated to energy efficiency and maintaining a sustainable global habitat. We are very proud to say that we are the only glass container company to win the EPA ENERGY STAR® Partner of the Year and Sustained Excellence awards. Verallia is also the only glass container company to have ENERGY STAR® rated plants.

We characterize our plant as having two distinct parts, a "hot end" and a "cold end". In what we call the "hot end" of the plant, we have furnaces that melt the raw materials and recycled glass. The glass is manufactured into containers with bottle making machines that use high volumes of compressed air at roughly 50 psi. Molten glass is shaped into bottles using molds to capture the shape while being blown by compressed air. Once the bottles are formed, they are annealed in temperature-controlled kilns.

In the "cold end" of the plant, we finish the production process with machinery that separates, inspects, conveys and packages the bottles into cases and then sends them out to be palletized. Much of the equipment in the "cold end" of the plant utilizes 90 psi compressed air to run all the cylinders, actuators, and blow-off functions of these machines.

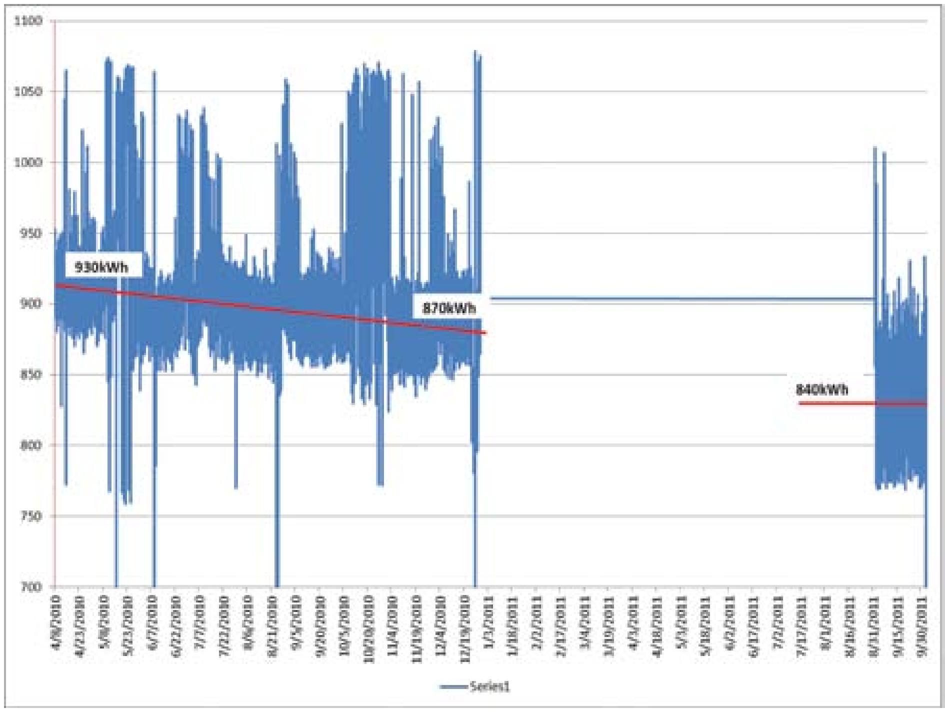
How is energy managed in the Madera plant? What was the energy spend and how is it split up?

Energy is a significant part of our production costs. It's a pretty equal split between natural gas and electricity.

I am the site Energy Manager and am directly responsible for all non-furnace energy consumption with input on trying to reduce the energy consumption of the furnace. I'm also the Asset Reliability Manager (ARM) at the plant. The primary aspect of this function is that I'm in charge of the Preventative Maintenance Program. The ARM function dovetails well with my energy objectives. Energy and ARM lead to process improvements. It's about a 50/50 split of my time. I report to our plant engineer, have exceptional support from my plant manager (critical to success), and am closely linked to the Saint-Gobain energy management team. This team has provided us with invaluable support and resources to discover and implement energy efficiency projects. Many excellent compressed air efficiency resources and ideas have come from this team.

Some of my initial projects included the use of VFD's to reduce the kW used on some cooling tower pumps and fans. We also did some lighting projects where I replaced high energy-intensity lighting fixtures with low energy-intensity fixtures.

However, compressed air is a big opportunity and is one of my primary focuses. Having made several comparisons of similar systems within the company, I decided to concentrate my attention on the end uses (demand side) in the system.



THE ENERGY MANAGER

Measuring Energy Savings at Verallia

What have the financial results of your compressed air efficiency efforts been?

When doing demand-side projects, it's critical to measure the supply-side of your system to ensure that the air compressors are actually consuming less energy. An independent engineering firm is contracted by Pacific Gas and Electric Co. to verify the energy savings, by performing data-logging on our air compressors, and to ensure that we "maintain the gain". In April 2010, our air compressor power demand for the 90 psi system averaged 930 kW. By implementing good practices, by the end of 2010, our average demand was 870 kW and by October of 2011 we averaged 840 kW. When multiplying our energy savings by our electricity rate, we've seen an annual savings in the neighborhood of $100,000.00 resulting from the 90 psi system reductions. We have fairly new air compressors and a supply-side compressed air system able to capitalize on our demand reductions. Part of the air leak projects, called retrocommisioning, relies on the collection of data achieved from the air waste reduction efforts. These records establish the initial baseline of each piece of equipment, and the final established best case cfm after repairs and upgrades. This new lower baseline then becomes the monitored acceptable equipment cfm level. The independent engineering firm uses this data to quantify the incentive amount from our local utility. Our current utility RCX program incentives pay for a portion of the material and labor to do these projects.

Compressed air flow meters are used on each case erector and flow is displayed and data-logged at a centralized location.

So you started with setting up a compressed air flow measurement system?

Correct. I like to say, "Measure What You Treasure". Our first step was to set up a measurement system designed to tell me whether or not we were doing anything "useful" **— at each end use machine.** When researching metering options, we found that CDI Meters provided a good flow measurement product that was economically suitable for my purposes. It was simple to install so it provided quick and accurate flow measurements from the digital readout. It is what I was looking for to achieve my goal of measuring how much compressed air flow each machine used.

We placed our first flow meter on a case erector which is a high demand air user in the "cold end" of the facility. The newly installed meter indicated that the machine was using 80 cfm — when it was at idle! This immediately told us that this machine represented a significant air leak reduction opportunity. Each time we fixed a leak, the flow meter would confirm a reduction in idle compressed air cfm consumption.

This flow measurement system worked so well that we created a single measurement and data collection point for all the case erector machines. Power and data leads from each flow meter come back to the box-mounted digital displays. We put a portable data logger inside the box to record the data at preset intervals. The measurement instruments and data loggers proved to be a great combination.

How did you identify the compressed air leaks on the case erector?

The "hot end" of the plant primarily uses low-pressure compressed air and consumes the largest portion of the compressed air we produce. Because of the large demand, it seemed like the logical place to start, but it is a hot and noisy environment making it difficult to find air leaks. Our maintenance staff did find

BEFORE: Two 2-position valves consumed 80 cfm when the case packer was idle.

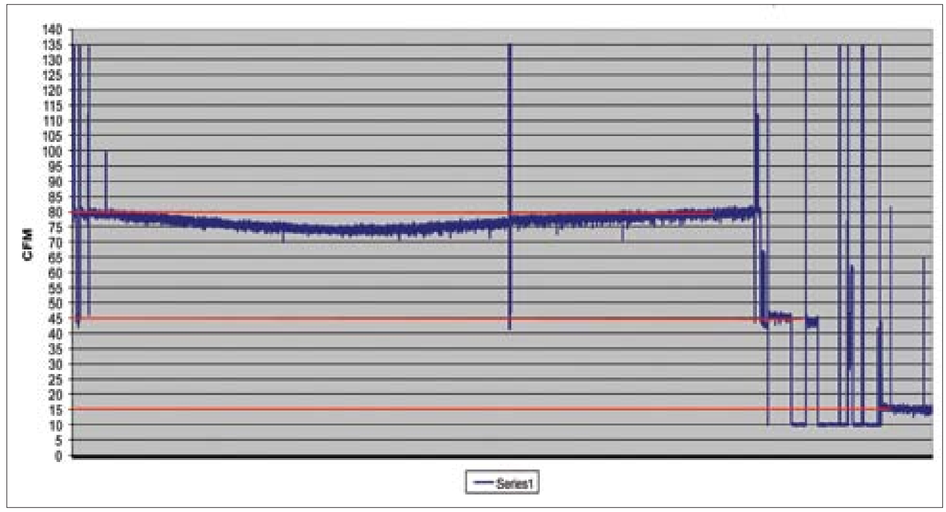
AFTER: The new 3-position Numatics valves reduced consumption to 15 cfm.

a couple of large leaks that they fixed, but we decided to concentrate on the high pressure system in the cold end where the environment was more suitable for developing our system for measuring and evaluating improvements.

We focused our efforts in the "cold end" of the facility and on the case erectors. We knew that we had eight (8) case erector machines consuming 80 cfm when idle. After installing cfm meters, we immediately repaired the air leaks we could hear on the machine. Most were located on pneumatic components inside the machine. This included changing out fittings, leaky regulators, and valves inside the machine. We also used an ultrasonic leak detector to find and fix smaller and harder-to-hear leaks on the pneumatic circuits.

Our lead man in the box shop identified two valves porting vacuum or high-pressure (90 psi) air to the vacuum cups on each case erector. These aren't leaks per-se, but waste designed into the equipment by the vendor. The vacuum cups are used to grab a case to form it or to release the case and move it on to the next station. The two-position valves were wide open, most of the time, and blowing off compressed air continuously through a ¼ inch port when not in the vacuum position. The only time the valve was in the vacuum position was when the cup was going to pull an unfolded case out of the magazine.

We identified a 3-position Numatics valve with a closed center. The valve shifts to the high-pressure 90 psi compressed air for ½ second to release the case and then goes to the center closed position. When we replaced the first valve, idle air flow dropped to 45 cfm. We then replaced the second valve and idle cfm dropped to 15 cfm. Using the 3-position valve reduced our idle cfm from 80 to 15 cfm. The energy cost reduction from one machine



exceeded the cost for the equipment to outfit all 8 case erectors identically.

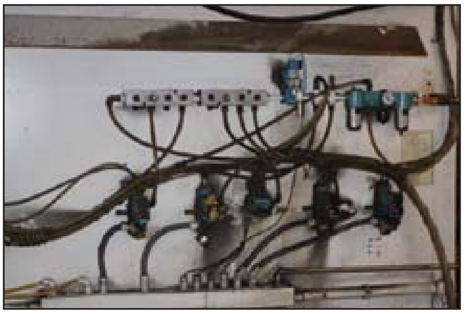
We then replicated this success on the seven other case erector machines. A key point here is that without the use of the flow meters, we wouldn't have had the information to manage or understand the relative impact we could have on the flow used by the case erectors.

THE ENERGY MANAGER

Measuring Energy Savings at Verallia

What are the keys to a successful leak management program?

The keys are having the ability to measure whatever you are attempting to control, a strong pneumatics partner, and program ownership in the hands of plant maintenance. I have spent more than twenty (20) years in maintenance. We like to say that until you are at the four foot level, nothing gets done. You have to touch it, feel it, and do it. That is where and when you really find the big energy wasters.



BEFORE: Pneumatic circuit on the load center machine consuming 75 cfm at idle.

AFTER: Pneumatic circuit on the load center machine consuming the "Best Practice" 23 cfm at idle.

We use the flow meters to establish and maintain the "Best Practice" flow for each machine. A good example is provided by machines used in our palletizing process. We set one up with a flow meter and found it used 75 cfm of 90 psi compressed air at idle. We then got to work optimizing the machine. Industrial Automation Group assisted with the integration of the new valve assemblies. We made a conscious decision to convert to Numatics equipment to reduce maintenance. They have no O-rings and are a matched set with an air seal that is a precision fit. Further, we like the fact that their duty cycle is in the millions (not thousands).

Changing the first valve assembly reduced our idle air flow consumption by 33 cfm from 75 to 42 cfm. A few days later we changed the second valve assembly and reduced it further to 23 cfm — which became our "Best Practice" flow rating for the palletizing equipment.

Just as important, our load center operators saw that the machine worked better with the new pneumatic circuits and began monitoring the flow rating on the machine. At one point after the meters and valve assemblies were installed, they reported observing a gradual rise in the flow readings on one of the flow meters. During our data logger rounds we confirmed that flow had increased to 36 cfm. We simply called our maintenance mechanic to see what was happening. It took forty minutes but he found a cylinder that was blowing out compressed air in a hard-to-see location inside the cabinetry of the machine. He replaced the cylinder and the flow returned to 23 cfm. In the past, we probably could have operated for a long time completely unaware of this air leak. This explains why metering is so critical.

What are your next steps and goals?

We are continuing to measure flow baselines for any new machine and all our existing machines. When we get a new machine, we install meters, find leaks, and perform repairs on the pneumatics. We then establish the "Best Practice" flow baseline. We are working on a plant-wide monitoring system to automate the collection and management of data.

We are also working to improve our specifications and standards for new equipment. Equipment should arrive optimized for energy efficiency and with an air, gas, or water meter on it. Electrical panels should arrive with CT's and meters pre-wired in so we can hook up a communication cable enabling us to look at voltage, amperage, kWh and phase balancing. Every plant needs to lower their energy costs and our equipment suppliers need to be involved with that. BP

Thank you for your insights.

For more information, contact Rod Smith at Compressed Air Best Practices®, email: rod@airbestpractices.com

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"Using the 3-position Numatics valve reduced our idle cfm from 80 to 15 cfm. This 65 cfm reduction equates to a $7,800 annual reduction in compressed air energy production cost."

— Gregory Rhames, Asset Reliability Manager/Energy Manager at Verallia

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THE SYSTEM ASSESSMENT

Bottler Best Practices: A Proven 3-Step Assessment Process

BY CREG FENWICK AND KYLE HARRIS, ACCURATE AIR ENGINEERING

Bottling companies and breweries, in California, are benefiting from a three-step system assessment process aimed at reducing the electrical consumption of their compressed air systems. The three-step process reduces compressed air demand in bottling lines by focusing on open blowing and idle equipment, and then improves the specific power (reducing the energy consumption) of the air compressors.

Step #1 – Replace Compressed Air in Open-Blowing Applications

The Situation

Bottling companies require 2-3 PSI "open-blowing air" for many applications including, but not limited to, **bottle drying for sleeve, paper or pressure sensitive labeling, crown and safety seal drying, warmer and pasteurizer discharge blow-off, combiner gap prevention, ionized air rinsing, drying prior to ink jet coding and shrink or cardboard packing of: cans, jars, PET and glass bottles, kegs & barrels, crates & pallets, boxed drinks, and pouches.** Due to convenience of installation, many bottling facilities use compressed air, even though it's produced expensively at 50 times the required pressure (typically 100 psi), for these low-pressure open-blowing applications.

A system assessment, at a soft drink bottler, identified the use of compressed air in a gap transfer on their canning line as a source of energy inefficiency. The compressed air was directed through two 1/4" copper tube nozzles to transfer empty, open aluminum cans from a single cable-pulley system to a second cable-pulley system over an unassisted gap of approximately 18-20 inches. The purpose of the gap was to provide access for the inkjet date imprinting which is visible on the bottom of the cans. The compressed air application, although an inefficient use of compressed air, enabled the continual flow of the cans

across the inkjet printer to the second cable-pulley system. A second concern was the high noise level caused by the nozzles at the transfer.

Although only needing 2-3 PSI of pressure at the site of the gap transfer, 100 PSI compressed air was used — a full 50 times higher than the required pressure. The air flow measured at each of the two nozzles was 50 cfm. Assuming the industry "rule-of thumb" of 4 cfm per kW, the application was requiring 22.7 hp (18 kW) of energy generation. With an operating schedule of 3000 hours per year, total energy usage was estimated at 53,430 kWh costing $4,530 a year.

The Solution

The solution was a high-speed motor, centrifugal blower, Variable Frequency Drive (VFD), and four custom adjustable-mount nozzles. The centrifugal blowers' direct-drive technology enabled adjustable operation speeds of up to 20,000 RPM, creating adjustable flow rates of up to 750 cfm at pressures of 2.3 PSI. The compact footprint of the

Beverage Drying: *For line speeds from 12,000-72,000 bottles per hour (Bph), custom-designed centrifugal blowers and air knives guarantee no moisture related problems with sleeve, paper or pressure sensitive labeling; crown and safety seal drying; pasteurizer discharge blow-off; post-steam shrinking, twist push-through; combiner gap prevention; ionized air rinsing; stress corrosion; hygiene blow-off; ink jet coding; and shrink or cardboard packing of: cans, jars, PET and glass bottles, kegs & barrels, crates & pallets, boxed drinks, and pouches. Photo provided courtesy of JetAir™ Technologies.*

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motor and blower enabled it to be located within feet of the application via 3" diameter (75 mm) hoses to the adjustable nozzles. The nozzles were then mounted at each corner of the guide rails (bottom/top-left, bottom-top-right) at the beginning of the gap. The custom mounting application and nozzles provided the soft drink bottling manufacturer adjustable air directional flow, while the VFD provided air flow and pressure adjustability.

The custom blower solution consumed only 3 Hp (2.2 kW) representing an energy reduction of 20 hp, or an 87% true energy consumption savings. Based upon the soft drink manufacturer's production cycle and kWh rate, annual energy costs were estimated at only $970 per year resulting in a total annual savings of $3,560. This drastically reduced the soft drink bottling manufacturer's annual energy costs by 80%. These energy cost savings offered an estimated 65% return on the investment in the first year, and 125% ROI in two years. As an added bonus, the new blower system eliminated the high-pitched operational noise emitted by the old gap transfer system.

Step #2 – Stop Idle Equipment from Using Compressed Air

The Situation

System assessments consistently discover that idle production equipment, in bottling lines, needlessly consume compressed air. At a California bottling company, a test was performed when no bottling lines were operating or in other words — no product was being made. During the test, the compressed air flow was 935 scfm, of which 700 scfm was from idle production equipment. From 0200 to 0600, and during normal plant operation of one of four bottling lines, 525 cfm of wasted compressed air was consumed. This wasted compressed air was the equivalent to 125 hp worth of energy-consuming air compressors running any time three of the four lines were not in operation.

In order to estimate the total amount of compressed air wasted each year at this facility, conservative figures were used to calculate the total amount of hours where production lines were not in use. It was assumed that each production line is down for a total of one hour during the daily hours of 0600 to 0200. During the early-dawn hours of 0200 to 0600 it was estimated that one production line was operating and three were down. The savings potential was estimated at 166,317 kWh or $20,000 per year.

The Solution

Stopping the supply of compressed air to the idled bottling equipment reduced the consumption of compressed air. **To do this, air shut-off valves were installed** before each piece of production equipment to ensure that the machine would not use compressed air when idle. A simple and cost-effective solution.

The electrically-operated (normally closed) air shut-off valves were wired into the on/off switch of each piece of bottling equipment. If the equipment had a separate run switch, wiring the normally closed air

Can Printing: *Printing on wet cans results in illegible lot/date codes and "can bursts" ruining packaging and unsellable pallets of product. Centrifugal blowers and air knives replace compressed and improve drying performance. Photo provided courtesy of JetAir™ Technologies.*

Water Container Drying: *A facility filling 5-gallon water containers replaced compressed air with a direct-drive centrifugal blower. Photo provided courtesy of JetAir™ Technologies.*

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THE SYSTEM ASSESSMENT

Bottler Best Practices: A Proven 3-Step Assessment Process

Kyle Harris is a U.S. Department of Energy Qualified AIRMaster+ Specialist for compressed air systems. Mr. Harris actively manages the Accurate Air relationship with California's utility companies and their third-party energy rebate program administrators. The Bottler Best Practices System Assessment will be eligible for energy incentives up to 50% of the installed project cost.

ENERGY STAR PARTNER

Accurate Air is an ENERGY STAR® Industrial Service and Product Provider partner that teams with companies to improve energy performance.

Kyle Harris was recognized by the DOE's Save Energy Now Program for "outstanding leadership and exceptional skill in performing Energy Saving Assessments."

shut-off valve into the run circuit had the added advantage of shutting off the compressed air during breaks and lunches. A second discovery from the system assessment was that all parts of the bottling process did not need air simultaneously. Solenoid valves were used to shut off the air supply when not required. Implementation costs were $10,000 providing a simple ROI of 6 months.

Step #3 – Optimizing the Specific Power (kW per 100 cfm) of the Air Compressors

The Situation

Once a system analysis has investigated all the ways to reduce compressed air demand and pressure in the facility, the system assessment turns its' attention to making sure that the air compressors are operating in the most efficient manner possible. The idea is to get the maximum volume of air flow (measured in cfm) for every kW consumed of power. This is called optimizing the specific power of the air compressors.

A system assessment, at a bottling facility in Southern California, revealed that the existing compressed air system did not optimally match compressor output to system demand. In multiple compressor installations, without automation, there is a high likelihood that the compressors will be partially loaded. The problem with this is that none of the compressors will operate at their maximum efficiency levels. It is always more efficient to operate one air compressor at full load versus operating two or three air compressors at partial load. **The cfm/kW value for this system was 23 kW per 100 cfm.** Well-designed systems can be expected to have an average specific power lower than 18 kW per 100 cfm.

A pressure drop from the air compressor's discharge to the plant was the result of filtration, inadequate pipe sizing and an additional, unnecessary air dryer installed. Piping velocities exceeded 51 feet-per-second (fps) at peak production, well above recommended guidelines. The higher the velocity, the greater the pressure drop, increasing energy costs. One of the 100 hp air compressors operates at least 3 to 4 psig higher than the other air compressors and runs partially loaded due to the unnecessary air dryer dedicated to this air compressor.

The storage capacity of the compressed air system was estimated to be 145 cf/bar or 10 cf/psig. This capacity was in multiple small air receivers totaling 760 gallons, over 500 feet of 3" pipe and over 900 feet of 2" pipe. This means that if the plant were to lose a 100 hp air compressor and assuming it was fully loaded, the plant pressure would drop 24 psig in less than 30 seconds.

The annual energy costs of this system, operating at a specific power of 23 kW per 100 cfm, was $183,187 consuming 1,813,729 kWh.

***Labeling at Breweries and Micro-Breweries:** When labels go askew, the major reason is a wet bottle. Water is an essential element of beer, but it creates a slippery surface on containers as they travel — often at speeds of 2,000 bottles a minute — into the packaging process. At 14,000 to 20,000 rpm, centrifugal blowers instantly strip water off, making labels adhere even in harsh conditions, like high humidity.*

THE SYSTEM ASSESSMENT

Bottler Best Practices: A Proven 3-Step Assessment Process

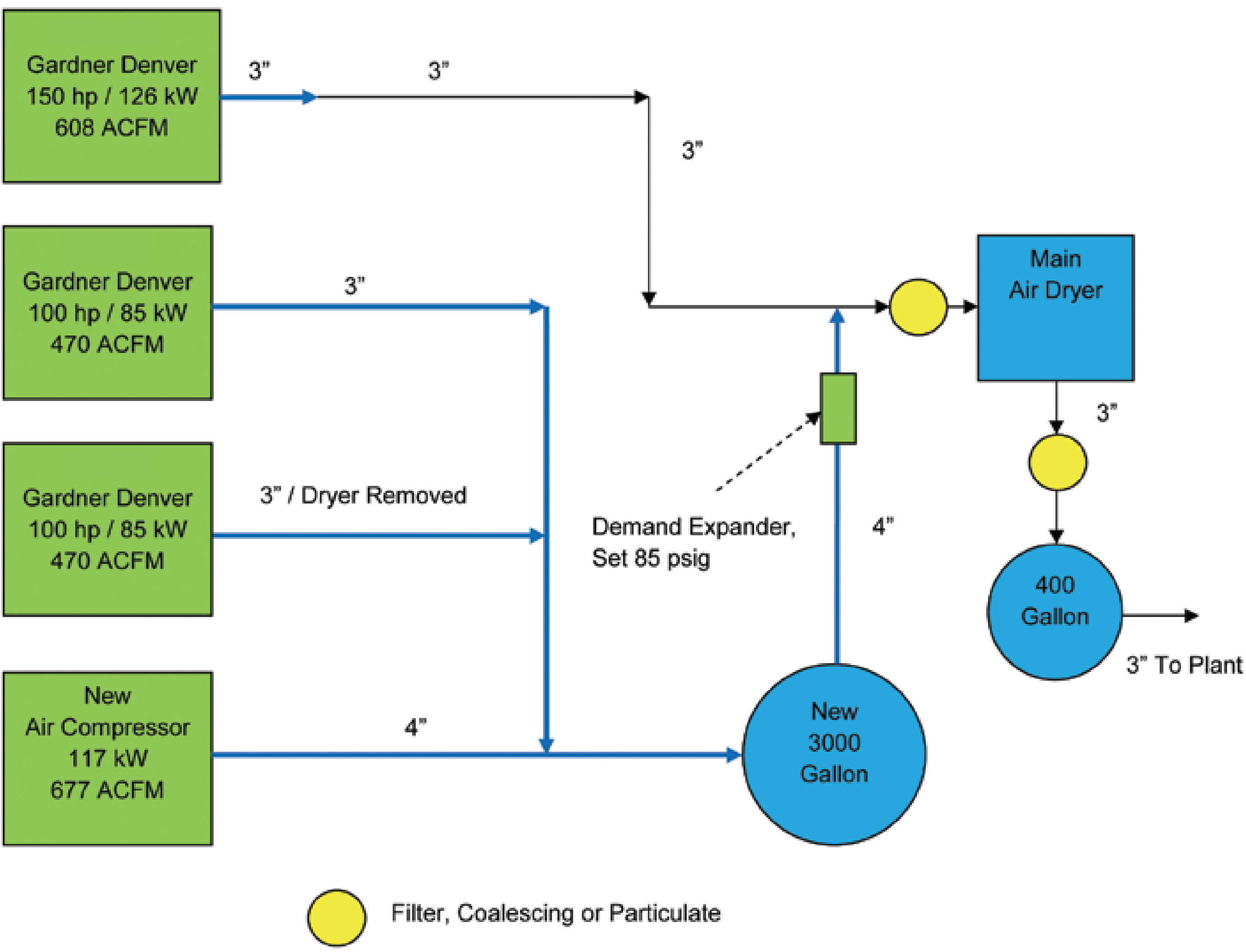
The Solution

A two-stage variable speed driven (VFD) air compressor was installed. This air compressor replaced an existing 100 hp air compressor and automatically adjusts its speed, thus matching compressor output to system demand. It was rated to produce a minimum of 675 acfm at 100 psig at less than 118 kW or better than 18.0 kW/100 acfm. The new air compressor can turn-down efficiently to less than 120 acfm at less than 26 kW. At minimum speed, the new air compressor can stop and then immediately load if required.

The compressor room piping header and primary branch headers were sized so that the air velocity within the header did not exceed 20 ft/sec to minimize pressure drop and allow for future expansion. Distribution branch lines were sized so that the air velocity within the header did not exceed 30 ft/sec. The undersized 2" discharge pipe on one 100 hp air compressor was replaced and the redundant air dryer was removed eliminating unnecessary pressure drop. This pipe was tied into a new 4" pipe from the new air compressor to a new 3,000 gallon air receiver. A new 2,000 cfm pressure flow controller/demand expander

3.3.1 Proposed EEM #3 Compressed Air Supply System Arrangement

Below is a simplified schematic of the proposed compressed air supply system after implementation of EEM #3:



Specific power was improved by 6 kW (per 100 acfm of air flow) with the new compressed air system design. Annual energy savings were $80,586 with a simple ROI of 1.8 years and only 1 year with the energy incentive.

was installed after the new air receiver. The new demand expander was set at 85 psig and maintains plus or minus 1 psig with a full PID digital control loop connected to a dedicated control. The existing 1,000 scfm main air dryer supported the reduced plant load (after a blower retrofit) at the lower pressure with average airflows calculated to be less than 575 acfm.

The air compressors were set up so that the new VFD air compressor supported the plant demand most of the time. When the demand exceeds the capacity of the new VFD air compressor, one of the existing 100 hp air compressor starts and runs 100% loaded. The VFD responds by slowing down and operating efficiently at part load. This was accomplished by setting the VFD target point to 100 psig with an unload point of 110 psig. One of the 100 hp air compressors was set to operate load/no-load and load at 95 psig and unload at 105 psig with no modulation. **The resulting specific power was less than 17 kW per 100 acfm — an improvement of 6 kW per 100 acfm.**

The new annual energy costs of the compressed air system, operating at a specific power of 17 kW per 100 acfm, were $102,601 consuming 1,015,858 kWh. The resulting energy savings were $80,586 with a simple ROI of 1.8 years and only 1 year with the energy incentive. BP

Contact Kyle Harris or Creg Fenwick at tel: 661-619-2470 or email: kharris@accurateair.com.

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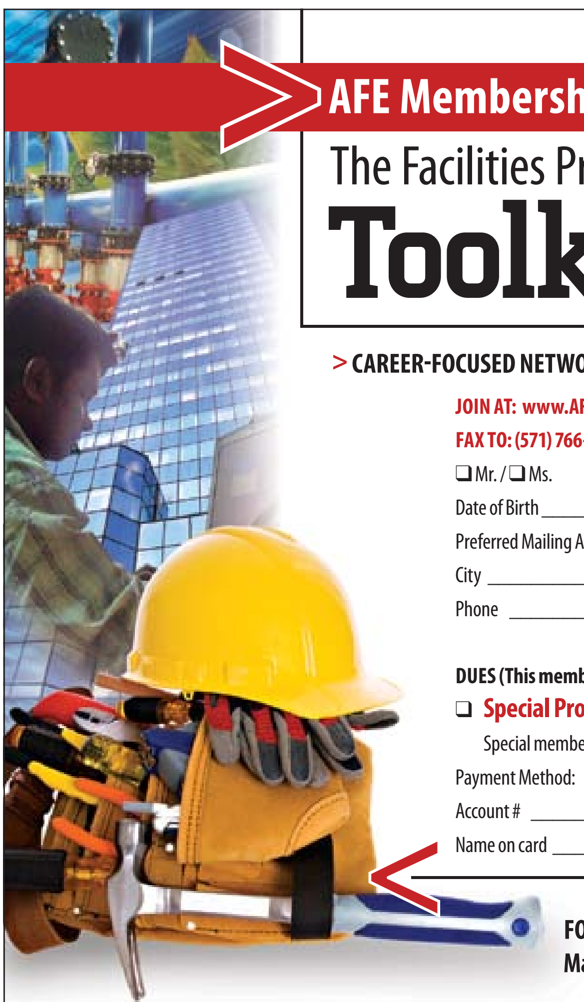

THE DEMAND-SIDE TECHNOLOGY PROVIDER

Festo Optimizes Compressed Air Consumption at Volkswagen

BY SACHIN KAMBLI, PRODUCT MANAGER, FESTO CORP.

Many passenger cars on roads in Germany contain efficiency concepts that make a considerable contribution to lowering emissions. Automotive manufacturers such as VW have gone even further than this, by applying efficiency strategies in their own value added chain. Because the benefits of pneumatics in automotive industry production processes have seen pneumatic actuation win over other drive technologies, efficient use of compressed air plays a key role in increasing energy efficiency.

As part of the Green Car Body Technologies innovation alliance, Festo, with its partners VW, Boge and the Fraunhofer Institute for Machine Tools and Forming Technology (IWU), have set themselves the goal of saving up to 50 percent on energy during the automotive production process.

In a subproject, Festo — as an expert in automation — is developing optimization potential (use of compressed air) in body manufacture due to its comprehensive approach on the consumer side and adding to this potential on the compressed air generator side. The goal, with the aid of reference models, is to describe compressed air generation, distribution and use as inputs for the entire energy consumption model for body manufacture.

A for Analysis: Identifying Parameters

"The situation today is that we are lacking transparent consumption data that can also be applied in relation to acquisition, operating and maintenance costs and that will thereby enable us to make comprehensive assessments for automation solutions according to Total Cost of Ownership (TCO) criteria during production," explains VW employee Thomas Rommel. "We want to know how to realize efficiency pragmatically." To this end, Festo has performed measurements and analyses on production systems in body assembly along with its partners. The link between consumption of compressed air calculated

theoretically and data measured was then established, thereby identifying the parameters for increasing energy efficiency.

"Examples of parameters are leak prevention, reduction in volume due to shorter hoses, lower pressure levels or optimal configuration of drives. During this observation, we will initially be pursuing a top-down approach," explains Jan Bredau, Customer Solutions Product Manager at Festo. "This means we will work from the greatest to least efficiency potential. There's no point in replacing or optimizing individual components if the greatest potential for increasing energy lies in optimized configuration and maintenance of a system."

This is the case with body production at VW. In the body assembly systems examined, compressed air is used primarily in over 350 pneumatic actuators such as in loading and unloading stations, robots with handling and processing functions or encapsulated laser welding stations. Automation functions executed include conventional or servo-pneumatic welding tongs, grippers, toggle-lever clamps and pin pulling cylinders. A smaller proportion of compressed air is required for the process itself, for example in the form of air blast for laser welding.

B for the Benefit of Pneumatics: An Example

A trend toward controlled pneumatics is evident, particularly with servo-pneumatic drive systems for welding tongs, with more than 5,000 Festo systems already in use in automotive construction worldwide. A benefit of servo technology in this application is the unrestricted, rapid positioning of electrodes, which reduces cycle time and enables obstacles to be worked around. Soft application of electrodes increases the quality of spot welding, service time of electrodes and reduces noise

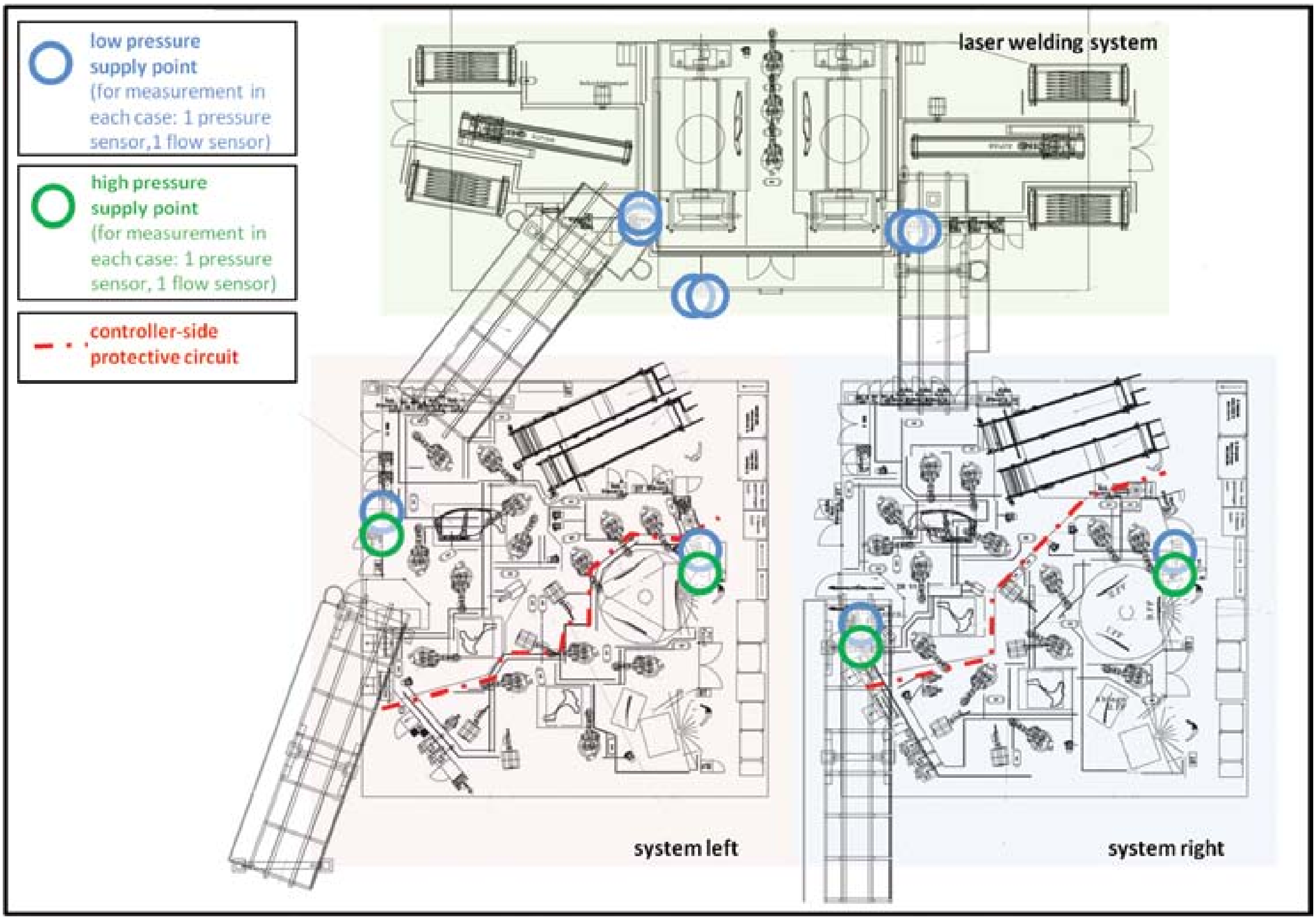

Fig. A: Example system for body production with measurement points

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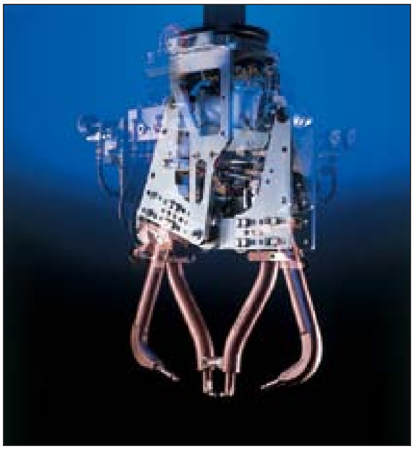

Fig. B: Servo-pneumatic drive system by Festo for welding tongs

levels. Controlled build-up of forces leads to better force reproducibility, reduction in cycle times and constancy of spot welding quality. Servo-pneumatic solutions are positioned outstandingly between standard pneumatics and servo electrics here due to their better TCO.

C for Condition Monitoring

As part of the Green Car Body Technologies innovation alliance, diagnostic systems known as condition monitoring systems are made available by Festo that permanently monitor consumption and any deviations, thereby deliberately recording leakage. Depending on a system's age and technological state, there are various optimization possibilities for increasing energy efficiency. The simplest is the rectification of leakages by repairing or replacing defective hoses, fittings or components. One system undergoing condition monitoring required steady 34 Nm³/h, which corresponds to ~18 percent of total consumption. Since idle consumption could not be traced back exclusively to leakages in the example system, however, based on Festo's experience of system analyses and leakage investigations and in view of the size of the system and number of actuators, the leakage rate could be classified as low to average.

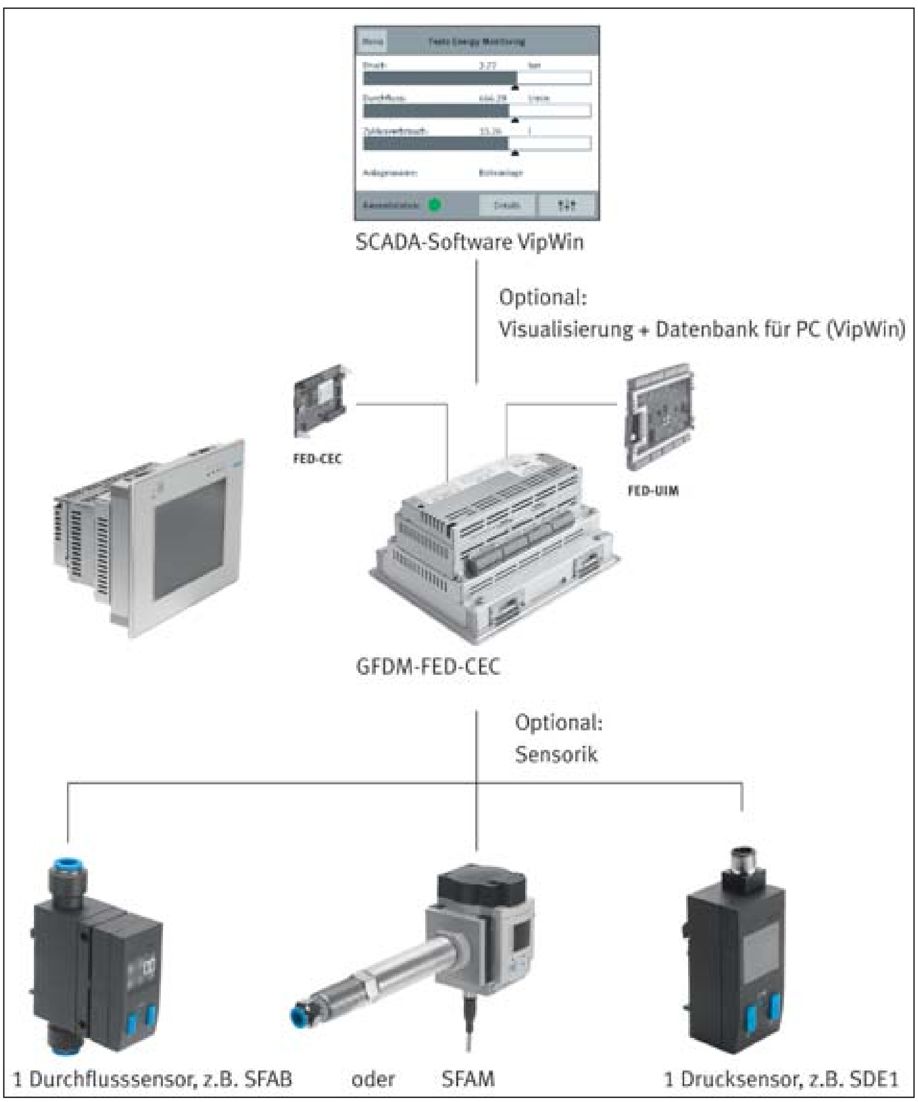

Figure C: condition monitoring

D for Definition: Detection of Consumption Patterns

One approach to increasing efficiency is to optimize existing systems. Measurements are made during active production in order to assign consumption and typical consumption patterns of individual subareas or components in existing systems.

Any peak values or drops in pressure are recorded, and air consumption is generally divided into dynamic consumption and idle consumption. Actuators in production condition (for example, closing clamping devices or setting spot welds) define dynamic consumption, while consumption in idle condition is defined by leakages and consumers that have been left on. And companies often fail to entirely switch off their production systems, meaning in turn that idle consumption takes place on a round-the-clock basis In the case

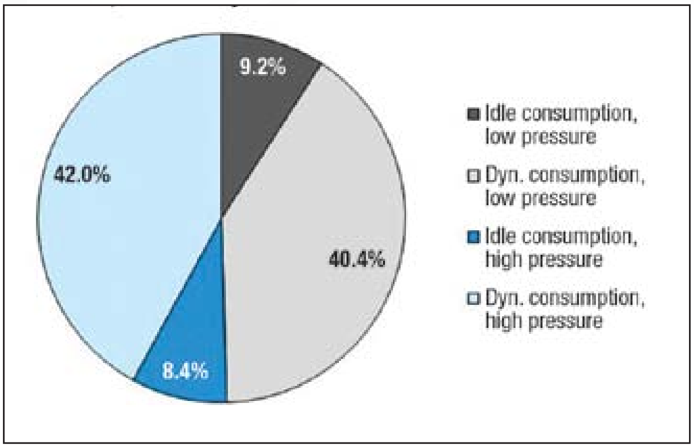

Fig D: Example measurement results

of systems monitored by Festo at VW, idle consumption accounted for 10-30 percent of the overall consumption.

Figure D shows an example of accumulated consumption values due to recording the flow pattern for one manufacturing cycle. These values depend very much on the size of the systems. If consumption costs of a few cents/feet^3 of treated compressed air are reckoned with as a common average value for the automotive industry, it can quickly be seen that, measured against the number of actuators, energy costs for entire pneumatic systems are very low. It is only when leakages occur that this figure rises.

P for Planning: Efficiency in the Planning Process — At A Glance

Besides the actual measurements made, Festo also calculated theoretical air consumption of the systems it examined. The aim of these observations was to show the extent to which air consumption can be calculated for later planning, in order to do justice to the claim that energy consumption of entire systems is transparent and easy to reproduce. "VW wanted a direct comparison of the costs for various solutions at a glance as early as the system planning phase," explains Daniel Ditterich from Innovation and Technology Management at Festo.

Festo is currently implementing a planning-support tool, both for simple estimations of energy consumption at system level and dynamic simulation at component level. This enables – virtually at the press of a button – the primary consumers to be identified and requirements for compressed air distribution and generation to be derived. Early integration in the factory planning process thereby enables users to develop potential for saving energy early on.

Features of this tool are:

- Illustration of the hierarchical system structure with aggregated results for the individual automation functions
- Illustration of current functions in automotive construction (clamping devices, grippers, drives for pneumatic and servo-pneumatic welding tongs)
- Graphical and numerical evaluations with simple break-even point definition
- Expansion possibilities via function plug-ins
- Connection to simulation backend for complex functions for which energy consumption cannot be defined empirically or by using calculation formulas.

"Depending on a system's age and technological state, there are various optimization possibilities for increasing energy efficiency. The simplest is the rectification of leakages by repairing or replacing defective hoses, fittings or components."

— Sachin Kambli

THE DEMAND-SIDE TECHNOLOGY PROVIDER

Festo Optimizes Compressed Air Consumption at Volkswagen

Data may be subject to variant calculations in relation to the entire system, individual cells or components. The illustration below shows two different configurations for handling robots with the same function. Robot B with optimized consumption uses clamping devices, among other things, that generate the same power due to their special kinematics, despite a smaller pressurized area, and that are significantly more expensive to acquire. Nevertheless, the higher investment is amortized, assuming compressed air costs of approximately .095 cents U.S./ feet³, after around just 15 months, but with costs of .075 cents U.S./feet³ only after approximately 45 months. Based on this, a planner may decide which type of clamping device makes more sense economically in the long term. Similar comparison calculations may also be generated for other components such as welding tongs.

Consumption data and key figures that were not previously available in this form now give a clear indicative value as to the amount of energy costs for pneumatics. Based on these orders of magnitude, the planner can decide the extent to which these are relevant for his or her needs and what financial benefits a change to different drive technologies would actually bring.

Z for "Zukunft" (The Future): Efficiency for All Concerned

Energy-efficient production assumes a holistic view of energy consumers, operating resources used and transparent possibilities for comparisons. Appropriate considerations and calculations must be applied during the factory planning stage. Based on the use of automation technology, this means estimation of consumption and costs as in the Total Cost of Ownership (TCO) approach. Considering actuators alone is not enough here.

The most important planning criteria are:

- Requirements for applications that will always need to be met (statics, dynamics, required forces, etc.). In many cases these factors will also preclude the use of certain technologies. This requirement essentially leads to the use of suitable selection and configuration tools, in addition to the know-how of production planners, taking into account internal company standards. A distinction needs to be made here between drive technology such as pneumatic cylinders, clamping devices, grippers, electrical drives and control technology (controllers, valves etc.) and operating resources required due to the process such as blast air for machines
- Resulting procurement costs, consumption data and consumption costs, including maintenance
- Suitable generation of the required operating resources such as compressed air and optimally coordinated distribution systems. Secondary use of energy types such as heat recovery also needs to be included in consumption and cost calculations here
- Appropriate concepts to obtain consumption of a system from commissioning to its withdrawal from service. With existing compressed air systems, this also means detecting leakages and rectifying these for the long term. Permanent condition and energy monitoring systems create transparency and highlight any deviations

The goal of the Green Car Body Technologies innovation alliance is to save up to 50 percent on energy during the production process for a car. The subproject, planning the efficient use of compressed air, has a goal of saving energy during compressed air applications due to better coordination between the generator and consumer sides. Taking the example of body production, consumption data is recorded, parameters for increasing energy efficiency calculated and planning and operating losses highlighted. In addition, planning tools for estimation of compressed air consumption are arising that, even beforehand, will enable optimal and energy-efficient coordination between the consumer and generator side in compressed air applications.

Outlook

For years now, Festo has been pursuing a holistic approach to increasing efficiency, from its products to the design of entire systems. With the Boge Company likewise working on a tool for configuring distribution and generation compressed air, Festo, as part of the Green Car Body Technologies innovation alliance, is now in a position, along with its partners like Boge, to create standard interfaces so that comprehensive statements on increasing energy efficiency can be made in the future. This represents a further milestone in the road to green production — realized by a comprehensive A to Z approach.

We would also like to express our thanks at this point to the German Federal Ministry for Education and Research (BMBF), which supported this projected as part of the overall concept of "Research into the production of tomorrow" and the project executing organization Karlsruhe (PTKA), which has also been active in a support role.

For more information on air consumption analyses, energy savings, and air quality assurance services from Festo, please use the contact information below. BP

For more information contact Sachin Kambli, Festo Corporation, tel: 631-404-3228, 1-800-993-3786, email: Sachin.Kambli@us.festo.com, www.festo.com/usa

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Figure E: Festo air consumption and energy savings services.

ARE COMPRESSED AIR LEAKS WORTH FIXING?

BY HANK VAN ORMER, AIR POWER USA

Why are compressed air leak programs often ignored or even discouraged by management, in addition to some energy recovery minded third parties?

This problem can be summed up as "Over Promise" and "Lack of Delivery". In the 1990's, the basic compressed air inefficiency energy transfer became a prime target for energy reduction programs promising great results with many low investments. Good payback programs, which they are indeed.

The least complicated program, easiest to understand and implement was to fix the leaks. The 1/4" leak at $10,000/year savings became the byword. Management was easily persuaded to support these low cost, high return programs and the race was on. But, the results were "underwhelming":

- Some "professional leak specialists" were known to find more leaks than the actual air supply
- Promised savings of six figure dollar air reductions failed to register even a small blip on the monthly electric bill

It didn't take long for this continuing situation to often sour management on programs that require financial and manpower investments. Management might "talk to talk" but hesitated to "walk the walk". Do not misconstrue, there were also many successful programs that scored well; however, we still see the same issues today with poorly implemented programs continuing to disappoint.

Figure 1A. Some leaks are easy to spot – Look for the duct tape

Don't Overestimate Size or Magnitude of Leaks

In the past, most compressed air leaks were sized with an educated estimate by experienced professionals. When a significant number of leaks were identified and repaired, and if the situation allowed, the total leak accuracy was checked with before and after system actions such as flow meter readings in off times, bleed down tests, etc. Further testing has created another accurate guideline:

- When 100 leaks are found and sized, a tight system: should average around 3 cfm each. A typical system should average around 4 cfm each and a high leak system should average around 5 cfm each. Numbers above or below these levels should have a clear explanations!

ARE COMPRESSED AIR LEAKS WORTH FIXING?

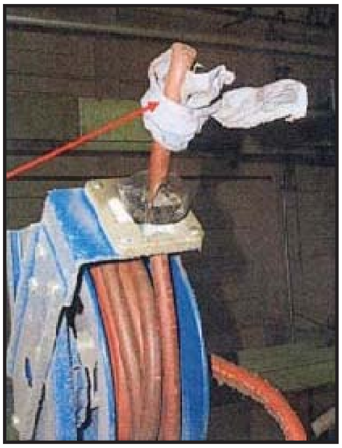

Figure 2. Check average size of leaks

The major issue is that inexperienced personnel often tend to overestimate the actual volume (cfm) which, when the project is completed and the results are disappointing, management support is lost.

Figures 3A. and 3B. Leak sizing from a standard orifice flow chart – 1/4" leak = 104 scfm, i.e. $10,000/year

FIGURE 3A. ESTIMATING THE VOLUME OF COMPRESSED AIR PER LEAK

	1/64"	1/32"	1/16"	1/8"	1/4"	3/8"
70 psi	.300	1.20	4.79	19.2	76.7	1.73
80 psi	.335	1.34	5.36	21.4	85.7	193
90 psi	.370	1.48	5.92	23.8	94.8	213
100 psi	.406	1.62	6.49	26.0	104	234
125 psi	.494	1.98	7.90	31.6	126	284

This chart is true but what is not said is that it is a test orifice of a given design and thickness with a specific "chamfer" to allow free flow to wide open ambient.

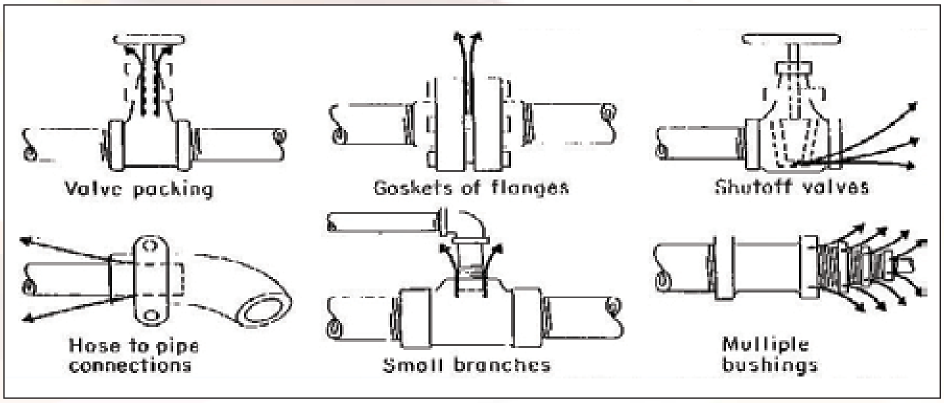

Figure 3B. Clearly, none of these leaks are machined round holes. Many are a relatively long, tortuous path from the compressed air source to the ambient.

Estimating Leak Size

As shown in Figures 3A and 3B, two very important pieces of data are missing to use the orifice table:

- What is the actual diameter, and more important, the area of the leak as it flows through the NPT threads, past the shaft seal, past the gaskets, etc.?
- What is the actual pressure at the leak? Even at 90 psig in the pipe, how much pressure is lost getting to the outside?

The same issues exist in leaking push/pull fittings, cracked fittings or pipe, cracked filter bowls, etc.

Using the orifice chart ***usually*** leads to a significant overestimating of the leak values.

Air Power USA performs compressed air system reviews and assessments on a continuing basis and often finds opportunities to observe and measure real compressed air leaks in real time situations. We believe there is no substitute for experience in sizing a leak; however, modern equipment has offered significant new capabilities.

Global Leak Load Tests

In addition to measuring leak loads from the bottom-up by listing individual leak sizes, it can be useful to measure the overall system leak load. During periods when the plant is not in production, one can measure the total leak volume with a monitored compressor operation or a bleed down test.

1. **Monitored Compressor Operation** During non-production, run the air compressor enough to hold a steady normal system pressure. Observe and record the percentage of load the compressor is running. This can be by timing the seconds loaded and unloaded with a 2-step controlled compressor. The percentage of time loaded versus the total time would be the percent of full load flow. For example, if the compressor is loaded for 700 seconds out of 1,000 seconds of operation, it would be 70% loaded. If the full load rated flow is 1,000 cfm then the flow to feed the leaks and air left on (e.g. open blows and operating machinery) is 700 cfm. There are more sophisticated ways to establish the percent load of units that are not 2-step controlled using the basic Compressed Air Challenge (CAC) capacity control performance curves.

2. **Bleed Down Test**

   - Estimate the total storage volume of the system, receiver, main headers, etc., in cubic feet (7.48 gallons per cubic foot)
   - During non-production pump the system up to full pressure
   - Shut off the compressor(s)
   - Allow the system to bleed down to about half the full load pressure psig (at 50 psig) and record the time
   - Use the following formulas:
     - Time minutes = Volume in cu ft. x (P2 start – P1 stop) x 14.5 ambient pressure psia x net flow out
     - Leak volume cfm = (Volume in cu ft.) (50 psid) x 1.25 = (14.5 psia) (Time minutes)

   The 1.25 multiplier corrects the normal system pressure allowing for the reduced leakage rate with falling system pressure. This answer in cfm will equal all the leaks and any processes left on. Deduct those processes that have to be left on and the result is a fair estimate of the total volume of wasted air from leaks. Any leak list that totals more than this number should be investigated.

3. **Use the plant's recorded data,** if available, to establish the total flow level during non-production periods. Or, if not trended, read flow meters in the distribution headers during non-production periods. This approach may also be useful for measuring air flows in branch headers, e.g. air going to only one production building, mill or area, especially if the entire plant operates continuously but

AIR BEST PRACTICES™

"Eliminating a majority of compressed air leaks and sustaining low leak levels is not an event, it is a continuous program and to be successful must be embraced by all personnel, often requiring a culture change."

— Hank van Ormer

ARE COMPRESSED AIR LEAKS WORTH FIXING?

individual production areas are shut off during some shifts. To mitigate inaccuracy in any flow meter, it is wise to use the same meter to measure the air flow during non-production to determine the total load.

Leak Repair Log

As leaks are identified and tagged for subsequent repair, they should be tabulated in a log sheet. Ideally this log would include an estimate of the repair time, include columns noting the actual repair date and costs, and document who did the work. This repair information will be very useful when determining the true value of the leak project.

Figure 7. Leak log shows the ability of a high quality, digital ultrasonic leak locator to quantify the leak volume. During a recent compressed air system review in a steel mill, our assessment team had the opportunity to install an in-line thermal mass flow meter (a CDI model 5400) in the line leading to a "blister leak" in a hose within the pipe mill. (See leak #4 in Figure 7.) The ultrasound leak locator (a UE Systems model 3000) calculated the leak at 2.9 scfm and the CDI flow meter registered 3.1 scfm. In this world, this is very, very accurate.

FIGURE 6. SAMPLE LEAK REPAIR LOG

#	LOCATION	DESCRIPTION	DB	EST CFM	CLASS **	ISOLATE ***	COMMENTS	DATE REPAIRED	MATERIAL COST	LABOR HOURS/ PERSON
1	Compressor room	Poly line	27	1	2	Yes		3-1-11		0.5 JK
2	Compressor room	Dryer filter bleed line	130	10	1	Yes		3-1-11		0.2 JK
3	Maintenance locker	QDC to grease gun	57	2	1	Yes		3-1-11		0.2 JK
4	Rice line packaging room	Poly line	23	0.5	1	Yes		3-1-11		0.3 JK
5	Rice line - bagger	Regular poly line	85	5	1	Yes		3-3-11		0.2 SM
6	Room 21C hopper	QDC fitting on hose	53	2	1	Yes		3-3-11	$10	0.3 SM
7	Room 21C chiller hopper fill	Cylinder on shaker	72	3	2	Yes		3-3-11	$30	0.6 SM
8	Rice bagging room	Inside blue hopper box	31	1	2	Yes		3-3-11	$20	0.7 SM

** Class of leaks indicates estimated repair time – 1=1/2hr; 2=1hr; 3=1-3/4hr; 4= >1-3/4hr
*** Isolate "yes" indicates leak can be isolated for repair with the system air pressure on; "no" means it cannot be isolated with the system air pressure on.

FIGURE 7. JUNE 2011 - LIST OF TAGGED AIR LEAKS

RECORD NUMBER	GROUP NAME	LOCATION NAME	TYPE OF GAS	PRESSURE AT LEAK (EST.)	DB READING	PROBLEM DESCRIPTION	SIZE OF LEAK CFM
1	Pipe mill	Labeling	Air	75	45	QDC Male&FM west grinder	2.5
2	Pipe mill	Labeling	Air	50	25	Threads on 1/4 elbow to reg (1)	0.7
3	Pipe mill	Labeling	Air	50	30	QDC Male&FM (1)	1.0
4	Pipe mill	Trim bevel N	Air	75	50	1/2" Hose Blister west side grinder	2.9
5	Pipe mill	Trim bevel N	Air	50	33	Threads at ball valve (2)	1.1

Valuing the Leak

After accurately identifying the magnitude of the total leak list and repairing them, the next significant challenge is to value the effect of the leak project on the monthly or annual electric bill. To management this is where "the rubber meets the road" — *are compressed air leaks worth fixing?*

Often the leak project identifies the cost of producing the total air leakage by volume (cfm); pressure, (psig), hours per year; and power rate. For example, often programs predict, "If you are saving 800 cfm at 4 cfm per input horsepower, we estimate it will cost 200 hp input to produce the air -or- 200 hp x .746 = 149.2 kW.

149.2 kW x .10 x 8,760 = $130,669/year to produce this air

This $130,669/year is what it costs to produce this volume of compressed air in annual electric energy cost — it is probably not the actual recoverable value.

The True Recoverable Value is "Site Situational"

Depending on the operations model pre- and post-projects the true recoverable value will vary by net system "specific power" (scfm/kW). The value shown above is full load efficiency. For the air supply in question, actual part load operation will always be less efficient and will vary by the type of compressor and capacity control. Under this situation the financial savings will probably be overstated, sometimes very significantly.

If the air reduction from the leak projects allow the system to completely shut off a very inefficient air compressor the overall system specific power will improve and the overall savings may be **understated.**

In summary it is site situational. The financial analysis must have an accurate baseline operating cost and then an accurate post-project cost. Air Power USA performs many air assessments with performance contraction, where they are paid ONLY for actual kW reduction. Predicting kW and kWh results have to be accurate. To oversimplify the procedure we created a measured (baseline) operating model and a projected operational alignment for post-projects. Internal software then generates a $/scfm/year of recoverable annual electric energy which is completely site specific and proven to be very accurate.

Eliminating a majority of compressed air leaks and sustaining low leak levels is not an event, it is a continuous program and to be successful must be embraced by all personnel, often requiring a culture change.

Are Compressed Air Leaks Worth Finding, Fixing and Sustaining?

Recently in a Steel Plant with rolling mills and galvanizing process, 625 leaks were identified, tagged and repaired. The projected scfm volume was 3,140 scfm and the measured volume saved was actually about 3,250 scfm. Due to the nature of the business the average leak size was 5 cfm and many leaks were located near each other (particularly under and near the mills). The repair cost was a little over **$68,000** and the actual recoverable energy reduction was **$333,158** year. ***APPARENTLY WORTH FIXING!*** BP

For more information contact Hank van Ormer, Air Power USA, Inc., tel: 740.862.4112, email: hank@airpowerusainc.com, airpowerusainc.com.

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

"The repair cost was a little over $68,000 and the actual recoverable energy reduction was $333,158 year. APPARENTLY WORTH FIXING!"

— Hank van Ormer

SUCCESS STORIES AT BC HYDRO

BY RON MARSHALL FOR THE COMPRESSED AIR CHALLENGE®

BC Hydro is a sponsor of Compressed Air Challenge and one of two Canadian utilities represented on the Board of Directors. BC Hydro's Power Smart Compressed Air Optimization program helps customers assess how their air system is working, helps with project implementation costs and provides for onsite training of plant personnel. The following profiles tell how two of their customers discovered excellent savings through the application of low cost measures.

Catalyst Powell River's Little Fix Saves $342,000 a Year

When Jennifer Mercer tallied up the energy savings from her first year as energy manager at Catalyst Paper's Powell River mill, she shared the news with staff in a "year in review" newsletter.

Catalyst employees (left to right) Paul MacLean, Ken Campbell and Tony Leach worked on a solution that resulted in fabrication of "mudflaps" – work done by sheet metal mechanic Peter Rowbotham – that removed the need for a costly use of compressed air.

> "Most people don't think about the cost of compressed air; they just think, 'It's just air, blowing.' But over 80% of your cost to produce compressed air is lost in heat."
>
> — Ken Campbell

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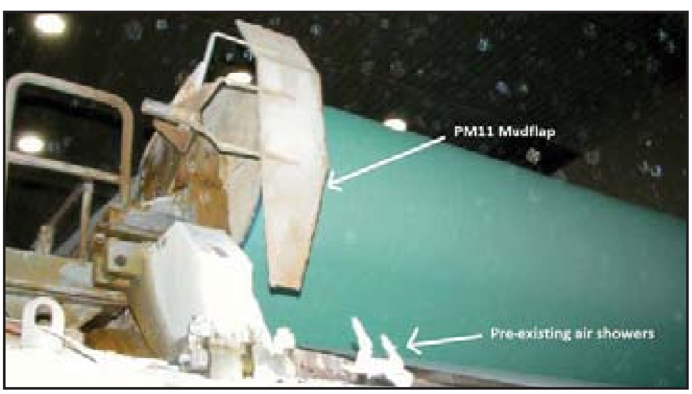


Then she got a surprise.

"I heard from Ken Campbell, the interim paper machine manager on paper machine 11, who told me about a fix they'd done on the machine," she recalls. "He said, 'I don't know if there are energy savings, but I just figured I'd let you know.'"

Campbell explained to Mercer that, for many years, two compressed air hoses had been used — at great expense — to blow away debris that would have fallen on the paper sheet.

"Those air wands had been in place for years, certainly for the eight years since I've been here, and probably since close to the startup of the paper machine in 1981," says Campbell.

The solution was a borrowed idea from the company's mill in Snowflake, Arizona — installing "mudflaps" on the paper machine to do the same thing the air hoses were doing.

"It was a device first used in our Crofton division, although nobody else was using compressed air the way we were," says Campbell. "I thought, if we put those on, think of the money we would save."

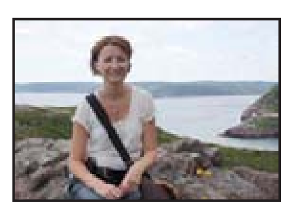
A $1,000 Fix Saves $342,000 a Year

Campbell's team fabricated a metal flap solution that stops water and debris rather than allowing it to fall onto the paper sheet.

"When we installed them, we kept the air showers on for a couple weeks while we were trialing them, but then we shut them off and we haven't had them on since," says Campbell.

He estimates the cost of the fix — materials and labour — was about $1,000.

So simple was the employee-led solution that it didn't come to Mercer's attention until her year end report prompted Campbell's note. Then it became apparent just how valuable the "mudflaps" are.



Jennifer Mercer, Energy Manager

SUCCESS STORIES AT BC HYDRO

"When I did the math on calculating 3/4 inch hoses continuously spraying compressed air onto the equipment I found each one is saving 930 cfm of compressed air," says Mercer. "And they were running 24/7; if the machine was down for maintenance days, they still ran. It was like running your garden hose full out, all the time."

Mercer did the math and was in for a welcome surprise. About $171,000 per hose, in annual savings.

Says Campbell: "Back when it was easy to make bundles of money, this was never in the forefront. Now, you want to save whatever you can, and you want to be environmentally sound as well."

Campbell's team now makes identifying leaks a priority. "On shut down days when it's nice and quiet, we go around and listen, to minimize the amount of compressed air that we use here," he says.

Past Practices No Longer Add Up

"At some point in the past, they obviously had a problem, they needed a solution, and somebody said just put an air hose there," says Mercer. "So they just grabbed the closest compressed air line and hooked it up and no one really thought before about what the actual ramifications of making that decision was."

"Most people don't think about the cost of compressed air; they just think, 'It's just air, blowing.' But over 80% of your cost to produce compressed air is lost in heat," she says. "You spend money to compress it to get it at the right pressure that you need, and by making sure you're minimizing any of your wasteful streams, it allows you to operate your entire system more efficiently."

Catalyst's Powell River site has one of the largest, most complex compressed air systems in B.C.

"So we want to make sure that when we need it, it is available," she says. "If you're using a compressed air line to keep motor bearings cool, or you're using compressed air for building or process cooling, mixing, or to clean tools and equipment, you're throwing thousands of dollars out the window."

Compressed Air Study Helps Save Newpro $40,000 A Year

When Northern Engineered Wood Products (Newpro) expanded its production capacity a few years ago, it was not surprised to discover that the plant's compressed air capacity also needed a boost.

Roger Smith, Newpro Plant Manager, beside air compressor.

But a few years later, there was a surprise. With a compressed air system study, Newpro was on a path to big savings with nearly no cost.

As a result of the air study and some simple fixes, Newpro is now saving 599,000 kWh of electricity per year — or about $40,000*.

Aerial photo of NEWPRO particleboard plant, Smithers, B.C.

Newpro is a composite panel manufacturer based in Smithers. The plant uses waste residue from sawmills to produce composite wood panels that are commonly used in kitchen cabinets and office furniture.

The plant has been in operation since 1980 and has about 50 employees.

"The entire facility uses compressed air," says Roger Smith, Newpro's Plant Manager. "We've got two units that run 24 hours a day, seven days a week, about 350 days a year."

Up until 2007, Newpro's operations were powered by a single 150 hp compressor, with another of the same size in place as a backup. Then, they expanded.

"We put a new melamine paper overlay line in, and we found we didn't have enough air with just one compressor, so we found we needed the second compressor running," says Smith. "Unfortunately, it was running all the time, but it was probably only really needed, capacity wise, for about 20% of its capacity. So it was basically running and discharging and just wasting a lot more than we were actually using."

Energy Efficiency: Study Reveals Low-Cost Fixes

View of the particleboard cooler

Newpro partnered with BC Hydro to investigate efficiencies, and the initial compressed air study targeted storage.

With additional storage tanks, the plant could operate with just one compressor and still have capacity for peak usage times. But as they took steps towards their new project, more information came to light.

"Between the guys with the study and our maintenance staff, we found a problem in the system itself," says Smith. The problem lay in a minimum pressure check valve on one compressor.

"By repairing that — a relatively simple fix, a couple hundred dollars and about a half an hour — we were able to just shut that second compressor back off. We realized a huge savings just from that. The audit made a huge difference, even if it had done nothing more than just found that one problem in the system."

The other low cost fix Newpro implemented as the result of the audit was to change the operation of four small compressed air lines that were blowing air to keep dust off of photocell "eyes." They were running continuously — but the study found they could give one blast of air every hour or so without jeopardizing operations.

"Now they run intermittently instead of all the time — that was quite considerable savings as well," says Smith.

Savings Hit About $40,000 a Year

As a result of the air study and some simple fixes, Newpro is now saving 599,000 kWh of electricity per year — or about $40,000*.

"You know, we've got a full complement of maintenance staff, but we're not compressor experts," says Smith. "We'd been running since 2007 with two compressors, and [the problem valve] was just never discovered until the audit came along. All along we would have been able to run with just one compressor if it weren't for this mechanical problem in our system.

"What it really comes down to, in our discussions with BC Hydro, is that we found some fairly significant savings with really not doing much work. If it hadn't been for the audit, we would just have just continued to basically waste energy. It was about as simple as that." BP

* Based on an average blended rate of 6.7¢ per kWh.

From the BC Hydro Current ENewsletter

BC Hydro Resources
Check out BC Hydro's resources at
http://www.bchydro.com/powersmart/industrial.html

Compressed Air Challenge Resources
Various reference documents are available to assist in helping assess low cost compressed air efficiency measures at www.compressedairchallenge.org
One excellent resource is CAC's "Best Practices for Compressed Air Systems". This 325 page book is available at our bookstore.

To read more ***System Assessment*** articles,
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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

SPX Flow Technology Launches New Dehydration Technologies

SPX brand introduced the new HES Series high capacity refrigerated air dryer and HCD Series heat of compression desiccant air dryer.

The HES series was specifically designed for large flow capacity applications ranging 3750 to 10,000 scfm (6371-16,990 nm^3/h). Utilizing the latest technological advancements, the HES series delivers load-matching performance by precisely matching input power to real time demand. Innovative modular construction employs independent air treatment modules for flexible arrangement, ease of installation and service. Dimensionally standardized modules may be efficiently combined to form larger combinations, quickly adapting to changing customer demand.

Redundancy in critical components offers fault-tolerant operation, delivering optimal system reliability. Multi-station redundancy provides alternative drying capability in the presence of component failure. Systems may be operated with an additional module to gain benefit of lower pressure drop and back-up redundancy, without compromising power consumption.

The HCD series heat of compression desiccant air dryer, flows 350-10,000 scfm (595-16,990 nm^3/h) reduce energy costs while delivering instrument quality compressed air. Ideally suited for oil-free air compressors, "waste heat" generated during the air compression process is effectively utilized to regenerate of the off-line desiccant tower.

Energy efficient design consumes less than 100 watts per year, approximately the energy utilized by a desk-top computer. No purge air is required for regeneration, delivering the lowest operating cost of all desiccant dryer designs. Reduced maintenance — no blower or heaters — provides trouble fee operation.

Contact SPX Flow Technology
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Redesigned Kaeser ESD Models

Available in 250 and 300 hp models, Kaeser ESD units provide flows from 816-1522 cfm and pressures to 217 psig. The ESD series was redesigned for increased efficiency and improved specific performance, as the one-to-one direct drive design includes a premium efficiency drive motor with three PT 100 temperature sensors. All models come standard with the new Sigma Control 2 intelligent compressor control for enhanced communications capabilities and equipment protection. Also standard is a variable speed fan for the fluid cooler that helps save energy by adjusting to cooling demands. Maintenance points are more easily accessible than ever before with five access doors and a removable panel.

Options include water-cooled and SFC variable frequency drive. ESD units with optional SFC are now 19 inches shorter than the previous design, with a footprint reduced by an impressive nine square feet.

Contact Kaeser Compressors
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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Ingersoll Rand

Ingersoll Rand announced that its Class 0 certifications have been updated to comply with the ISO 8573-1 Class 0 2010 standard. The certifications were granted to the entire range of Ingersoll Rand air-cooled, water-cooled, oil-free rotary screw compressors (37 to 350 kW/50 to 450 hp) and water-cooled, oil-free centrifugal compressors (160 to 5000 kW/200 to 6,700 hp) by TÜV Rheinland®, a global leader in independent testing and assessment services. Ingersoll Rand was the first manufacturer in the world to be certified Class 0 for centrifugal air compressors.

"Our products had to pass rigorous tests to qualify for recertification to the revised Class 0 standard," says Paul Maguire, portfolio manager for Ingersoll Rand. "This demonstrates the company's desire to comply with the latest technical standards in the industry, and our ongoing commitment to providing best-in-class equipment to our customers."

Contact Ingersoll Rand
www.ingersollrandproducts.com

Festo MPA-L Valve Manifold

The Festo MPA-L valve manifold offers a perfect mix of value and performance. It is scalable down to a single valve slice, so directional valves can be adapted to any application. This saves costs and reduces size.

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All standard valve functions are available. These include 5/2, 5/3, and the cost/space saving dual 3/2 types. All valves use Festo's patented cartridge principle, which has proved extremely durable, and offers outstanding flow rates. There are well over 10 million valves with this technology in service.

The manifold is suited for most pneumatic applications for discrete and process automation. The high flow rate to size ratio makes for universal applications from food and beverage packaging to semiconductor fabrication. The valve can run pressure and vacuum, with multiple zones. Key features include:

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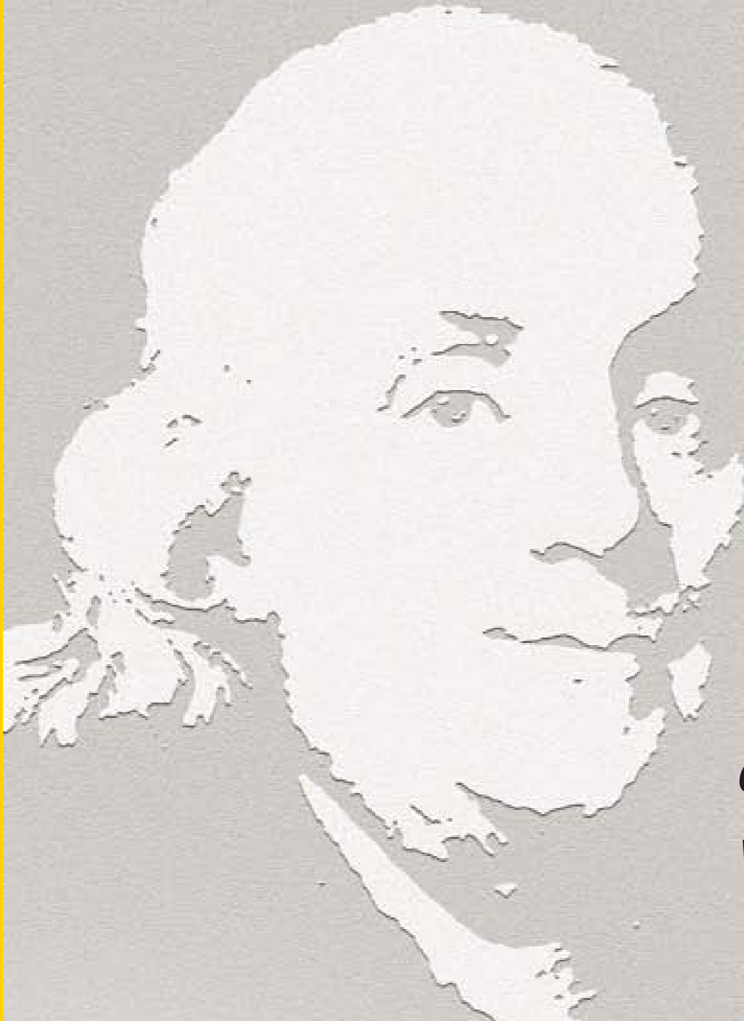

"Beware of small expenses. A small leak will sink a large ship."

Benjamin Franklin

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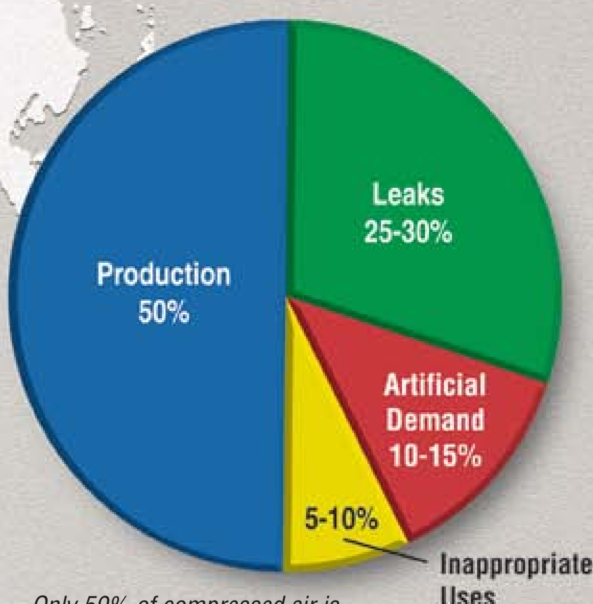

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