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

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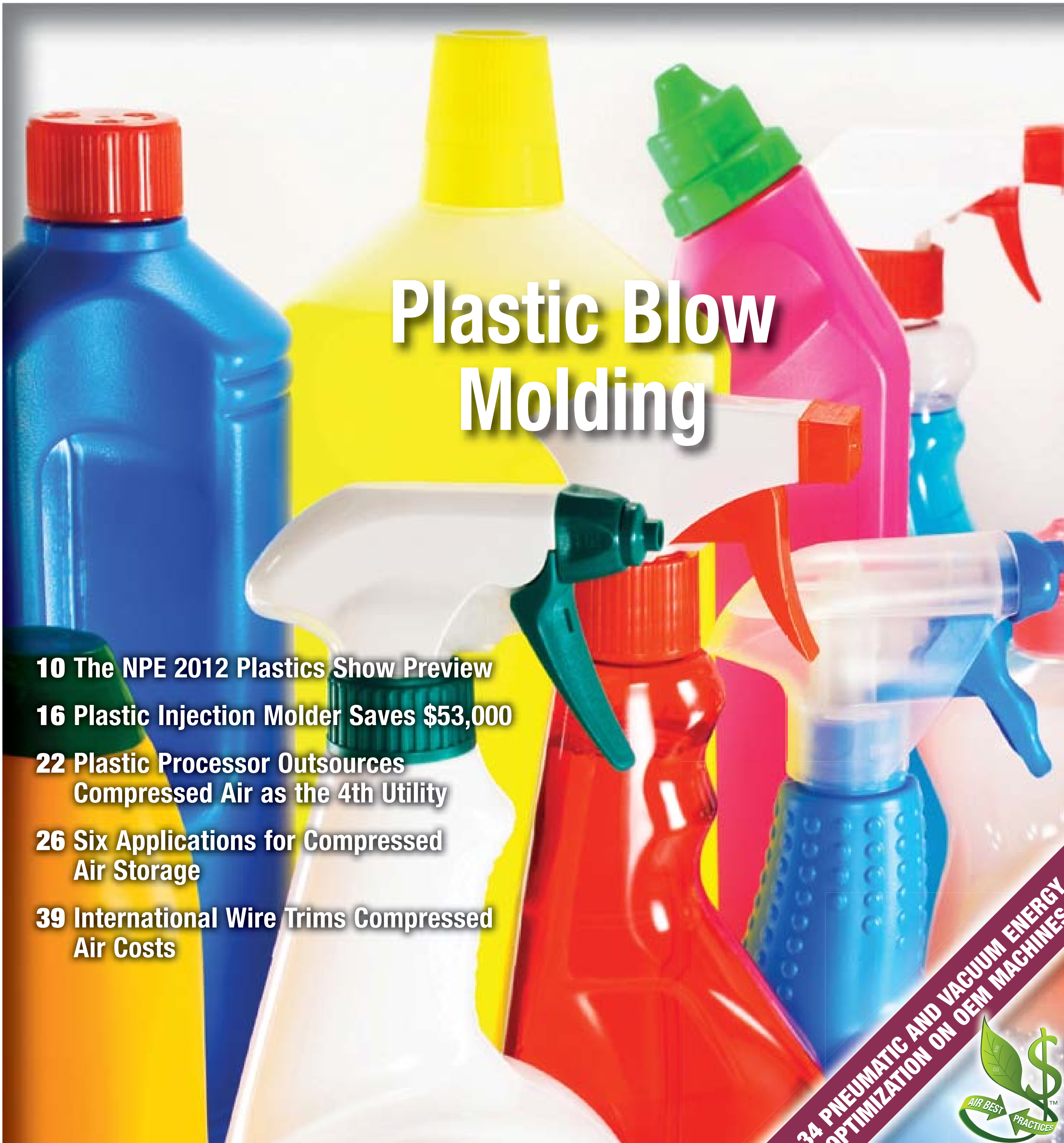
March 2012



Plastic Blow Molding

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
- Multi-stage cooling for stable discharge temperatures
- Highest Air Purity
- Environmentally Friendly
- Low cost of operation
- Ultra low sound with standard quiet enclosure
- Space Saving Footprint
- Product Range
  1.5kW — 5.5kW Simplex Units
  7.5kW — 16.5kW Multiplex Units
- Pressure applications up to 145 PSI
- Energy Saving Variable Drive Mode (Multiplex Only)

SRL Series Multiplex
(Multiple Motor/Multiple Scroll Configuration)

Interested to become an Authorized Distributor for Hitachi SRL Series Compressors? See our ad in the Job Market Section.

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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FROM THE EDITOR

The Plastics Industry at 100 psi

The plastics industry is the third largest manufacturing segment in North America. The U.S. plastics industry employs 1.1 million workers in the U.S. and provides nearly $379 billion in annual shipments. Past issues have talked about the PET blow molding industry that uses 580 psi compressed air for bottle blowing. This issue focuses on the larger plastics industry segment, using 100 psi compressed air, engaged in injection and extrusion blow molding. There are over 1,100 plastics manufacturing firms in California alone. Average installed air compressor horsepower is 400–800 hp.

Over 45,000 visitors will have the opportunity to learn more about the compressed air, pneumatic, blower and vacuum systems required to run their blow molding operations at the triennial NPE 2012 international plastics exposition. Our "2012 NPE Show Preview" has an overview of the firms exhibiting.

Veteran system assessment expert, Hank van Ormer, provides us with a case study on how his firm helped a plastic injection molder reduce their annual energy costs by $53,000 — a reduction of over 50%. The plant operated 450 horsepower of air compressors at 105 psig. The system assessment found ways to reduce compressed air demand and then automated the air compressors to run in a more efficient manner. The costs to implement were so insignificant that the ROI was 30 days.

Many of these plastics blow molding plants (again at 100 psi) have a dense-phase transport system creating significant compressed air flow spikes. Tim Tensing, from DirectAIR, provides us with an interesting article on how his firm helped a plastic processor address these spikes and reduce their compressed air annual energy costs from $276,000 to $111,000. Interestingly, the firm also decided to outsource compressed air, as the 4th Utility, and realize further benefits.

Veteran plastics industry system assessment expert, Dean Smith, provides us with a very organized and detailed article on "The Six Applications for Compressed Air Storage". The significant benefits include increased production output and reduced energy consumption from the air compressors.

"Pneumatic and Vacuum Energy Optimization On OEM Machines", is an article provided to us by Philip O'Neil from Bosch Rexroth. This topic represents the next frontier in system assessments. End users are beginning to realize that they must ask their OEM suppliers to provide energy-optimized equipment.

Tom Taranto and Ram Kondapi, on behalf of the Compressed Air Challenge®, finish off the edition with an excellent system assessment case study titled, "International Wire Trims Compressed Air Costs Using the Systems Approach".

Our mission is to distribute educational and motivational content 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. We thank the authors above for sharing their knowledge and 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

Mattei Compressors introduced a Gas Compressor line of products. Jay R. Hedges, General Manager of Mattei Compressor, North America, announced that Mattei has developed a full line of Rotary Vane Gas Ends and Gas Compressor packages for the North American Market. Part of a global strategy to move aggressively into the natural gas, landfill gas and micro turbine markets, Mattei North America now offers a full line of Gas Ends ranging from 5.5 hp (23 cfm) to 75 hp (313 cfm).

"We see Natural Gas and Landfill Gas compression as growing markets as the U.S. These are market driven steps toward American energy independence through traditional and non-traditional fuels" Hedges said. "The U.S. has an abundance of untapped Natural Gas reserves that are slowly becoming economically competitive as oil prices remain high. Methane gases produced by landfills and sewage treatment facilities are technically and financially viable after decades of experimentation, and new EPA regulations.

The Mattei Rotary Vane Technology is well suited for gas applications due to its energy efficiency running at slow speeds ranging from 1200 rpm to 1800 rpm at 60 Hz, compared to pistons and rotary vane compressors typically running from 3500 to 7500 rpm. Running at slower speeds increases the life of compressors makes the compression process more efficient, reduces wear on moving parts, and reduces service costs. With no bearings to wear or decrease efficiency over time, Mattei Rotary Vane compressors boast a design life of 100,000 hours.

"Our Italian affiliate, Mattei SPA has designed and built complex engineered packages for gas applications such as compressing landfill gas to drive large Micro turbines. Building on this experience, our North American strategy will be to supply standard gas ends from 5.5 hp (23 cfm) to 75 hp (313 cfm). We will work with a network of Gas Packagers in North America to engineer and assemble gas packages for complex projects in our markets", according to Hedges.

"The entry into Gas Compression is a strategic decision as we position Mattei's Rotary Vane Technology, to expand into new applications and new markets where we have competitive advantages" added Guilio Contaldi, CEO of Mattei SPA based in Milan, Italy. "As the world's largest Rotary Vane compressor manufacturer, we have taken the time to study market demand and to develop a product line of high quality gas compressors that will meet the needs of a major part of the market from 4 kW to 55 kW. Moving into Gas Compression offers an opportunity for growth globally, but particularly in the U.S. where Mattei Compressor sales have doubled in the past 4 years." www.matteicomp.com

mattei®

Atlas Copco has been ranked the world's tenth most sustainable company in the annual Global 100 list, presented today at the World Economic Forum in Davos, Switzerland. Atlas Copco is the highest ranked industrial company. "Our work to develop Atlas Copco in a sustainable and profitable way is yielding results," said Annika Berglund, Senior Vice President Corporate Communications at Atlas Copco. "This long-standing effort was further enhanced last year with the introduction of a range of new goals. We are proud to see this development recognized on the Global 100 list." The Global 100 list is presented annually at the World Economic Forum. It is based on a selection of 4 000 developed and emerging market companies, which are measured against key performance indicators such as revenues in relation to consumption of energy and water. Atlas Copco was included on the list for five consecutive years until 2010, but was not ranked in 2011. http://global100.org

Atlas Copco

Festo Corporation introduced Festo Energy Saving Services. Pneumatic installations frequently do not include any monitoring facilities. More and more industrial companies are using precise compressed air consumption data as the main criterion for the choice of new equipment. With a detailed compressed air consumption analysis, they can make savings of up to 50% more than with conventional methods. Even before commissioning, a compressed air consumption analysis can determine the precise compressed air consumption of an installation — both during normal operation and with machines at a standstill. It thus guarantees optimum dimensioning of the compressed air supply system and prevents unnecessary costs, which might be caused by an overdimensioned compressed air distribution system.

When an installation is optimized with Energy Saving Services, the aim is to avoid damage and breakdowns in advance. Festo offers various condition monitoring and diagnostic measures for this purpose. Through the continuous monitoring of critical components, it is possible to detect wear, pressure, and flow changes at an early stage and avoid the danger of machine downtime. If a breakdown nonetheless occurs, the diagnostic systems ensure that the cause of the trouble is quickly located. Energy Monitoring GFDM is a complete system for the continuous monitoring of compressed air consumption and volumetric flow. Alternatively, installation operators can select a customer-specific condition monitoring system. Diagnostic systems are compiled from function modules in accordance with individual customers' requirements. The available functions include not only consumption monitoring, but also time monitoring of actuators and valves, monitoring of vacuum applications, and detailed monitoring of actuators (e.g. force monitoring and fault detection). www.festo.com/us.

FESTO

Sullair Corporation announced today that it will invest in its global headquarters here, creating up to 113 new jobs by 2015. Sullair expects to invest up to $12.7 million to purchase new equipment and make energy efficiency upgrades at its 410,000 square-foot LaPorte County facility. "Sullair has called Indiana home for decades and we are pleased that they are continuing to invest in our state," said Governor Mitch Daniels. "By maintaining one of the best business climates in the nation, Indiana is able to attract and retain companies like Sullair and we look forward to many more years of success from this global leader."

Established in 1965, Sullair is headquartered in Michigan City with manufacturing facilities in China, Australia and the United States. The company has already begun hiring new

COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

production associates. "We expect to see increasing demand in our developed markets as the worldwide economy shakes off the lingering effects of the recent recession," said Henry Brooks, president of Sullair. "Investing in our U.S. sites will help us meet that demand while providing resources for technological research." www.sullair.com

SULLAIR®
Always air. Always there.

UE Systems announced Ultrasound World VIII set for May 14-17, 2012. Ultrasound World, considered to be the major forum for ultrasound technology will take place May 14 through 17, 2012 at the Clearwater Hilton in Clearwater Beach Florida. Entering its eighth year, it has grown to become recognized as one of the top conferences for reliability and energy conservation. The program will include presentations and short courses by users of the ultrasound technology and will cover a wide range of topics for condition monitoring and energy conservation. One presentation by Todd Fraser of Procter and Gamble titled "No More Equipment Failures! Can You Say That?" will describe how his department dramatically reduced bearing failure incidents using ultrasound technology. Also of interest is a short course: Clean, Green and Reliable, "How equipment reliability delivers low cost, energy efficient assets at plants around the world!" Other important topics such as: detecting and analyzing electrical fault conditions with ultrasound, and effective energy conservation practices will be included in the program. www.uesystems.com

UE SYSTEMS INC

Chicago Pneumatic announced the appointment of Todd Francis as the new Vice President, North America for stationary compressors. Francis will be based out of Chicago Pneumatic's Rock Hill, S.C., office, and will be responsible for new business development and further building Chicago Pneumatic's distributor network across the North American compressor markets. "On behalf of the entire Chicago Pneumatic team, I am very excited to welcome Todd to his new role as Vice President, North America," said Ellen Steck, President, Chicago Pneumatic. "Todd's extensive background with Chicago Pneumatic Construction and the Atlas Copco Group, combined with his experience leading business development efforts across a variety of construction and heavy equipment business units, position him for immediate success as our new Vice President, North America."

Francis joins the Chicago Pneumatic executive team after more than two decades in the commercial construction and heavy equipment sales and rental field, including more than seven years as part of the Atlas Copco group of companies. Francis previously served as National Account Manager for Chicago Pneumatic Construction, where he was responsible for managing and expanding national accounts, cross-selling CP products while developing new business opportunities. Prior, Francis served in senior sales management positions with Allied Construction/Sandvik Tamrock and The Caterpillar Rental Store. www.cp.com

Chicago Pneumatic

Spirax Sarco announced a plant expansion in its' Blythewood, South Carolina operation to accommodate growth in its steam system solutions business. The new facility has over 35,800 square feet of office and production space. "Our business is continually growing due to the hard work and dedication of our employees. This facility will enable Spirax Sarco to successfully meet the growing industry demand for steam system solutions and to better serve our customers nation-wide," said Stephen Gow, Director of Marketing. www.spiraxsarco.com/us

spirax sarco

Gardner Denver announced fourth quarter results that established a quarterly record for DEPS, and full year results that established records for revenue, operating income, operating margin, net income and DEPS.

- Fourth quarter revenues of $614 million and orders of $598 million increased 16% and 14%, respectively, over the prior year
- Delivers record fourth quarter diluted earnings per share ("DEPS") of $1.52, including $0.02 of profit improvement costs and other items, resulting in Adjusted DEPS of $1.54, up 34% over last year
- Expects first quarter 2012 DEPS of $1.20 to $1.30, including acquisition related and profit improvement costs totaling $0.10 per diluted share, resulting in an Adjusted DEPS range of $1.30 to $1.40

- Expects total year 2012 DEPS of $5.85 to $6.05, including acquisition related and profit improvement costs totaling $0.15 per diluted share, resulting in an Adjusted DEPS range of $6.00 to $6.20

www.gardnerdenver.com

GARDNER DENVER
Experience Proven Results

Atlas Copco reported fourth quarter results with continued growth in orders and revenues. Profitability remained on a good level. For the full year 2011, Atlas Copco reached new records for sales and operating profit. "We have had a solid end to a year that was nothing less than fantastic for Atlas Copco," said Ronnie Leten, President and CEO of the Atlas Copco Group. "Demand for our products and services was better than expected during the quarter." Revenues in the fourth quarter increased 16% organically to BSEK 22.3 and the operating profit was BSEK 4.6 (4.0), corresponding to a margin of 20.6% (20.7). The full-year organic revenue increase was 22% to BSEK 81.2, with a margin of 21.6% (19.9). In the near term, the overall demand for Atlas Copco's products and services is expected to weaken somewhat from the current high level. "We have a good starting point but a challenging task ahead; the global outlook is difficult to predict and we will continue seeking long- and short-term growth opportunities," Leten said. "During the fourth quarter we invested in competence development in all markets, developed our manufacturing capacity in Asia and made acquisitions to extend our presence and product offering." www.atlascopco.com

Atlas Copco

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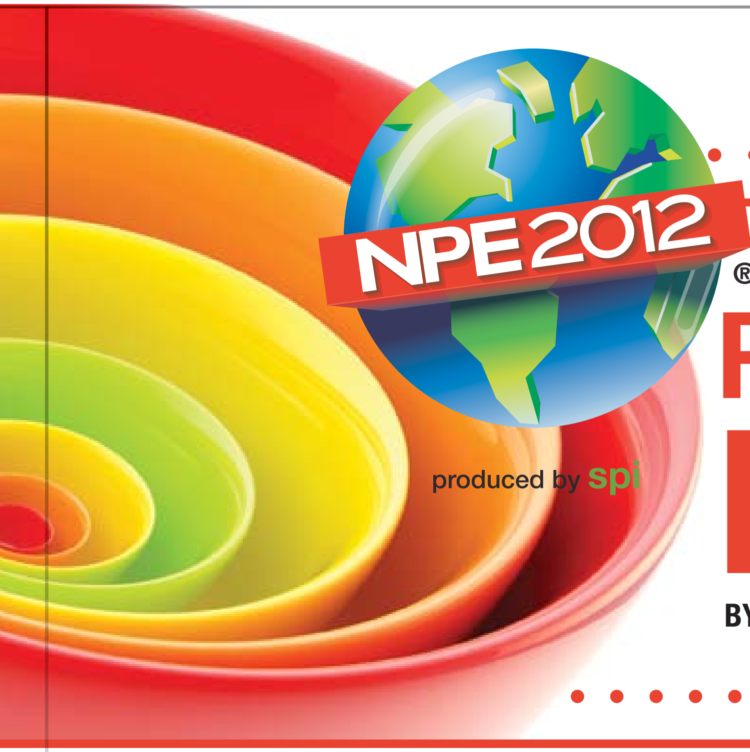


PLASTICS SHOW PREVIEW

BY COMPRESSED AIR BEST PRACTICES®

NPE2012 will be the ***largest plastics exposition in the Western Hemisphere,*** providing access to North America's $400-billion/year plastics marketplace and serving as a hub of trade for plastics companies from South America, Europe, and Asia. In 2009, NPE attracted 1,851 exhibitors on 977,660 sq.ft. (88,00 sq. m) of net space; 33% of them came directly from outside the U.S. More than 45,000 people from 19,000 companies in 101 countries registered for NPE2009. A complete schedule of events can be found online at www.npe.org.

Produced by SPI: The Plastics Industry Trade Association, the triennial NPE international plastics exposition will next take place on April 1–5, 2012, at the Orange County Convention Center in Orlando, Florida, after 40 years in which the show was held in Chicago. "The improved economies and logistics of the new venue have encouraged many NPE2012 exhibitors to purchase more exhibit space and bring more machinery to the show, much of it to be operated on-site," said Gene Sanders, SPI senior vice president of trade shows and conferences. "Contributing to this enhanced commitment by exhibitors is the steadily improving manufacturing sector of the U.S. economy."

TABLE 1. COMPRESSED AIR, PNEUMATICS, BLOWER AND VACUUM TECHNOLOGY EXHIBITORS AT NPE 2012

COMPANY	BOOTH NUMBER
ABC Compressors	8584
AF Compressors	575
Atlas Copco Compressors	31013
Becker Pumps	29038
BOGE Compressors	10021
Bosch Rexroth	2563
Busch Vacuum Pumps	63042
Cameron Compression Systems	20036
Compressed Air Best Practices Magazine	10022
Dekker Vacuum Technologies	3095
Gardner Denver, Bellis & Morcom, CompAir	623
Hitachi Air Technology	33028
Kaeser Compressors	7377

Compressed Air, Pneumatics, Blower and Vacuum Technology Exhibitors

We highly recommend that blow molders take the time to review their compressed air, pneumatic, blower & vacuum systems, and then visit the booths at NPE 2012 of these technology providers to discover the ways they can improve the energy efficiency and productivity of their systems.

GD Bellis & Morcom **(Booth 623)** oil-free reciprocating compressors are specifically designed for PET bottle-blowing to ensure many years of reliable trouble-free operation in all operating environments. These compressors are designed for optimum performance resulting in low power consumption providing a cost effective solution for today's bottle blowing applications.

The VS Series™ , from Gardner Denver, is a complete, revolutionary, rotary screw air compressor line that delivers optimal

Booth 623: GD Bellis & Morcom oil-free reciprocating air compressor for PET bottle-blowing.

performance over a wide operating range. The flexibility of this line provides stable pressure in the plant resulting in maximum productivity. The VS Series™ is so reliable that Gardner Denver backs it with the best warranty in the business. The "Bigger Is Better" philosophy has never held truer than with the Electra-Saver II rotary screw air compressor. The BIG, slow-speed air end, along with the gearless design of the Electra-Saver II, results in a 3–5% efficiency advantage over the competition.

Kaeser Compressors (Booth 7377) announced it's versatile aluminum SmartPipe™ is now available in a 6" diameter. The new size brings all the advantages of the popular compressed air piping to larger industrial air systems. SmartPipe is a modular piping system for dry, wet, or lubricated compressed air and inert gases. Made from engineered alloys and polymers, SmartPipe will not rust and the smooth interior results in better flow. It is completely removable and reusable, and can be modified to accommodate changing needs. The system is designed for simplified installation without threading, welding or brazing. The new 6" SmartPipe not only integrates easily with existing steel or copper systems, but also SmartPipe sizes down to 2 ½".

Booth 7377: Kaeser Compressors SmartPipe™ system.

NPE 2012 PLASTICS SHOW PREVIEW

Booth 31013: Atlas Copco ZT22 Full-Feature Oil-Free Air Compressor.

Atlas Copco Compressors (Booth 31013) will be unveiling a brand new booth concept at the 2012 NPE show. With energy-recovery continuing to be a hot topic within the industry, the booth has been designed with an energy recovery concept throughout and will be showcasing the wide range of air compressors, accessories and auditing capabilities that are specifically tailored for the Plastics Industry.

Both oil-free and oil-injected technologies will be on show, as well as giving visitors the chance to interact with the latest energy-saving control systems live on the booth. Products on display will include the GA&, ZT22 and ES360.

Becker Pumps Corp (Booth 29038) is introducing their new VTLF2 series of pumps featuring improved cooling, reduced noise, greater ease of maintenance, and hands-off evaluation of the filters. Continuous duty vacuum levels to 27 in.HgV, with flows from 127 to 173 cfm. Applications include PVC extrusion, thermoforming, VARTM, and more.

Booth 29038: Becker Pump new VTLF2 Series vacuum pumps.

AF Compressors (Booth 575) specializes in providing high-pressure, oil-free systems for PET stretch blow molding applications. Since providing the first PET air compressor over 30 years ago, the entire Ateliers Francois organization has been dedicated in providing the best product and aftermarket support for their customers throughout the world.

AF's unique "L-Design" is a proven, robust compressor that can reduce your plants total operating expenses, in both maintenance and power costs, versus other competitive machines that are being offered in our market. The compressor range offers capacities from 225 to 3,200 m³/h at a 40 bar operating pressure. Each compressor package includes refrigerated air dryer, air receiver, and starter/control panel with PLC controls. As options, we can provide closed loop cooling systems, high pressure regulators, variable speed drives, and multiple compressor controllers to meet the specific needs of your project. AF Compressors has over 4,000+ PET air compressors in 137 countries.

Booth 575: AF Compressor "L-Design" PET Air Compressor.

Displaying the some of the newest technologies of oil-free air compression will be the **Hitachi Air Technology Group (Booth 33028).** Serving the highest ISO 8573.1 Air Quality Classifications, the Multiplex SRL Series Oil-Less Scroll compressor and related Oil-Free Air Purification are amongst the many unique products within Hitachi's Oil-Free Compressed Air Portfolio that will be on display.

Booth 33028: Hitachi SRL Series Oil-Free Air Compressor.

Companies engaged in blow molding need compressed air at a range of different pressures in the plant. **BOGE Compressors (Booth 10021)** will be displaying their SRHV Series Booster Compressor. This product is a two-cylinder machine rated for up to 94 cfm at 580 psi. BOGE will also be displaying the C 30 rotary screw air compressor, featuring a small footprint and high efficiency profile, rated for 135 cfm at 100 psi.

Booth 10021: BOGE Booster Compressor.

Blow Molders Can Save Energy in their Compressed Air Systems

Plastic is a material that surrounds us in the products we use every day. Simply put, at NPE one finds all the machinery required to make these plastic products! This is why thousands of blow molders visit NPE. After years of system assessments in blow molding facilities, we at Compressed Air Best Practices® Magazine know that most have significant energy savings opportunities in their compressed air systems. Almost all of these projects have simple ROI's in the 1–2 year range.

Injection and extrusion blow molders manufacture the plastic bins, car panels, toothbrushes, cell phone covers, printer covers, and plastic containers we use in every day life. They require compressed air systems running at 80–100 psi. "Most injection and extrusion blow molders typically have 400-800 horsepower of installed air compressors, generating $200–$500,000 per year in energy costs with a 35–45% savings opportunity," according to Dean Smith of iZ Systems.

Stretch blow molders manufacture plastic beverage bottles for water, soft drinks, juices, and beer. Thy require compressed air systems ranging from 294 psi (1/2 liter water bottles), 440 psi (1-liter bottles for carbonated soft drinks and juices), and 520 psi (2-liter bottles for carbonated soft drinks). They also need 100 psi "plant air". Smith continued, "Most stretch blow molders typically have 2,000 to 4,000 horsepower of

Injection and extrusion blow molders operate compressed air systems at 100 psig generating average annual energy costs of $200-750,000. SPI: The Plastics Industry Trade Association

NPE 2012 PLASTICS SHOW PREVIEW

Stretch blow molders operate compressed air systems ranging from 100 psig to 520 psi generating average annual energy costs of $1–$3 million. Image Source: SPI: The Plastics Industry Trade Association

installed air compressors, generating $1–$3 million in annual energy costs with a 10–20% savings opportunity."

All blow molders deploy pneumatic, blower and vacuum technologies present in a variety of OEM machinery present in upstream and downstream applications from the molders.

We also recommend that companies engaged in stretch blow molding visit SIDEL (Booth 8825) and ask about their ECO Services program. The ECO Booster™ component of this program is available for the SBO Series1, Series2, and Series3 PET blow molders. This audit will examine ways to reduce the compressed air costs generated by these SIDEL blow molding machines.

KRONES (Booth 649) offers the Air Wizard package on their Contiform Blow molding machines to optimize the energy costs associated with

Booth 649: KRONES Contiform 3 PET blow molding machine.

compressed air. The Air Wizard will achieve the following improvements:

- The reduction of the dead space volume comprises a reduction of the valve block volume and blowing nozzle volume
- Based on the optimisation of the process-technological processes of final blowing, the final blowing pressure necessary regarding the quality and shape of the PET bottle can be reduced
- When recycling the final blowing pressure, a part of the blowing air is used during the pressure relief phase

To conclude, don't forget to visit the booth of Compressed Air Best Practices® Magazine (Booth 10022) and to sign up your colleagues in the plastics industry for a FREE subscription to our monthly publication! BP

For more ***Plastics Industry*** articles, visit www.airbestpractices.com/industries/plastics

THE SYSTEM ASSESSMENT

Plastic Injection Molder Saves $53,000

BY HANK VAN ORMER, AIR POWER USA

March 2012 System Assessment of the Month

Where: North America
Industry: Plastic Molding
Issues: Compressor Automation and Inappropriate Uses
Audit Type: Supply and Demand Side

System Assessment Win/Win Results*

Energy Savings per year:	$53,191
Project Investment:	$4,170
Simple ROI:	28 days
Reduction in Energy Use:	967,100 kWh
Equivalent CO_2 Emissions:	694 metric tons*
Equivalent CO_2 for homes:	62 homes
Equivalent CO_2 for vehicles:	133 vehicles

*Source: CO_2 Calculator on www.airbestpractices.com

The Facility

This facility is part of a corporation producing molded plastic products. There are many injection and extrusion molding processes. The factory was spending $94,934 annually on energy to operate their compressed air system. This system assessment detailed seven (7) project areas where yearly energy savings totaling $53,191 could be found with a minimal investment of $4,170. Due to space constraints, this article will detail only the higher impact project areas. The over-all strategy for improving this air system centers on improving specific power performance of the installed air compressors and reducing over-all demand with compressed air savings projects.

Measurement Actions Establish the Baseline

The following actions were taken to establish the baseline for flow, power and pressure.

1. Temperature readings were taken on all units with an infrared surface pyrometer. These were observed and recorded to relate to the unit's performance, load conditions and integrity

2. Critical pressures including inlet and discharge were measured with a single Ashcroft digital calibrated test gauge with an extremely high degree of repeatability

3. All units had the input kW measured with a Fluke motor analyzer and recorded with the Hawkeye kW monitors and MDL logger

4. System pressure was measured using an Ashcroft pressure transducer and the same multi-channel MDL data logger. These pressure readings were consistent with the panel gauges on the compressors and the single control pressure transformer mounted in the discharge line downstream from the after-filter

Existing Supply-Side System Overview

The "specific power" rating of the current system is 5.12 cfm/kW. This energy efficiency metric means that for every one kW consumed, the air compressors generate 5.12 cfm (cubic feet per minute) of compressed air flow. Measurements showed that the system consumes 973 cfm and 190 kW. This is an efficient supply-side system.

When doing system assessments, the energy savings estimates depend, in part, on the air compressor capacity control system effectively translating lower air use into reduced electric cost. The currently installed air compressors have this type of unloading controls. Additionally, the existing piping system will allow the controls to accomplish their goals.

The compressed air system operates 8,760 hours a year. The load profile (air demand) of this system is relatively stable during all shifts.

System Before Assessment		System After Assessment	
Energy Costs per year:	$91,542	Energy Costs per year:	$38,351
Operating hours:	8760 hours	Operating hours:	8760 hours
Power Cost kW/h:	$0.055	Power Cost kW/h:	$0.055
Avg. Production Air Flow:	973 cfm	Avg. Production Air Flow:	518 cfm
Input Electric Power:	190 kW	Input Electric Power:	79.6 kW
Specific Power:	5.12 cfm/kW	Specific Power:	6.40 cfm/kW
Compressor Discharge Pressure:	105 psig	Compressor Discharge Pressure:	100 psig
Avg. System Pressure:	95 psig	Avg. System Pressure:	95 psig

THE SYSTEM ASSESSMENT

Plastic Injection Molder Saves $53,000

The main "air compressor room" supplying the compressed air system has four 100 horsepower lubricant-cooled, air-cooled rotary screw air compressors installed. The newest is Unit #5. The compressed air then goes into a "wet" compressed air 1500 gallon storage tank. The compressed air is dried to a +38 F (+3 C) pressure dew point by two refrigerated air dryers. One dryer is a non-cycling dryer rated for 1700 cfm and the second, newer unit, utilizes a "cycling digital scroll" refrigeration compressor, able to unload and load almost an unlimited number of times for lower operating power. This unit is rated for 2,000 cfm. Particulate and oil coalescing filters are installed after the refrigerated dryers.

The four "compressor room" air compressors come from two different manufacturers. The air treatment equipment comes from two other manufacturers. All the equipment is performing well and maintenance is regularly scheduled and executed by the compressed air system vendor.

Unit #4 is working as a baseload machine and is running fully-loaded. Unit #2 (the 1st trim unit) is never loaded for a full minute and the system pressure rises 5 psig in 50 to 55 seconds. Total load time is 30 hours; total running time 1,314 hours. Unit #5 is the 2nd trim unit and is never off for more than 50 seconds. Unit #1 is OFF.

The Warehouse has "Unit #3" — a 50 hp lubricant-cooled, air-cooled, rotary screw air compressor. It is connected to a 120 gallon receiver tank and a non-cycling refrigerated air dryer. This system has been OFF for some time and has been valved-out of the piping system.

Project #1: Adjusting Air Compressors and Dryers to Lower Demand Profile

The first key to this project was that we were able to find 455 cfm of flow reduction opportunities. The second key (leading to the rapid payback) is that we already had the air compressors that could transform the flow reductions into energy savings.

After the energy conservation projects were realized, our new system flow requirement of 518 cfm can be met by Unit #5 running fully-loaded. This allows us to TURN OFF compressors #2 and #4 completely. The new total direct energy consumption will be 79.6 kW.

TABLE 1. COMPRESSOR USE PROFILE — CURRENT SYSTEM

UNIT #	COMPRESSOR: HORSEPOWER AND PRESSURE SETTING	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (CFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL CFM
All Shift: Operating at 105 psig discharge pressure for 8760 hours							
1	100 hp at 125 psig	77	440	OFF			
2	100 hp at 105 psig	81	458	37	30	2	9
3	50 hp at 105 psig	47	250	OFF			
4	100 hp at 105 psig	83	490	100	82	100	490
5	Newer 100 hp at 105 psig	82	520	95	78	91	474
			TOTAL (Actual):		**190 kW**		**973 cfm**

TABLE 2. COMPRESSOR USE PROFILE — PROPOSED SYSTEM

UNIT #	COMPRESSOR: MANUFACTURER/MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (CFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL CFM
All Shifts: Operating at 100 psig discharge pressure for 8,760 hours							
1	100 hp at 125 psig	77	440	OFF			
2	100 hp at 100 psig	81	458				
3	50 hp at 100 psig	47	250				
4	100 hp at 100 psig	83	490				
5	Newer 100 hp at 100 psig	82	520	99	79.6	98	518
			TOTAL (Actual):		**79.6 kW**		**518 cfm**

We will also be able to bypass the refrigerated dryer rated for 1700 cfm and use the cycling digital scroll refrigerated air dryer. The primary benefit will be the elimination of a 5 psig pressure drop we saw in the air dryer. The cycling digital scroll dryer unit has load-matching turn-down capabilities well suited to manage the lower demand profile. The potential energy-savings (in kW) of running this dryer at partial load are not included in these estimates.

Realign compressor units and bypass old dryer — a savings of 20% of current operating cost of air system	$18,308 /yr
Total pressure reduction	5 psig
Value of pressure reduction	$452.71 /psig
Energy cost reduction	$2,289/yr
Estimated cost to complete project	$0

Project #2: Leak Identification and Repair

We attempted to run a partial leak-tagging program with an ultrasonic leak locator in the major production area, but the high volume of open blows created too much background ultrasonic noise. Until the number of open blows is reduced significantly (Projects #5 and #7), we suggest you be sure to check for leaks during a shut down. The plant already owns a high-quality ultrasonic leak locator.

Estimated reduction of air flow with proposed project	100 cfm
Recoverable savings from air flow reduction [Section 2.3]	$70.39 /cfm/yr
Annual electric cost savings with proposed project	$7,039 /year
Unit cost of leak repairs ($15 materials per leak and $35 labor per leak)	$1,650

Project #3: Modify Blow-off Air in the Tumblers

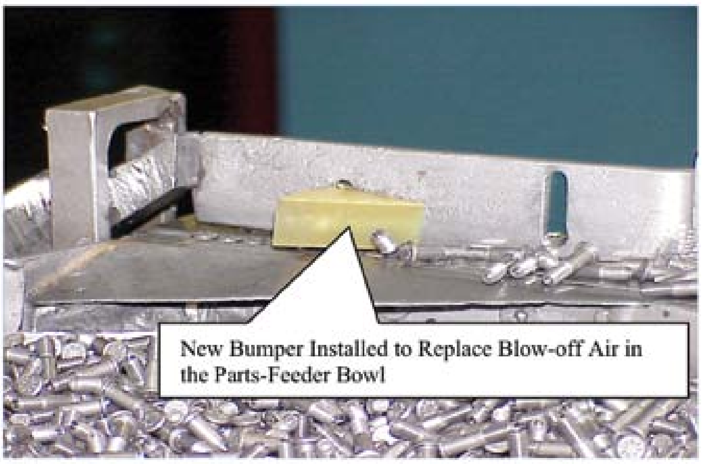
Regardless of application, there are several guidelines that should always be applied to compressed air being used for open blow off:

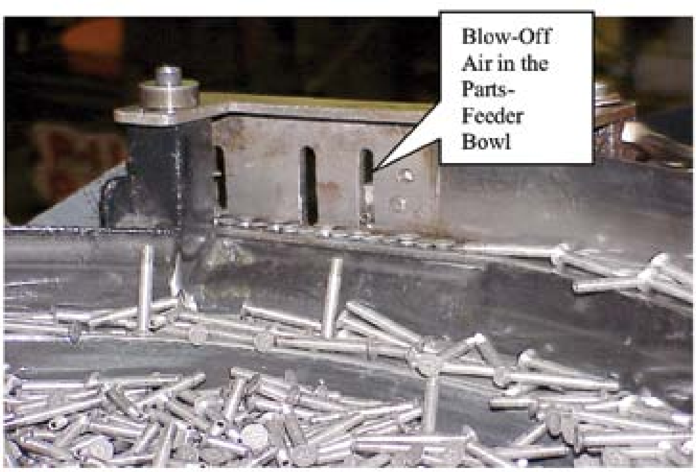
- Use high pressure only as a last resort
- All blow off air should be regulated
- All blow off air should be regulated to the lowest effective pressure—higher pressure means higher flow, which may not be needed
- Use Venturi air amplifier nozzles whenever and wherever possible—this will usually reduce blow off air at least 50%, freeing up more air flow for other applications
- All blow-off air should be shut off (automatically) when not needed for production

THE SYSTEM ASSESSMENT

Plastic Injection Molder Saves $53,000

The factory has over four hundred (400) 1/8th inch blows in the tumblers/sorters throughout the plant. Each of these use at least 1 cfm of air at 30-40 psig pressure. If we replace just 200 of these with appropriate mechanical devices, the savings would be 200 cfm. An example of a mechanical "bumper" is pictured below.





Value of compressed air savings in $cfm/yr	$70.39 cfm/yr
Electrical Energy Cost value of 200 cfm of compressed air saved	$14,078/yr.
Cost of 200 mechanical blocks installed $5 each	$1,000

Project #4: Reduce Pressure to Nozzles in Conveyors

We noticed many large (1" or more) Venturi vacuum nozzles used for small material conveying. This is a good application, however, many of them seem to be over-powered. Reducing the pressure to twentyfive (25) of these units will reduce the compressed air flow by at least 20 cfm and may enhance quality.

Electrical Energy Cost savings per cfm	$70.39/cfm/yr.
Electrical cost savings of 20 cfm	$1,408/yr.
Cost to implement	$ -0-

Project #5: Replace Lechler Dispersion Air Nozzles

Replace sixteen (16) yellow or black Lechler plastic dispersion air nozzles with Venturi air inducers or amplifiers, which will use less air and deliver more total air to the process.

Net minimum savings	130 cfm
Electrical energy cost savings per cfm	$70.39
Electrical energy cost savings of 30 cfm	$9,151/yr
Cost of 16 nozzles implemented	$320

Project #6: Air Vibrator Retrofits

Air vibrators are used to keep product or packaging moving or separated — e.g., keeping lids separated prior to sealing. If a plant employs air vibrators that use about 10 cfm each, they will require about 2.5 hp or more to produce the same as a similar electric vibrator, which might use about 0.25 hp input energy. A list of air vibrator retrofits is provided below.

TABLE 3. LIST OF AIR VIBRATOR RETROFITS

	LOCATION	QTY	CURRENT AIR FLOW (CFM)	USAGE (%)	NET SAVINGS (AVG CFM)
#1	3" Diameter Air Vibrator	1	7	100	7
#2	1 ½" Diameter Air Vibrator	2	3 each	100	6
				TOTAL	**13**

"In this report, the supply-side efficiency savings total 20% of the current system operating costs or $18,308."

— Hank van Ormer, Air Power USA

Electrical energy cost value of compressed air	$70.39 cfm/yr
Electrical energy cost value of 13 cfm	$915 /yr
Estimated cost of electric vibrators	$1,200

Conclusion

Most of the overall system assessment savings of $53,191 are simply the difference between the operating costs of the current air compressors ($91,542) and the proposed compressors ($38,351).

Savings from improvements in supply system efficiency can be calculated by comparing the relative improvement in "specific power" ratings as defined as 1 — (5.12 cfm/kW for the existing system divided by 6.4 cfm/kW for the new system). In this report, the supply-side efficiency savings total 20% of the current system operating costs or $18,308. This estimate is then subtracted from the compressor operation cost savings of $53,191, leaving $34,883 to be allocated between pressure reduction projects and flow reduction projects.

Savings from pressure reduction projects are estimated by using the rule of thumb that electric costs are lowered by ½% for every pound of pressure reduction. In this report, there was a reduction of 5 pounds of pressure for an electric savings of 2.5% of the current compressor operating cost or a total of $2,289 per year (or $457.71 per psig).

The remaining system savings of $32,594 are allocated among the air flow reduction projects, which are saving 463 cfm at a calculated value of $70.39 per cfm. BP

Contact Hank van Ormer; tel: 740-862-4112, email: hankvanormer@aol.com, www.airpowerusainc.com

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TABLE 4. SYSTEM ASSESSMENT PROJECT SUMMARY

PROJECT	SAVINGS PROFILE	ENERGY AND OTHER SAVINGS			TOTAL PROJECT COST ($)
		AVG KW	KWH	SAVINGS ($)	
1. Realign compressor units and bypass air from compressor room around the Pneumatech dryer and filter	20% efficiency improvement	38.0	332,872	$18,308 /yr	- 0 -
1. Reduce discharge pressure of compressor by 5 psig	5 psig	4,7	41,618	$2,289 /yr	- 0 -
2. Implement ongoing leak management program; estimated minimum reduction (33 leaks)	100 cfm	14.6	127,896	$7,039 /yr	$1,650
3. Replace 200 1/8 " blows with mechanical pieces in tumblers	200 cfm	29.2	255,792	$14,078/yr	$1,000
4. Reduce pressure to 25 venturi nozzles used in parts conveyors	20 cfm	2.9	25,404	$1,408 /yr	- 0 -
5. Replace 16 blue/yellow/black Lechler compressed air dispersing nozzles with 1/4" variable Venturi amplifiers	130 cfm	19.0	166,382	$9,151 /yr	$320
6. Replace three compressed air vibrators with electric units	13 cfm	1.9	16,644	$915 /yr	$1,200
TOTAL	**5 psig 463 cfm**	**110.4 kW**	**967,100 kWh**	**$53,200 per year**	**$4,200**

Plastics Processor Outsources Compressed Air as the 4th Utility

BY TIM TENSING, DIRECTAIR®

Introduction

Outsourcing compressed air as the 4th Utility can be an excellent way to transform a high-cost, inefficient system into a modern system able to reduce the total cost of ownership. Treating compressed air as a true utility and outsourcing the entire process is a growing trend in the industry. If a plant does not generate their own power, provide their own water or deliver their own natural gas, then why not treat compressed air requirements in the same manner? This article will use a recent project as a case study to show the benefits one factory received by making the decision to outsource compressed air like a utility.

The Plastics Processor

This factory is in the plastics raw materials industry and operates 24/7 all year. The major processes, using compressed air, are air-operated control valves for mixers and material movement processes and secondly (but more importantly) the dense phase transport systems.

The total cost of ownership was very high for the compressed air system. Seven air compressors had been installed throughout the plant as it grew over the years. The air compressors generated an annual energy bill of $226,000. The average age of the air compressors, from a variety of brands,

The DirectAIR® Installation.

TABLE 1. COMPRESSED AIR SYSTEM COST OF OWNERSHIP ESTIMATE	
Air Compressor Energy Costs	$226,000 per year
Contracted Service & Repair Costs	$35,000 per year
Maintenance labor costs	$15,000 per year
Total	**$276,000 per year**

was fifteen (15) years. One air compressor was thirty years old. To keep the aging air compressors running, contracted service and repair costs averaged $35,000 per year plus an estimated $15,000 per year of labor costs from plant maintenance personnel to monitor and control the air compressors. Moisture, in the compressed air, was causing excessive repairs and replacements of pneumatic components (solenoid valve rebuilds) in the production equipment. Oily condensate, from all the air compressors, was channeled into the plants' sump wastewater treatment system where they were spending $80,000 per year on carbon filters. The final issue, facing management, was the capital being tied up in spare parts inventory and the realization that new air compressors would need to be purchased in the near future.

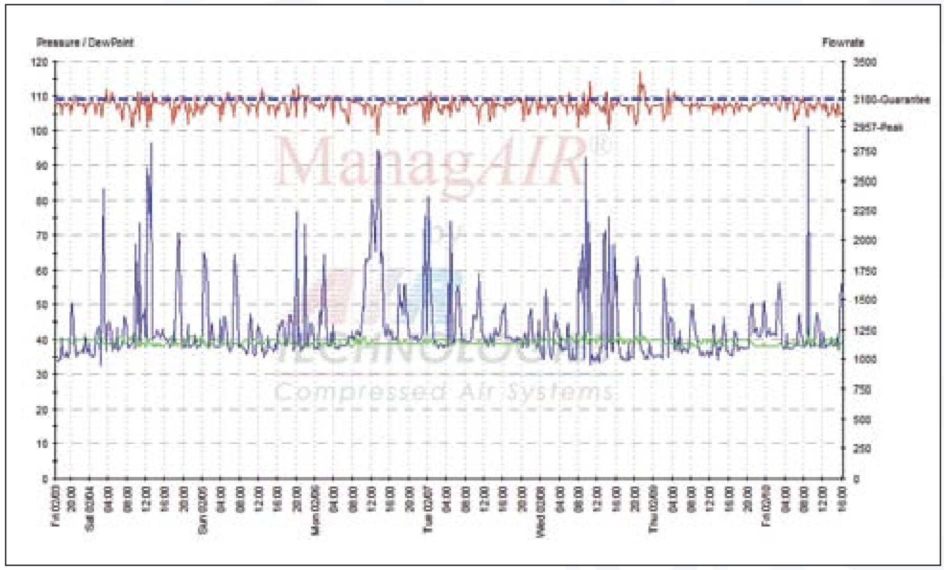
The System Assessment Establishes a Demand Profile

This was the situation when the factory asked DirectAIR® to conduct a system assessment and make a proposal on outsourcing compressed air as a 4th Utility. The system assessment was conducted twice, with each assessment logging measurement data on site over a one-week period. The two assessments provided virtually the same results.

Peak compressed air consumption was 2,957 cfm. One-third of the compressed air demand went to the production area, consistently consuming 1,250 cfm at an average pressure of 105 psig. The unique challenge in this system is presented by the dense phase transport application using significant volumes of compressed air during periods lasting up to 45 minutes. These demand events occurred on average eight times per day. The air compressors were struggling to maintain system pressure, during these demand events, and were not operating in the most efficient manner possible.

The site had six rotary screw air compressor located in five places throughout the plant of varying sizes. Some had load/unload controls and others were modulating and trying to maintain system pressure at 105 psig. There were two receiver tanks, each with 1000 gallon storage capacity. The plant had only one compressed air dryer — a decentralized desiccant air dryer used for the "control air" of 1,250 cfm for the production area. All of the air for the dense phase transport system was "wet" — with no compressed air treatment being used at all.

The air compressors ran inefficiently and were load/unload and/or modulating. When the demand spikes came, they would all ramp up to try and keep up. Compressor Units #1 through #4 were working the most. The #4 air compressor, a 300 horsepower model, was unloaded for too many hours and consuming approximately 30% of its' power when unloaded.



The demand profile established a base load of almost 1,250 cfm with demand events all day reaching up to 2,957 cfm.

PLASTICS PROCESSOR OUTSOURCES COMPRESSED AIR AS THE 4TH UTILITY

Both system assessments reflected this load profile on the six air compressors. The average weekly energy consumption was 62,220 kWh and the energy cost was $4,348. This created a yearly average energy consumption of 3,235,446 kWh and energy cost of $226,481. It became clear that with these energy costs, significant energy savings could be realized with a compressed air system configuration designed for this load profile.

TABLE 2. AVERAGE WEEKLY AIR COMPRESSOR LOAD PROFILE AND ENERGY COST

	UNIT #1	UNIT #2	UNIT #3	UNIT #4	UNIT #5	UNIT #6
FAD* (cfm)	657	464	439	1,447	439	439
Loaded Time (h)	167	20	48	52	4	0.4
Unloaded Time (h)	0	77	119	114	19	22
Stopped Time (h)	1	71	0.6	1	145	145
Loaded kWh	19,997	1,642	3,929	13,855	300	29
Unloaded kWh	0	2,450	2,970	15,749	594	594
Total kWh	19,997	4,092	6,899	29,604	894	623
Energy Cost ($)	$1,400	$286	$483	$2,072	$63	$44

*Free Air Delivery

TABLE 3. DIRECTAIR® AVERAGE WEEKLY AIR COMPRESSOR LOAD PROFILE AND ENERGY COST

	UNIT #1	UNIT #2	UNIT #3	UNIT #4	UNIT #5	UNIT #6
FAD* (cfm)	534	534	534	534	534	534
Loaded Time (h)	158	167	78	17	3	0.3
Unloaded Time (h)	0	0.3	7.5	1.3	0.2	0.4
Stopped Time (h)	9.5	0.4	82	149	164	167
Loaded kWh	9,492	16,530	7,738	1,717	326	31
Unloaded kWh	0	14	323	65	15	21
Total kWh	9,492	16,545	8,061	1,781	340	52
Energy Cost ($)	$664	$1,158	$564	$125	$24	$4

*Free Air Delivery

The Compressed Air Utility Service Solution by DirectAIR®

The new system was designed to meet the demand profile. As already illustrated, the demand profile featured a stable level of 1250 cfm running 24/7. The demand events (spikes) occur roughly eight times per day and demand jumps to 2,950 cfm. These demand spikes were not going to go away.

The DirectAIR system is located right outside the plant wall. Power was brought to it from a transformer located right next to the modules. The DirectAIR system consist of seven modules. Each module has an air compressor and a refrigerated air dryer. There is a header connecting all the units within the module. The compressors are all managed by the ManageAIR automation system. The module has exhaust ports and also openings for heat recovery systems.

The objective of the new system design was to have three air compressors optimize the efficiency of providing compressed air to the baseload of 1,250 cfm and then have another three air compressors available to do the same for the demand spikes — and then shut to them down and minimize unloaded energy consumption.

The stable "base load demand" of 1,250 cfm for the production area is efficiently supplied by compressor units #2 and #3. They are running continuously with the variable speed drive unit #1 trimming the base load of 1250

> "The system is designed to consume $132,028 in energy costs per year – representing a reduction of $94,453 fromthe original costs of $226,481."
>
> — Tim Tensing, DirectAIR®

cfm. Each air compressor has a dedicated refrigerated air dryer and the air will also go through the decentralized desiccant air dryer (in the plant) during the winter months.

Air compressors #4, #5, and #6 are set up to handle the demand spikes and the last one is off and is the back-up. Each one has its' own dedicated refrigerated compressed air dryer. The biggest difference is that the three air compressors for the spikes are completely off when not needed (as opposed to being in the unload mode).

The ManageAIR compressor automation system controls the machines and one of its' main goals is to turn the air compressors off any time they see more than a couple of minutes of off-load time. The air compressors will time out and shut down automatically after a couple of minutes when the measured pressure stops going down.

The Results

The system is designed to consume $132,028 in energy costs per year — representing a reduction of $94,453 fromthe original costs of $226,481. After six months, the DirectAIR® system is on pace to consume only $115,000 per year in energy costs.

DirectAIR® owns the system and is 100% responsible for all maintenance and service costs. The ManageAIR® compressor automation system runs autonomously and alerts DirectAIR® service technicians if there are any issues and when service needs to be scheduled. The module has a back-up air compressor (Unit #7) in case any of the units should go down. DirectAIR® guarantees 100% reliability and pays penalties in the event that flow, pressure, or dewpoint guarantees are not met.

Since installation, the plant has reported two unplanned positives from the system. The first is that they have typically spent $80,000 per year on the carbon filters used to treat the wastewater of the plant. Now that the air compressors are not contributing oily condensate to the plants' wastewater system, their spend has dropped to $40,000 per year.

TABLE 4. ESTIMATED ANNUAL COST OF OWNERSHIP SAVINGS

Air Compressor Energy Costs	$111,000
Contracted Service & Repair Costs	$35,000
Maintenance labor costs	$15,000
Wastewater Carbon Filters	$40,000
Heat Recovery	$10,000
Total	**$211,000 per year**

The second unplanned benefit has been $10,000 reduction on the HVAC natural gas bill due to the heat recovery package installed on the air compressors. Additionally, the air quality from DirectAIR® is dry and more savings will be realized from the elimination of the production equipment solenoids maintenance that was previously caused by wet air.

Treating compressed air as the 4th utility in the plant is yielding financial benefits for this plastics processor. The plant pays a fixed fee for the service plus a compressed air use fee based upon actual flow consumed. The savings outlined above have more than paid for all the fees and no capital is being deployed on new air compressors. BP

For more information please contact Tim Tensing, DirectAIR®, tel: 513-539-6763, email: TTensing@aircompressors.com, www.DirectAIR.com

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Six Applications for COMPRESSED AIR STORAGE

Photo Courtesy of TIGG Tanks.

BY DEAN E. SMITH, iZ SYSTEMS

There are many ways to use storage in a compressed air system to improve the performance and repeatability of production equipment. No one method is a total solution. Some industry professionals will tell you that storage is not required for certain types of compressors. The system, however, can not afford the impact on either performance or operating costs. The alternative to applying storage is to operate at higher pressures with more power all of the time in order to support critical applications and the peak air demand experienced in the system. There are six basic areas where storage should be properly engineered and applied in the system. These are:

1. Dedicated storage to improve the speed, thrust, or torque of an application
2. Dedicated storage to protect a critical application from pressure fluctuations
3. Dedicated storage to meter a high rate of flow application into the system
4. General or overhead storage to support applications during the transmission time to the supply side and to create transparency between applications
5. Control storage to support events in the system within an allowable pressure drop
6. Off line, higher pressure air stored to support large system events and reduce peak electrical demand

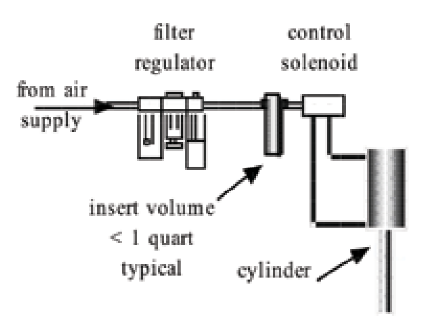
There are a few fundamental principles which must be discussed to understand when and how to apply storage in the system. First, *the article pressure in a system is the terminating pressure at the actual inlet connection to the device.* It is not at the regulator or the header, so when someone says they have to have 90 psig for a particular device, it is very important to know where they are monitoring that pressure. This appears to be a small distinction but it makes a huge difference in what is required to support the article. Second, *the purpose of the system is to deliver the required mass of air to the article within the required time.* Compressed air travels at a limited velocity inside the system determined by the pressure differential that exists. At 1 psid, this velocity is approximately 250 feet/second which means if the compressors are more than 250 feet away, they won't see an event which is less than 1 second duration until after it is complete. If you forget to consider time, the value of these storage concepts will be very difficult to grasp. Third, *the primary formula for applying useful storage or capacitance is the capacity to store times the allowable pressure drop.* For example, if I have a 660 gallon tank and I can afford to allow the pressure to drop 10 psi then the useful storage is calculated as: (660 gallons/7.48 gallons/cubic foot)/14.5 psia = 6.07sscf/psi x 10 psi = 60.7 scf of usable stored air. With these principles in mind, let's take a look at each of the six areas where we can apply storage and discuss the benefits of each case.

Application #1. Dedicated storage to improve the speed, thrust, or torque of an application.

There are many pneumatic applications which actuate faster than a regulator can react. The result is a drop in article pressure which reduces the speed at which the required mass of air can be delivered. When someone speaks of this type of application requiring a certain pressure to work properly, they are usually referring to the starting pressure not the terminating pressure. The terminating pressure, however, is the final article pressure and is the actual pressure supporting the application. With actuation speeds of less than 1 second, virtually all of the mass required for the article will come from storage. With longer actuation cycles, the mass from storage will control the pressure drop while flow is established across the regulator to support the application. Controlling the amount of pressure drop will improve the repeatability of the application as well as the speed, thrust, or torque, as applicable. The alternative to applying storage or capacitance is to increase the terminating article pressure by cranking the regulator open to increase the starting pressure. If the performance is still unacceptable, then the system pressure is increased. Either solution increases the available mass but increasing the pressure has significant operating costs penalties and will increase the amount of the article pressure fluctuation. Applying storage reduces the pressure fluctuation and will allow you to reduce the header pressure if you are working on those applications which are dictating the operating pressure for the system. Remember, this is one of our fundamental principles: *you can increase the capacity to store or you can increase the useful pressure differential.* The additional capacitance should be located down stream of the regulator as depicted in DIAGRAM #1. The required storage can be calculated by using a variation of the primary formula:

(the size of the event in cubic ft)
X (atmospheric pressure)/
(the allowable pressure drop) =
(required storage in cubic ft) X (7.48 scf/gal)
= (required storage in gallons)

DIAGRAM #1
Proper Installation of Supplemental Storage for High Speed Cylinders



For example, the volume of storage required to control the pressure drop of a 0.01 scf use to 5 psi would be calculated as 0.01 scf x 14.5 psia/5 psi = .029 scf or .22 gallons. This would be typical of small, high speed air cylinders in packaging or assembly applications.

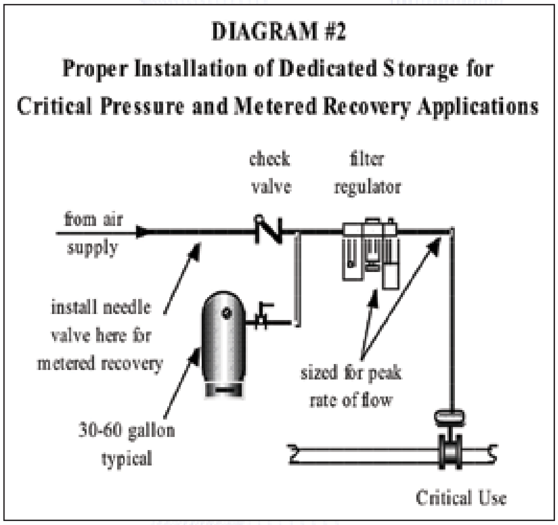
Application #2. Dedicated storage to protect a critical application from pressure fluctuations.

Another type of a pneumatic application which can cause high system pressures is a critical application that must be protected from fluctuations in header pressure. Often, this type of application requires relatively low pressure, such as 60 psig, but the entire system pressure will be elevated to 95 or 100 psig to insure that the critical use pressure will remain above the minimum pressure experienced in the header. A better solution would be to increase the capacity to store locally and dedicate the additional volume to the critical application with a check valve. For example, the diaphragm actuator on a fail-closed valve might require 1 cubic foot of air at 60 psig. Using the primary formula, the storage volume required to control the pressure drop to 2 psi would be:

(1 scf x 14.5 psia/2 psi) = 7.25 scf x
7.48 gal/scf = 54.3 gallons per actuation

The tank should be located upstream of the regulator and checked from the system as depicted in DIAGRAM #2. This arrangement will prevent transient system problems from impacting the availability of the required air for the application. In this example, the header

SIX APPLICATIONS FOR COMPRESSED AIR STORAGE



pressure could be dropped to 72 psig which allows 10 psid across the FRL and still provides the required mass and pressure for the actuator.

Application #3. Dedicated storage to meter a high rate of flow application into the system.

A variation on this use of storage is to protect the entire system from an intermittent application which causes header pressure fluctuations when it actuates. In this case, the storage volume is calculated and installed in the same manner as for protecting a critical application but a needle valve is installed along with the check valve. Upon actuation, the receiver provides the mass of air required. The needle valve is adjusted to control the rate of recovery of the receiver pressure which creates a more constant and lower rate of flow to the system. For this application to work well, the recovery time must be equal to or greater than the actuation time. The receiver pressure need only recover before the next actuation so the use volume can be spread out over the entire cycle time. For example, reverse pulse baghouses pulse on solenoids with open times less than 0.25 seconds. While the total volume of air required will only be approximately 2 cubic feet, the rate of flow created is 480 scfm (2 scf x 60 sec/0.25 sec). This high rate of flow will cause the header pressure to drop with each pulse and

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Six Steps To Optimizing Your Compressed Air System

1. Measure the air consumption to find sources that use a lot of compressed air.
2. Find and fix the leaks in your compressed air system.
3. Upgrade your blowoff, cooling and drying operations using EXAIR engineered compressed air products.
4. Turn off the compressed air when it isn't in use.
5. Use intermediate storage of compressed air near the point of use.
6. Control the air pressure at point of use to minimize air consumption.

1

EXAIR's **Digital Flowmeter™** accurately measures compressed air usage and monitors waste. Trends can be monitored to find excessive air use. Detects leaks at compressed air fittings when the machinery is off. Regular monitoring can detect leaks that develop as the machinery ages.

- **Easy to install - No adjustments or calibrations needed**
- **Digital readout displays actual airflow through pipe**

www.exair.com/78/4dfm.htm

2

EXAIR's **Ultrasonic Leak Detector** can help you identify costly leaks in your compressed air system. Leaks can account for 30% of total compressor output! In many cases, finding one small leak can quickly pay for the leak detector.

- **Detects leaks up to 20' (6.1m) away**
- **Accurate in noisy industrial environments**

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3

EXAIR's award winning **Super Air Knives™, Super Air Nozzles™,** and **Super Air Amplifiers™** entrain large volumes of room air using only a small amount of compressed air as the power source. They dramatically reduce air consumption and noise.

- **Low cost - Replaces noisy blowers**
- **Improves blowoff performance and safety**

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MEETS OR EXCEEDS OSHA REQUIREMENTS

4

EXAIR's **EFC™** is an electronic flow control that minimizes compressed air use by turning off the compressed air when no part is present. For use on blowoff, drying, cooling, conveying and static elimination operations.

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5

An EXAIR 60 gallon **Receiver Tank** can be installed at the point of high demand so there is an additional supply of compressed air available for a short duration. Meets ASME pressure vessel code.

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6

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SIX APPLICATIONS FOR COMPRESSED AIR STORAGE

could cause more critical users in the vicinity to require a higher pressure than otherwise necessary. The pulse occurs every few minutes so the recovery of the receiver pressure can be metered in easily over 15 seconds which will reduce the rate of flow to 8 scfm (2 scf x 60 sec/15 sec). This significantly reduces the peak in air demand caused by such applications and will reduce the on line compressor horsepower correspondingly.

Application #4. General or overhead storage to support applications during the transmission time to the supply side and to create transparency between applications.

To appreciate the value of general storage, you must keep the time component in mind. When a large user enters the system, air flows toward the application drawing down the pressure in the surrounding header. The increase in air demand moves outward at 250 feet per second until it reaches the compressor signal location. When the compressors respond with adequate power and increased delivery, the pressure decay will stop. The amount of pressure drop which will be seen in the header is directly related to the storage volume in the header, the size of the event, and the distance from the event to the supply. Assume the largest event is the start up of a 600 scfm application located 1000 feet in header distance from the compressor room. This application will remove air from the header for 4 seconds (1000 ft/250 fps) at a rate of 10 scf/sec (600 scfm/60 sec). At that point, the event will have reached the compressor room and the supply can respond with storage or power. Assuming we want to control the pressure drop to less than 2 psi, the storage requirement would be (4 sec x 10 scf/s) = 40 scf x 14.5 psia/2 psi = 290 scf x 7.48 gal/scf = 2,169 gallons. You can subtract the existing volume contained in the header piping from this figure if it is significant. Adding receivers to the header is the most economical means of increasing the storage volume. These receivers should be spooled in near the large events; it is not necessary to "flow through" the tank. In many systems the largest coincidental event will be shift start up when most users hit the system at very close to the same time. The alternative to adequate general storage is to raise the header pressure until the largest pressure fluctuations don't impact the highest critical use pressure. Unfortunately, as the pressure increases so does the demand for air in all unregulated uses such as leaks, open blowing, and users with the regulator cranked all the way open. This phenomenon is called artificial demand and it prevents the compressors from being able to equalize the pressure throughout the header. Eventually, the pressure rises to the modulation or unload setpoint on the compressor or in systems with high levels of artificial demand, the system actually absorbs the increased flow and the pressure stabilizes before the compressor unloads.

Application #5. Control storage to support events in the system within an allowable pressure drop.

If you have been around compressed air very long, you have heard, "... this type of compressor does not require a tank...". The compressor may not need the tank, but the system sure does! Consider a typical 500 hp rotary screw compressor system with 1,500 feet of 6" headers, 3" subheaders and no tank in a manufacturing plant. The total capacitance will be less than 19 scf/psi which is calculated by dividing the total volume of the piping by the atmospheric pressure (similar to the storage formulas above). If the system is operating two 200 hp and one 100 hp compressors, the failure of a 200 hp base load unit will result in a loss of approximately 1000 scfm or 16.7 scf/sec supply. The pressure will drop at a rate of .88 psi/sec (16.7 scf/s/19 scf/psi) which means in 20 seconds the pressure will drop 17 psi. The first time this kind of pressure decay occurs, it is a pretty safe bet that production will be impacted and the backup compressor will be turned on and left on. To properly manage the system during a compressor failure, we must provide adequate storage in the compressor room to allow the backup compressor to autostart. This control permissive time varies from 10 seconds for rotary screws with full voltage starters to 120 seconds for many centrifugal compressors. The event volume that must be supported from storage will be the rate of flow in scf/sec times the control permissive time of the backup compressor. As we have demonstrated,

> "If you have been around compressed air very long, you have heard, '... this type of compressor does not require a tank...'. The compressor may not need the tank, but the system sure does!"
>
> — Dean E. Smith, iZ Systems

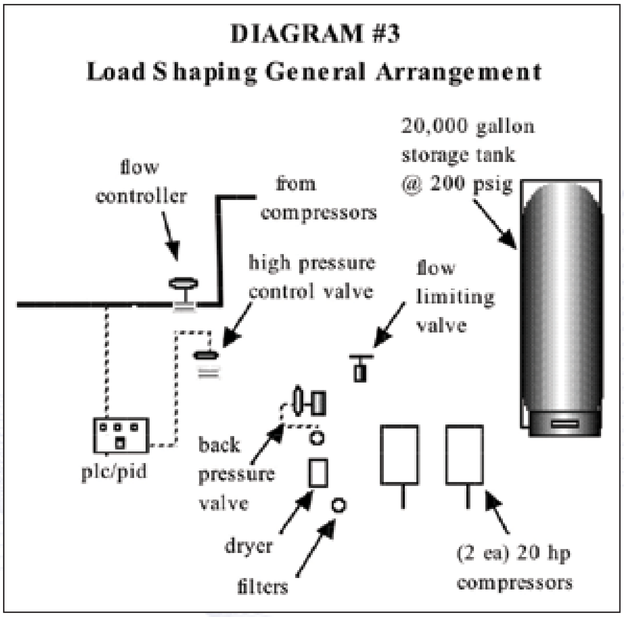
SIX APPLICATIONS FOR COMPRESSED AIR STORAGE

useful storage or capacitance is the capacity to store times the allowable pressure drop. But we have been attempting to minimize system pressure, so how do we provide adequate storage without increasing the system pressure and incurring the associated higher operating cost? What we require is a means of separating the demand side from the supply side of the system. This is the function of a demand expander or flow controller.

A flow controller allows the system to operate at maximum efficiency by controlling the expansion of the air down to the lower header pressure. This minimizes waste and achieves more consistent and reliable results. On the supply side, the compressors can be operated at the design pressure which achieves maximum mass delivered per kW consumed. The difference between the two pressures eliminates artificial demand and creates true usable storage in the system. When a demand event occurs in the system, the controller will respond by modulating the flow control valve to match the down stream requirements. This is very different from a regulator in that it does not introduce an energy loss in the system but rather controls expansion across the valve to match the demand and maintain a fixed pressure on the demand side. Looking back at the 500 hp system example, we can increase the value of a receiver dramatically with the flow controller in place by increasing the supply to the design pressure which will be 125 psig for our example. If we add a 5000 gallon (668 scf) receiver to the system and operate the demand at 75 psig, we can calculate the usable storage as: (668 scf/14.5 psia) x (125–75 psig) = 2,300 scf. This stored air can be accessed by the system at any rate of flow at any time without increasing the online horsepower. In the case of the failure of the 200 hp compressor, the pressure will now drop at 0.36 psi/sec (16.7 scf/sec/668 scf/14.5 psia). Now in 20 seconds, the pressure will only drop 7.2 psi on the supply side of the expander and the demand side pressure will not have changed at all. In a non-automated system, the autostart set point could be set approximately 10 psi above the expander setpoint. This would provide ample time to autostart a backup rotary screw compressor with control permissives of 10-20 seconds before the demand pressure would be impacted. In fact, the storage can support the demand after the loss of the 200 hp compressor for over 2 minutes ((125–75 psig)/0.36 psi/sec) before there would be any impact on the demand side pressure.

Application #6. Off-line, higher pressure air to support large system events and reduce peak electrical demand.

There is another method for supporting large intermittent system events or compressor failures. This involves the use of higher



pressure off line storage very similar in concept to a water tower. A water tower is supplied by smaller horsepower pumps that run continually to pump water up to the elevated tank. When peaks in demand occur, the water in the tank can be added to the on line system at almost any rate of flow without turning on large horsepower pumps. Each off-line, high pressure air system must be engineered and applied to the requirements of the specific system but typically will consist of two 10–20 hp compressors delivering air at >200 psig to a 10,000–20,000 gallon receiver which is isolated form the header system by a control valve arrangement. A flow controller and a PLC based automation system which constantly monitors the rate of change in the system are required to make off-line, high pressure air function properly. The automation

> "The next time someone complains about insufficient air pressure, remember there are alternatives to raising the pressure and buying or operating another compressor."
>
> — Dean E. Smith, iZ Systems

system will open the high pressure air control valve and introduce the stored air into the header to support the event. The control of this process is critical because if the stored air causes the pressure to rise, base load compressors will unload which would lead to a system collapse when the high pressure air storage is exhausted. At the end of the system event, the automation system will close the control valve and begin recovery of the pressure in the 20,000 gallon receiver with the 20 hp units which produce approximately 75 scfm each. The 200 psig compressors depicted in DIAGRAM #3 are standard equipment available from several major manufacturers as single stage rotary screw units.

Off-line, high pressure air is useful to protect systems which are ultra-critical due to financial or safety issues. However, the primary reason for most systems is to avoid running a large, base load compressor to support large demand events or to support a large system during a compressor failure. For example, in centrifugal based systems there is almost always an extra compressor operating to support the system when a compressor fails or surges. This is due to the control permissives which can be 120 seconds and makes control storage impractical. For example, if the compressor that fails is 700 hp and 3,000 scfm or 50 scf/sec, the storage will have to support 6,000 cubic ft (120 sec x 50 scf/s). A 20,000 gallon receiver provides 184.4 scf/psi (20,000 gal/7.48 scf/psi/14.5 psia). Dividing the 6,000 scf requirement by the 184.4 scf/psi capacitance determines that the pressure will drop 32.5 psi to 142.5 psig in the high pressure air receiver. After the backup compressor starts and the high pressure air valve closes, the recovery of the receiver pressure will begin. Dividing the total event of 6,000 scf by the output of the high pressure air compressors at 75 scfm each indicates 80 minutes would be required if both compressors ran or 160 minutes for one compressor. The initial cost of this system will be a fraction of the cost of a backup 700 hp compressor and will obviously be much less expensive to operate when required.

Conclusion

By applying the basic storage principles involved in a compressed air system, you can immediately improve the performance of production equipment in terms of productivity and quality, and make major reductions in the operating costs of your compressed air system. The alternative to applying these basic storage principles in the system is to operate too much pressure and power all of the time to compensate for the lack of storage. The next time someone complains about insufficient air pressure, remember there are alternatives to raising the pressure and buying or operating another compressor. BP

Dean Smith is the General Manager of iZ Systems, a consulting firm specializing in auditing and designing compressed air systems, and was formerly the Principal of Air Management, Atlanta, GA. He is a member of the Technology Core Group which wrote the training materials for the Compressed Air Challenge of the DOE. He has performed complete system audits on over 1,000 plant compressed air systems providing recommendations that have improved quality and productivity while reducing plant operating costs. For further information, Mr. Smith can be reached at 404-307-6836 or email at dsmith@izsystems.com.

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THE DEMAND-SIDE TECHNOLOGY PROVIDER

Pneumatic and Vacuum Energy Optimization On OEM Machines

BY PHILIP O'NEILL, BOSCH REXROTH CORPORATION – PNEUMATICS DIVISION

The push to achieve reductions in energy consumption is a significant global trend. Many companies have begun offering incentives to employees to reduce cost and achieve higher energy efficiency. In some regions of the U.S., companies can profit from rebates given by electric power suppliers for reductions in compressed air usage.

Machine builders aiming to improve the energy efficiency of their machines tend to focus on using energy media other than Pneumatics (typically Electro-Mechanical or Hydraulic) since Pneumatics, as traditionally applied, is viewed as inefficient due to factors like leakage and over-pressurization (i.e.: supplying a higher pressure in an actuator to accomplish a task which is endemic in practice). But they shouldn't. When generating and using compressed air, it's true that there are many places in the system where energy can be lost, however targeted measures within a comprehensive energy saving concept can prevent these losses and significantly reduce energy consumption at the machine level.

Consider the following tactics to avoid dead volumes and optimize the use of compressed air:

Bigger Not Always Better

On new machine applications, correct component dimensions are a great start to obtain optimal energy usage. With pneumatic components, bigger doesn't mean better when over-dimensioning leads to unnecessarily high air consumption. It is common practice to assume "when in doubt, go one size bigger," or to re-use designs that were selected and worked on previous projects even though they may be overkill in terms of space and weight on the machine. This causes avoidably high air consumption and costs more to purchase and operate.

Reducing cylinder diameters helps to save air volume. The use of online configuration tools, calculation programs, and energy saving calculators help determine what component dimensions are needed for the application.

In one lumber industry application, a sawmill machine's output increased 13% by simply reducing the size of the pneumatics used on the sorter gates of the machine. The cylinder bore was reduced from 3.25" to 2", ½" air valves were reduced to ¼", and pressure was reduced from 100 psi to 60 psi. With these seemingly minor alterations, the company effectively increased its production speed, and achieved energy savings of 75% on the machine.

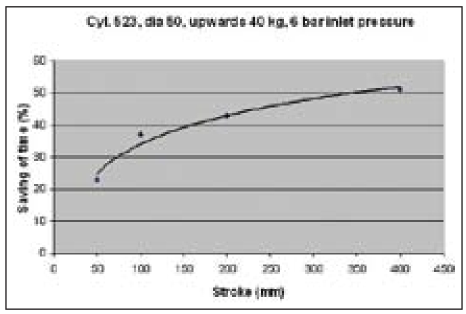
What about OEMs that build standard machines and sell to a variety of end-users? In order to mass-produce a standard machine, it needs to be designed and sized to accommodate the end-user with the lowest available pressure. This usually means specifying larger, more expensive components, resulting in increased air consumption. This issue can partially be solved by ensuring that the supply pressure to the machine is regulated down to the design pressure level. It is common for operators to increase supply pressure on Regulators in the hope of improving performance but this ends up costing the end-user significant amounts of money in operating costs for no actual benefit

When generating and using compressed air in industrial machines, targeted measures within a comprehensive energy saving concept can significantly improve energy efficiency at the machine level.

if the components were sized correctly. It is important to monitor machine system pressure to ensure that it is within both a minimum AND a maximum value to avoid energy waste.

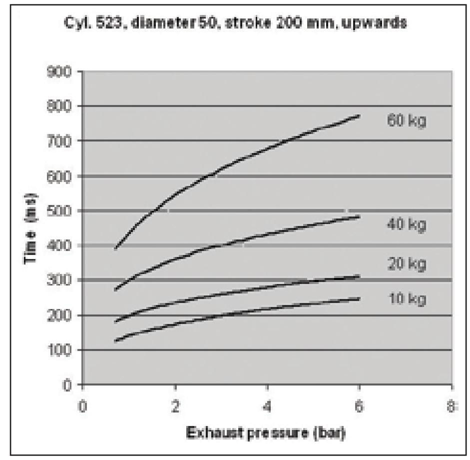
Pressure Regulation — Use Only What is Required

Best practices of lean manufacturing call for the elimination of any waste that does not add value to the product or process at hand. With pneumatics, energy is frequently wasted in this manner when too much pressure is applied for tasks that do not require that equivalent level of force. This can be overcome by using pressure regulators in pneumatic cylinders to control exactly when to exert energy and when to conserve it. By applying the exact amount of pressure needed for each task, machines can realize energy savings of up to 40% in many cases. It is important to note that Pressure Regulators installed between a valve and cylinder are capable of operating with "reverse-flow" which are becoming increasingly common and lower in cost-usually much more economical and easier to install than traditional sandwich pressure regulators. Many standard in-line Pressure Regulators do not have this functionality and in such cases a check-valve is required in parallel to accommodate the reverse flow.



Cycle time reduction for different strokes: 2 bar compared to 6 bar as "no-load" pressure.

In many applications, there is either a "push" or "pull" load but not both. Most often, the



Stroke time with different "no-load" pressures.

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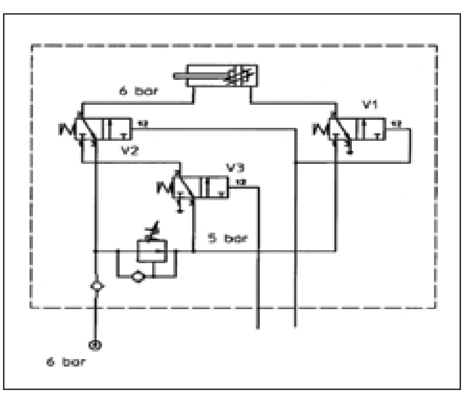
same pressure is used for both the "push" and "pull" strokes which is extremely inefficient.

In one application example, a pneumatic cylinder was being used in a press-fit operation to perform an assembly task. The cylinder required 100 psi pressure to perform the press operation, and 100 psi was also applied to the retract. However, the retract function only required <10 psi pressure to accomplish the same task. By adding a pressure regulator between the valve and cylinder port, the retract pressure was reduced to 10 psi — a 90% reduction — resulting in a significant drop in energy consumption for the press-fit operation. In total, the machine attained 38% energy savings per cycle, and ROI of the components is approximately 2,100 cycles.

Typical machine tasks that could benefit significantly from non-load stroke pressure regulation include press-fit processes, and applications that utilize rodless cylinders or lifting cylinders, such as automotive assembly elevators. In general, the larger the cylinder the larger the efficiency gain and the key characteristic to be on the lookout for is where there is a sizeable difference in the force required for each stroke direction.

Energy savings is just one of several benefits of applying pneumatic pressure regulation. Since piston speed is governed by the rate at which the air on the non-load side of the piston is exhausted, reducing the non-load pressure of the cylinder enables faster piston speed on the working stroke, decreasing cycle time. Other advantages include reductions in shock, vibration, and noise as well as longer life expectancy for the components and the machine itself. If there is leakage in the system, its cost is inherently reduced by reducing the air pressure at the leakage point.



Regenerative Valve circuits divert air being exhausted from the cylinder stroke and use it to charge the opposite end of the same cylinder when out-stroking.

Regenerative Circuits

For some applications that require pressure for a load in both the "push" and "pull" stroke directions, the implementation of a regenerative air savings system can produce an air savings of up to 50%. Rather than installing a pressure regulator to cut air consumption (such as in the example above), instead the air in the load side of the cylinder is recirculated back into the other side of the cylinder to do work.

An example of where this can be applied is on crust breaking in aluminum processing. Large cylinders are mounted vertically with the rods facing down. Due to the weight of the tooling, high air pressure is required to retract the cylinder rods. High pressure is also required to extend the cylinders even though they are assisted by gravity. The high pressure is needed towards the end of their stroke to create a force to break a crust. The same characteristics apply in some clamping applications where the high force is only required towards the end of the working stroke. Regenerative Valve circuits divert air being exhausted from the cylinder stroke that has gravity assist and it is used to charge the opposite end of the same cylinder when out-stroking.

Optimize Vacuum Applications

Machine applications that use Vacuum Generators (or Ejectors) typically consume much more energy than is necessary to perform the material handling task at hand. In conventional systems, vacuum generators are energized by a solenoid valve that supplies

Look for vacuum generators with air-savings options, which have integrated sensors to monitor vacuum levels and greatly reduce air consumption and operating costs.

compressed air, and vacuum cups of various profiles and materials come into contact with the product itself. As long as vacuum force is applied to hold the component at the vacuum cup, air is being consumed by the vacuum generator. Since vacuum cups are prone to wear over time, vacuum generators tend to be over-sized to accommodate this and therefore consume a higher amounts of compressed air, leading to increased operating cost of the equipment and greater noise in the machine.

To remedy this, consider retrofitting the machine with a vacuum generator that has an automatic air-savings option. Vacuum generators with air-savings, such as the ECS series from Bosch Rexroth, monitor vacuum levels with an integrated sensor. Once the generator is switched on, the vacuum valve remains active only until the preset vacuum value is reached. As long as the vacuum value lies within the programmable hysteresis range, the valve automatically de-energizes and remains closed, consuming no compressed air. If the vacuum drops below the preset limit value (due to a leak or other disruption), the solenoid valve is energized again until the preset vacuum value is reached.

Optimizing vacuum applications with air-savings control can greatly reduce air consumption and operating cost. Vacuum generators with air-saving functions can be easily installed or retrofitted to improve efficiency. Other tangible benefits include significant noise reduction on equipment due to increased off-time of the vacuum valve. Furthermore, the frequency of vacuum sensor activation can be used as an indicator of both wear and overall efficiency of the system.

Minimize Leaks, Control "Off-Duty" Air Pressure

Leaks are costly. For end users seeking to improve the efficiency of the pneumatics on their machines, the low-hanging fruit is finding and fixing leaks.

Leakage can commonly be attributed to factors such as valve design and the deterioration of seals. Some valve designs, such as lapped spool valves with metal sealing, have inherent internal leakage up to 700cc/min even when brand new. The leak is constant as long as there is air supplied to the valve. Switching to comparable valves with soft seals instead of metal seals can cut the allowable leak limit to between 10 and 30cc/min.

Leakage can also be caused by chemicals in the air system that are incompatible with industrial elastomeric seals. The first component to fail due to incompatible chemicals in the air supply is the pressure regulator. If deterioration of elastometric Buna seals occurs, consider installing an active carbon filter bed or lubricator, or switching to devices with non-Buna seals such as HNBR, Viton, Teflon, Hard Sealing, or Polyurethane.

The implementation of automatic air reduction control is another means of significantly increasing machine efficiency. Most existing machine installations have no automatic means of shutting off air to machines when not in use, and having maintenance personnel individually turn off air to specific machines is too cumbersome. Some machines may require pressure for certain functions to be supplied even after the machine is turned off and there is no production (examples include air bearings, air gauging and cleaning). Frequently however, these functions can be satisfied with greatly reduced supply pressure or with pressure for a limited time period. If a plant has two shifts/five days a week, an automatic air reduction control package can be added to automatically reduce the supply pressure during the hours that the plant is not

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Pneumatic and Vacuum Energy Optimization On OEM Machines

Pneumatics optimization can yield significant gains in energy efficiency in industrial machinery. Consider these tactics to avoid dead volumes and optimize the use of compressed air:

- Bigger isn't better — size components exactly and correctly
- Apply pressure regulators to cylinders with no-load strokes
- Consider regenerative circuits when there is load in both stroke directions
- Optimize vacuum applications
- Minimize leaks, control off-duty air consumption
- Decentralize the valving

End users should incentivize OEMs to design equipment that reduces the total cost of ownership, and explore what steps can be taken at the machine level to achieve maximum energy efficiency.

Special polymers allow for smaller, lighter, chemical-resistant valves — like the LS04 valve from Bosch Rexroth — that can be mounted right next to the actuator.

in operation. In the event that higher pressure is required during off-hours, the system can be overridden.

Decentralize the Valving

Centralized valve manifolds not only have the reputation of being cumbersome and using long air lines, they also consume a lot of energy. Small, decentralized valve units with competence and intelligence at the site of the application offer greater efficiency. The concentration of pneumatic functions prevents pressure losses through long lines from the control cabinet to the pneumatic drive. Tubing connections can be significantly reduced (by 50%) by using valve/actuator units, resulting in an energy saving of 35%.

Manufacturers of pneumatic components now offer smaller, lighter, chemical-resistant valves — thanks to special polymers — that can be mounted right next to the actuator. This direct connection of valves and cylinders eliminates pressure losses, which arise from long connection lines. Decentralization of the system can also yield faster response times, and higher cycle frequencies.

Modern valves and manifolds are available with IP69K protection and sanitary design with materials that are suitable for food processing. This eliminates the need for the traditional locating of pneumatic valves in remote stainless steel enclosures with long tubes in between. The energy savings is gained by the elimination of over 50% the tubes and improved response time due to the valve being located where the actual work is being done.

The Bottom Line

On a plant-wide level, steps to achieve greater energy efficiency can certainly be implemented, but end users should work with their OEMs to consider what steps can be taken at the machine level. Energy costs comprise more than half the total cost of ownership in pneumatics today, and a constructive evaluation of pneumatic applications will quickly pay off. Every application is different, and the overall machine concept and types of components used influence the potential for energy savings. Pneumatics should be considered in the strategy to achieve greater energy efficiency in industrial machinery. BP

For more information on energy-saving tips using Bosch Rexroth pneumatic components, and to download the "Energy Efficiency in Pneumatics" brochure, visit www.boschrexroth-us.com/sustainable.

For more information contact Phil O'Neil, Product Manager-Standard Products, Bosch Rexroth Corp. — Pneumatics, tel: 859-281-3426, email: phil.oneill@boschrexroth-us.com, www.boschrexroth-us.com

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INTERNATIONAL WIRE TRIMS COMPRESSED AIR COSTS USING THE "SYSTEMS APPROACH"

**BY TOM TARANTO AND RAM KONDAPI
FOR THE COMPRESSED AIR CHALLENGE®**

International Wire Group, Inc. (IWG) headquartered in Camden, NY is the largest bare copper wire and copper wire products manufacturer in the United States with expanding operations in Europe. Products include a broad line of copper wire configurations and gauges with a variety of electrical and conductive characteristics, which are utilized by a wide variety of customers primarily in the industrial and energy, electronics, data communications, aerospace and defense, medical electronics and devices, automotive, and consumer and appliance industries.

IWG culture is one of continuous improvement, and customer satisfaction on the basis of quality, reliability, price, reputation, customer service, and on-time delivery. Advanced quality assurance and testing equipment plus continuous improvement upgrades and investments to manufacturing equipment ensures products will consistently meet customers' specifications and quality requirements.

The IWG Plant Engineering team members recognized that the compressed air system was a major energy user in the plant and its performance directly impacted the manufacturing process and product quality. Team members, Dave Sherwood, Tom Lewis, Eric Bryant, and John Hoyt represent a cross section of plant management, production, engineering, and R&D. The key to success was the interactive spirit of cooperation to prepare for the assessment, experiment with process modifications, and respond to challenges with the expertise and determination to troubleshoot and overcome obstacles necessary resulting in the successful outcome for the project.

The plant operates six high speed production lines that draw copper wire and plate the wire to exacting customer specifications. The continuous high speed plating lines pass wire through various liquid chemical process

INTERNATIONAL WIRE TRIMS COMPRESSED AIR COSTS

TABLE 1 - COMPRESSED AIR SYSTEM OPERATIONAL BASELINE		
Baseline Operation (July 23rd– August 6th, 2010)		
Installed Capacity (Qty 5) compressors 125 psig rating.	1,350 acfm	350 hp/275 kW
Measured Performance at 92 psig average pressure	1,120 scfm	223 kW
	Weekday Baseline	**Weekend Baseline**
Plant Compressed Air Demand (measured)	995 scfm weekday	969 scfm weekend
Annual Energy use	1,581,927 kWh	257,218 kWh
Total Annual Energy use 1,839,145 kWh	**Present Energy Cost**	**Future Energy Cost**
Baseline 350 days/year, 15 down days	@ $ 0.080/kWh	@ $ 0.095/kWh
Baseline energy cost of operation	$ 147,132/yr	$ 174,719/yr
Average cost of compressed air	$ 294/MMscf	$ 349/MMscf

tanks that clean, etch, and plate the wire. Between tanks the liquid that has adhered to the wire must be removed before the wire enters the next chemical process. Compressed air powered "Air Wipes" blow the residual liquid from the wire as it passes through the center of the air wipe. Given that air compressors are large consumers of electricity, and the air wipes are large consumers of compressed air; attempts have been made to reduce the number of air wipes in use.

Through experimentation, it was found that quality control issues arose when several air wipes in the process were taken out of service. Without proper removal of process liquids, downstream chemical tanks become contaminated. Beyond the $30K to $40K cost of replacing spoiled chemicals, plating quality can be compromised; an unacceptable risk to IWG's strict quality standards.

IWG plants in the area are served by National Grid, a major utility in the North Eastern USA. National Grid helped organize Compressed Air Challenge (CAC) "Fundamentals of Compressed Air Systems" 1 day training which was attended by IWG team members. Funding for the training was sponsored by NYSERDA (New York State Energy Research & Development Authority) and DOE (Dept. of Energy).

At Compressed Air Challenge (CAC) Training the IWG Team learned about the CAC systems approach; matching compressed air supply to actual production requirements for pressure and flow. Upon return to the plant, team members explained to IWG Management that rather than focus only on the air wipes the solution was to look at the entire compressed air system and understand the actual production requirements of pressure and airflow. National Grid provided co-funding with IWG to perform a comprehensive compressed air system assessment. Tom Taranto of Data Power Services; a CAC Instructor and US DOE (Dept. of Energy) Sr. Instructor for AIRMaster+ Qualified Specialists, was contracted to conduct a compressed air system assessment at IWG Plant 3. National Grid was represented by Ram K. Kondapi, Sr. Technical Support Engineer and Mr. Tom Higgins, Account Manager.

The IWG Plant 3 compressed air system supplies all plant air requirements including pneumatic cylinders, tools and other ancillary pneumatic equipment. Air wipes are the largest compressed air demand consuming the majority of the plant air, and are a critical compressed air end use application which directly influences the wire plating process and product quality. Growth of the plant over the years and physical space considerations resulted in less than optimal arrangement of compressors, support equipment, piping and piping layout. Five air compressors; two stage lubricant free design, with their auxiliary equipment were installed at four different locations within the plant. Baseline measurement of system performance including measured Airflow, Power, and Pressure data were taken during July and August of 2010.

In the past, plant personnel have conducted trials with various blow off nozzle configurations and have optimized the performance of individual air wipes. Previous efforts to reduce air consumption by using fewer air wipes were unsuccessful. At CAC Fundamentals training the plant team learned about *"Artificial Demand";* and how operating compressed air end use applications at greater than necessary air pressure increases air consumption without any benefit to the production end use performance. Therefore, one technical objective of the system assessment was to assess air wipe performance and compressed air consumption at various supply pressures. Perhaps rather than reducing the number of air wipes, savings could be attained by controlling the air wipe pressure so that each air wipe consumed less compressed air while still giving satisfactory performance.

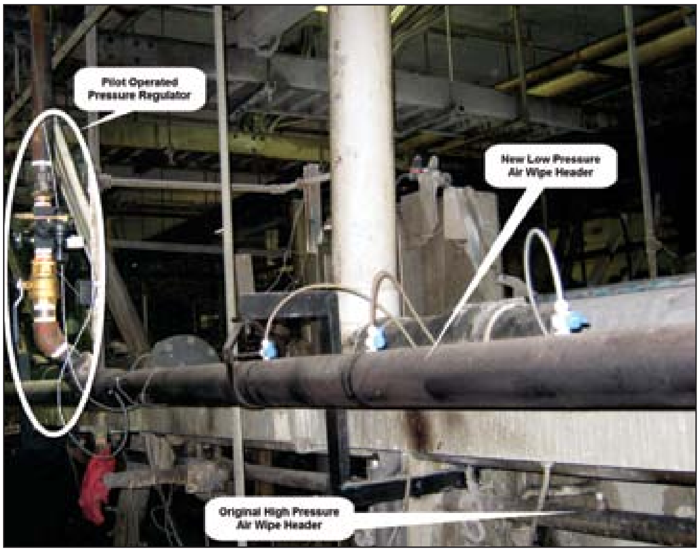

Figure 1 — Air Wipe Test, Pilot Operated Regulator and New LP Air Wipe Header

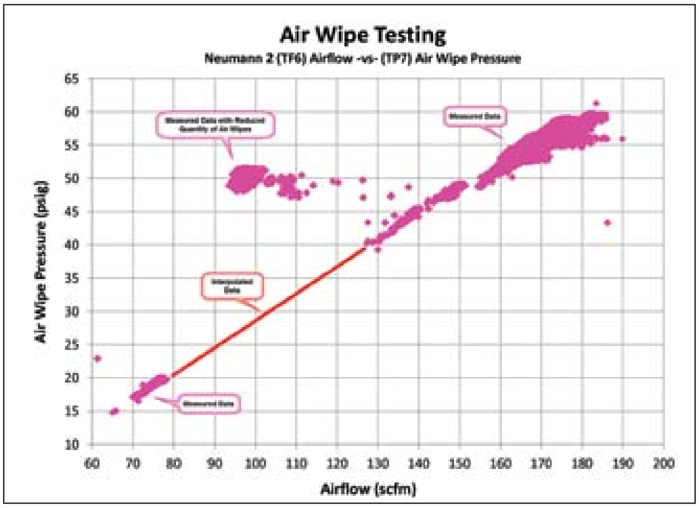

Figure 2 — Air Wipe Test Results, Air Consumption -vs- Pressure

During the compressed air system assessment one production line was selected for air wipe testing. A 3" diameter Low Pressure (LP) compressed air header was installed in parallel with the existing 1" plant air pressure header (see Figure 1). A high flow precision pilot operated pressure regulator was installed to allow adjustment of air pressure to the LP air wipe supply header. Tests were performed to measure the air pressure –vs– airflow relationship while carefully monitoring the process chemical tanks and product quality. The data in Figure 2 is a scatter plot of air wipe supply pressure versus measured compressed air consumption. Operating data was measured for pressure ranging from 40 to 60 psig and non operating data was taken at 15 to 20 psig with interpolated air consumption calculated between 20 and 40 psig.

Testing concluded that operating air wipes at 40 psig resulted in 45 scfm compressed air demand reduction. For six plating lines the projected air demand reduction was 270 scfm. Analysis was performed with the US DOE AIRMaster+ compressed air system software tool and energy savings of 624,306 kWh/yr and $59,309 per year cost savings were projected.

Other key findings of the IWG Plant 3 compressed air system assessment were:

- Compressed air distribution piping is undersized with 2½" main line headers
- Control pressure signals at the compressors were inconsistent due to multiple compressor locations and piping restrictions between compressors
- Failed air dryers needed to be replaced
- There is an area available to centralize the compressor installation providing an opportunity for heat recovery to make up air for space heating
- Target pressure for air wipes is 40 psig, a select few air wipes may need to remain at higher pressure
- Operating a portion of the compressor capacity as dedicated LP generation provides additional savings potential of 88,894 kWh/year with annual savings of $8,445
- Air wipes that can operate with Low Pressure air supply total over 70% of the present plant air demand

Assessment Recommendations:

Recommendations included a two step implementation process with Phase 1 providing system redesign to operate as a split High and Low pressure generation, transmission, and end use sectors; and replacement air dryers. The proposed system block diagram is shown in Figure 3 below.

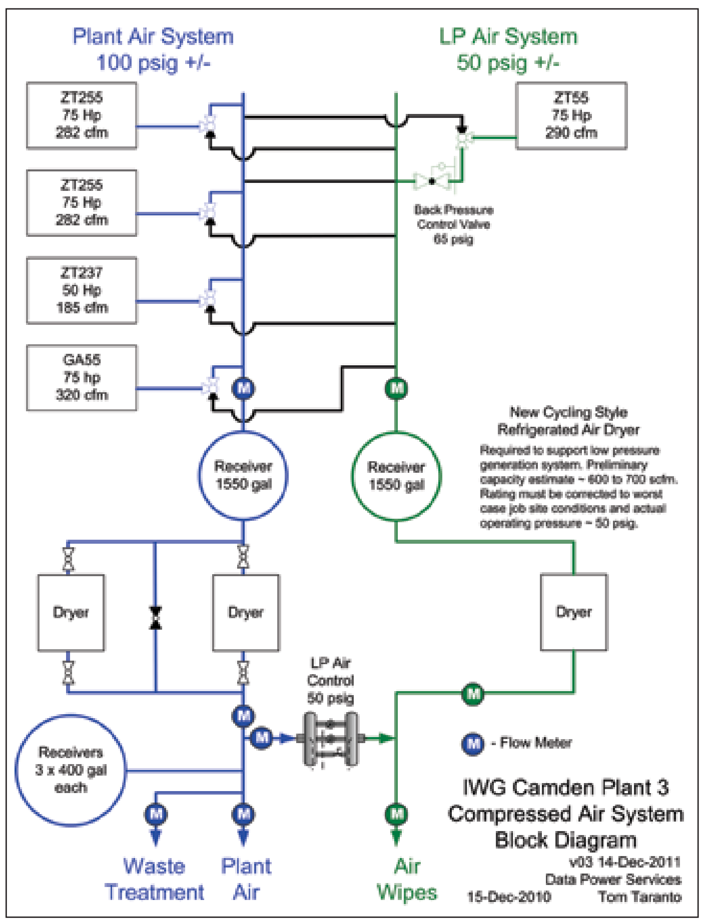

Figure 3 — Block Diagram of Phase 1 Recommended System Design

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Phase 1 Implementation:

- Use existing air compressors relocated to a single area of the plant with improved ventilation and heat recovery
- Improve compressor control with properly designed supply side piping and primary storage to allow existing auto-dual control to automatically start and stop excess compressor capacity
- Allow two stage lubricant free compressors to be selected to supply either High or Low Pressure generation
- Install a flow/pressure control operating as "spill valve" used to base load LP generation and control pressure of the LP demand sector
- Upgrade treatment equipment to support both High and Low Pressure generation sectors
- Distribution system upgrade including installation of a 6" diameter LP main line header
- Total projected energy savings are 471,500 kWh/year ($44,800/year)

Note that since the final LP target pressure (between 40 and 60 psig) had not been determined 60% of the maximum calculated savings were apportioned to Phase 1.

Measurement and Verification (M&V) of Phase 1 Implementation documented savings at 93% of projections. The M&V measurement plan targeted a 2 week baseline measured during the reporting period from 02–15 August 2011. Measured energy savings of 442,300 kWh/year yielding cost savings of $42,000/yr.

Heat Recovery:

In addition to the electrical energy savings as a result of implementation of above measures, the plant engineering staff also designed and implemented heat recovery of waste heat from the compressors to preheat make up air for the plant. Each compressor was connected to an insulated duct and plenum wall chamber equipped with motorized dampers that allowed warm air to be delivered to the plant during winter months and vented to outdoors during the summer months. The total heat recovery from the compressors was estimated to be approximately 544,290 BTU/HR during the winter months resulting in substantial savings in space heating.

Phase 2 of this project will include replacement of aging compressors with compressor performance optimized to the new air demand profile and High/Low Pressure generation system.

Phase 2 Implementation:

- Using M&V data evaluate the new air demand profile to optimize compressor performance selections
- Installation of one or more new air compressors as LP base load capacity
- Consider a new HP (High Pressure) compressor optimized for trim capacity

Phase 2 Assessment Findings indicated that air wipes were operating at the high end of the 40–60 psig target range, operating at 58.8 psig. Investigation revealed that while the majority of air wipes can be operated in the lower end of the target pressure range, a few air wipes at key locations required the higher 58.8 psig pressure. Those few air wipes can be reconfigured to operate from the HP Plant Air header and the LP System target pressure can be further reduced.

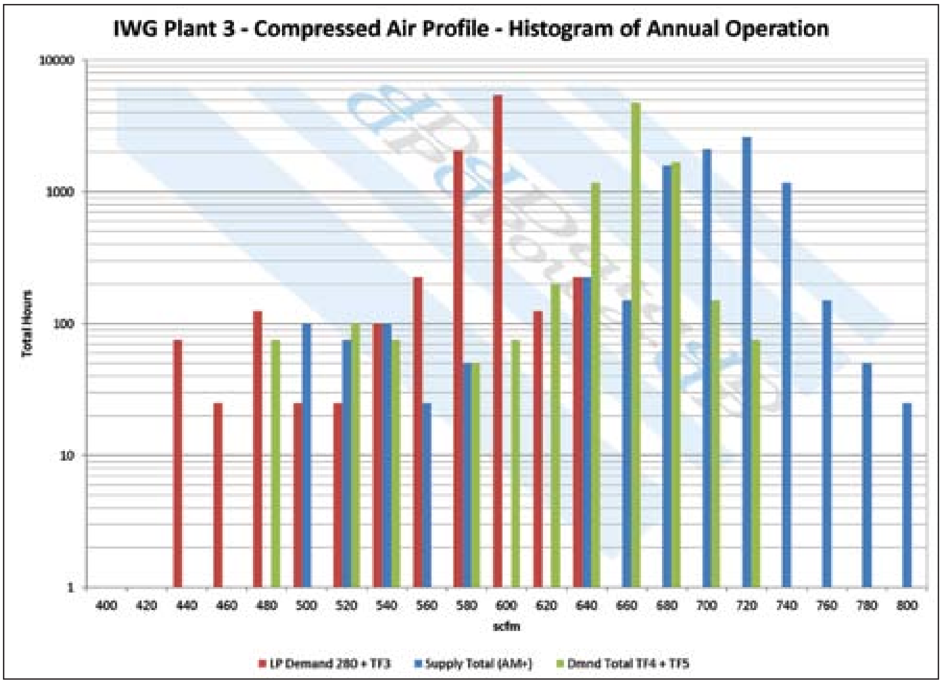

Figure 4 — IWG Plant 3 Phase 2 Compressed Air Demand Histogram

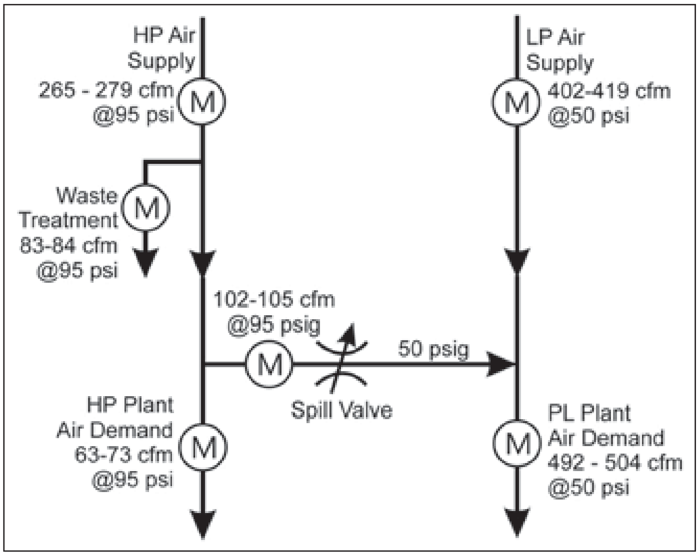

Figure 5 — IWG Plant 3 Phase 2 Flow Profile Spot Check Data

Other key findings of the IWG Plant 3 Phase 2 Assessment include the new compressed air demand profile. The Compressed Air Profile Histogram in Figure 4 shows airflow data measured at a 6 second data interval averaged to 1 minute readings and plotted in a histogram using 20 cfm buckets from 400 to 800 scfm. Data shows total air demand is normally 600–720 scfm with 500–640 scfm LP demand indicating HP demand is between 80 and 100 scfm. Data validation compares measured Demand Total to Supply Total (AM+)data calculated using AIRMaster+ software. AIRMaster+ indicates slightly greater air flow which is expected since AIRMaster+ is calculating acfm and measured data is scfm. Performance was measured in August when elevated ambient temperatures would reduce measured scfm readings.

Flow profile data in Figure 4 was measured before the system was modified to move key air wipes to the HP Plant Air and the LP Air Wipe pressure was reduced from 58.8 psig to 50 psig. After making those changes, spot checks of measured airflow provided the data as shown in the diagram in Figure 5 below. As expected LP air demand is reduced at 50 psig operating pressure and HP air demand is slightly increased with addition of key air wipes being supplied from the HP Plant Air System.

Phase 2 Assessment Recommendations:

Based on the demand profile in Figure 5; Phase 2 of implementation includes measures to further reduce air demand and improve the system's supply/demand balance. The following action plan addresses recommended remedial measures.

- Install new air compressors to provide flexibility to meet the system's range of new lower demand profiles and replace the existing aging less efficient air compressors
  - Install one 40 hp two stage lubricant free rotary screw compressor to operate at 178 cfm and 50 psig
  - Install one 50 hp two stage lubricant free rotary screw compressor to operate at 226 cfm and 50 psig
  - Install one 100 hp Variable Speed Drive two stage lubricant free rotary screw compressor with a capacity of 80–331 cfm at 100 psig working pressure
- Install pilot operated regulators (Qty 2), one each on the existing HP Plant Air Supply pipeline and the pipeline that serves Waste Treatment. Each regulator should be set to the lowest optimum supply pressure required by each of the demand sectors that they supply. Target pressure of about 85 psig is anticipated

Normal plant operation with the recommended mix of air compressors will allow full load operation of the two LP System (50 psig) air

CAC® Qualified Instructor Profile

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Tom Taranto is a L2 CAC Certified Instructor. He is an independent compressed air system professional with more than 30 years of experience providing services to industrial clients, utilities, and energy agencies. He is the owner of Data Power Services, LLC. He has extensive experience in design and application of fluid power systems both hydraulic and pneumatic. Tom's work involves compressed air system design, air compressor application, and performance of related compressed air system components. He conducts compressed air system assessments, equipment testing, and compressed air system training throughout the world. More information about Tom can be found at the CAC website.

INTERNATIONAL WIRE TRIMS COMPRESSED AIR COSTS

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compressors totaling 404 cfm of delivered airflow. As a result the HP System will require between 165 cfm and 225 cfm of air supply; 80–100 cfm HP to LP spill flow, 45 cfm HP Plant Air @ 85 psig, and 40 to 80 cfm of air demand in Waste Treatment. The recommended VSD air compressor with capacity of 333 cfm will operate between 50% and 68% of full load capacity.

The initial control strategy is for operators to manually start and stop Low Pressure compressors operating as base load capacity, and the new High Pressure VSD compressor to operate as trim capacity. The overall air demand is relatively constant and changes incrementally as one or more of the six production lines are started and stopped. Since there are normally few changes in the plant operating scenario, and reduced operating scenarios represent a small fraction of operating hours manual operation is possible. It is recommended that consideration for compressor control automation be evaluated in the future.

Phase 2 Energy Reduction and Cost Savings Projections:

Installation of new air compressors optimizing the supply/demand balance is projected to result in 238,900 kWh energy reduction with an additional $22,700 annual savings. The plant is presently purchasing and installing the equipment to complete Phase 2 implementation.

Summary:

Compressed Air Challenge Training provides fundamental understanding of the system approach to design and manage industrial compressed air systems. Efforts to improve the system addressing only a single component (the air wipes) of the system was unsuccessful in reducing energy use and improving system reliability. However, when applying the CAC System Approach, understanding production's compressed air requirements and designing and optimizing the system to support those requirements results in energy savings, cost reduction, and improved system reliability.

To quote IWG Plant 3 Manager Eric Bryant; "After some initial issues requiring minor repair of the compressors, the system has performed for several months at 100% reliability." The Phase 2 replacement of aging compressors is just beginning installation and commissioning. BP

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Analysis was performed with the US DOE AIRMaster+ compressed air system software tool and energy savings of 624,306 kWh/yr and $59,309 per year cost savings were projected.

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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Tuthill Qx™ Positive Displacement Blower

At Tuthill, they have listened to what customer wants in a blower and have begun to improve on the traditional PD blower. An outcome of the Voice of the Customer process has been the Qx™ series positive displacement blower and the Qube™ blower package.

Some positive displacement blowers can have a sound pressure level of over 100 decibels (dBA). Tuthill has addressed this by incorporating a patented noise reduction feature into its Qx series of blowers used in the Qube blower package. The new integral silencer design results in an average 10 dBA reduction of noise pressure across the rpm and pressure range of operation. During the Qx design, other customer wants, such as improved efficiency, were focused on by improving internal component profiles and reducing the amount of slip. Slip is a way to judge a blower's performance and is directly affected by clearances. Optimizing the PD design gives the Qx blower one of the highest available PD pressure ratings in the industry at 18 psig.

Most companies address excessive noise by adding sound attenuated enclosures and external accessory silencers. Tuthill Qube blower packages do not even require an external discharge silencer because of the already low noise generated from the Qx blower inside. In eliminating the external silencer, the result is a lower cost product, a smaller footprint and improved efficiency due to the reduction in air flow restriction. It also removes the possible contamination and corrosion that comes with having an external silencer.

The noise reduction feature also serves a dual purpose for the QX blower. Its unique design reduces the pulsations in air flow that are inherent of most PD blowers. This dampening affect results in less shock on downstream equipment. Less shock means longer life and fewer service issues for industry.

Contact Tuthill Vacuum & Blower Systems
Tel: 417-865-8715
http://vacuum.tuthill.com

Kaeser AirCenter

Kaeser's AirCenter packaged compressed air systems come complete with a Kaeser Sigma rotary screw compressor, refrigerated air dryer and optional filter — all compactly mounted on a receiver tank. Simply connect the power and air-line, and you have a fully operational compressed air system. Compressor size ranges from a single 5 hp to twin 30 hp units with pressures from 80 to 200 psig, and flows from 12 to 248 cfm. The compressors are complete with starter, aftercooler and sound attenuating enclosure.

The CFC-free refrigerated dryer delivers a consistent pressure dew point as low as 38 °F for the dry air you need. The package can be customized with filters that remove particles as small as .01 micron, oil aerosols and even oily smell or taste from the compressed air.

Contact Kaeser Compressors
Tel: 877-586-2691
www.kaeser.com/aircenter

New VTLF2 Series Vacuum Pump by Becker

Becker Pumps Corp. is introducing their new VTLF2 series of pumps featuring improved cooling, reduced noise, greater ease of maintenance, and hands-off evaluation of the filters. Continuous duty vacuum levels to 27 in.HgV, with flows from 127 to 173 cfm. Applications include PVC extrusion, thermoforming, VARTM, and more.

Contact Becker Pumps
Tel: 888-633-1083
www.beckerpumpscom

TECHNOLOGY PICKS

Ingersoll Rand adds Xe-Series Control to R90-160 Rotary Screw Air Compressors

The Xe-Series control is a more convenient and reliable monitoring system that provides a window into all vital compressor data. The Xe-Series controller debuted last year on the Ingersoll Rand R55-75ne Nirvana VSD Premium Efficiency and R55-75n Nirvana VSD Efficiency rotary screw air compressors and is now available on the larger systems.

The Xe-Series has an easy-to-read, high-resolution color display, an intuitive menu layout and large navigation buttons to make the system user friendly. High-intensity LED indicators clearly show the compressor's status from a distance and a real-time clock enables operators to program start and stop schedules to help reduce plant's operating costs. The controller also provides a performance analysis, graphics and visual trending information so controllers can track system efficiency.

"The Web-enabled access allows operators to monitor vital system data and adjust the compressor from remote locations using the Internet browser on their PCs, tablets and smartphones," said Vipul Mistry, marketing manager for Ingersoll Rand. "Users can rely upon automatic email notifications to alert them if a trip occurs, so they can address the issue quickly."

The Ingersoll Rand R90-160ne Nirvana VSD Premium Efficiency and R90-160n Nirvana VSD Efficiency rotary screw air compressors run on 125 to 200 horsepower and maximize energy savings through the use of their exclusive Hybrid Permanent Magnet Motor™ (HPM). The HPM motor can perform unlimited starts/stops, constant pressure control and starting amps below full load to provide unmatched efficiency. The Xe-Series controller can be retrofitted onto systems currently using Ingersoll Rand R90-160ne and R90-160n compressors.

Contact Ingersoll Rand
www.ingersollrandproducts.com/air

New TNX Series Expands Nitrogen Generation Possibilities

The new TNX Series of on-site Nitrogen Generators offers a solution to the problem of increasing Nitrogen production without having to make large up front capital equipment expenditures. Typically, companies purchase oversized Nitrogen Generation systems in anticipation of future growth needs. The expandable TNX Series gives companies the flexibility to buy the capacity they need today and easily increase that capacity (up to a factor of 4 from base models) as their Nitrogen needs grow.

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Contact James Bowers, Titus Nitrogen
Tel: (888) 722-5253
Email: jrbowers@titusco.com

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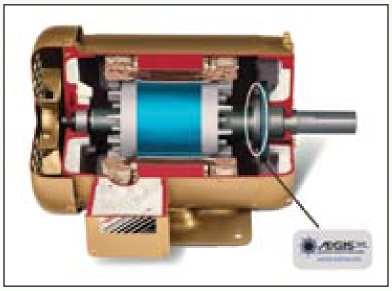
TECHNOLOGY PICKS

Baldor Expands Offering of Super-E® Motors



Baldor Electric Company has added 98 new ratings to the popular Baldor•Reliance® Super-E motors with Internal AEGIS Bearing Protection Ring. Originally launched in 2010, this product line provides end-users with off-the-shelf availability of motors equipped with a pre-installed shaft ground. The additional 98 ratings expands the existing 4 pole line of TEFC & ODP designs through 100 hp and adds a generous offering of 2 and 6 pole models, as well. Additionally, 575V TEFC motors were added, 1 to 50 HP, as well as TEFC & ODP close-coupled pump motors.

While most shaft ground applications utilize a shaft ground on the outside of the motor, the Baldor•Reliance Super-E has the grounding ring factory installed internally on the motor. This internal design minimizes exposure to the outside elements and keeps the grounding ring from being damaged by external forces. Applications include heating, ventilation and air conditioning blower and fan motors, pump motors, and other general purpose applications using an adjustable speed drive.

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