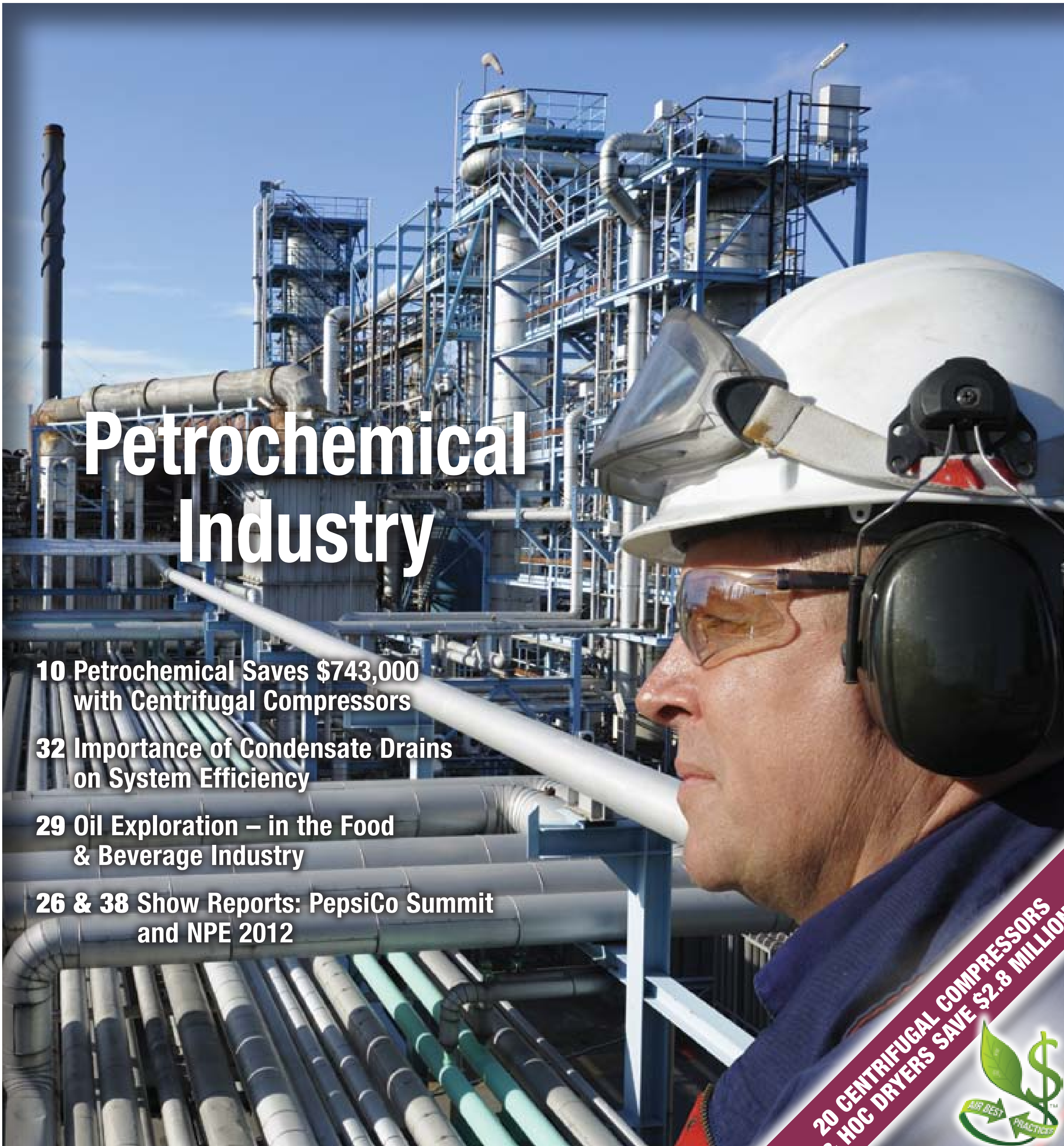
The Magazine for ENERGY EFFICIENCY in Compressed Air, Pneumatics, Blower and Vacuum Systems

COMPRESSED AIR BEST PRACTICES®

airbestpractices.com

May 2012



Petrochemical Industry

20 CENTRIFUGAL COMPRESSORS & HOC DRYERS SAVE $2.8 MILLION

Clear the way for quality air

Hi, I'm Michelle and I have been working with our customers across the United States for the last 10 years. Products that optimize quality in your air supply are not just accessories we offer; they are a way of life for us at Atlas Copco. That's why we produce such a wide variety of dryers, aftercoolers, filters and oil-mist eliminators just to name a few.

We all perform best when working within our optimum environment, right? And, manufacturing environments are no different. Moisture in your air supply is something that should be avoided at all costs. Water is a by-product of compressing air. But there are ways to ensure this moisture doesn't get downstream and cause equipment malfunction. And more importantly, moisture can lead to contamination of your end products, leading to costly product failures and potentially harming your hard-earned reputation.

Our mission is to continue to bring sustainable productivity through safer, cleaner, more energy-efficient, and cost-effective compressed air technology. Simply log onto **www.atlascopco.us/michelleusa** or call **866-688-9611** to learn more about us, our products, and how we have earned and will continue to earn our reputation.

Sustainable Productivity

Atlas Copco

HITACHI
Inspire the Next

Ultimate Air Quality
ISO 8573-1:2001 Class 0

Class Zero

Approaching 100 years of compressed air experience, Hitachi has been and continues to be the technology leader via continuous innovation of air compression oriented towards Customer Value. With growing concerns for the environment we live in, along with the products we consume, not only Oil Free, but Contaminant Free air is quite important.

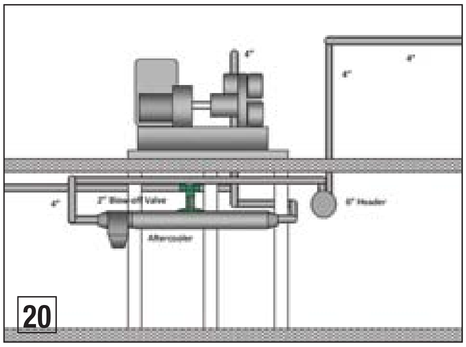
The foundation of Hitachi Innovation is derived from more than 50 years of Oil Free Compressor technology, with the world introduction of Hitachi Oil Free Reciprocating compressors in 1954.

Continuing our pioneering spirit with societal responsibility, Hitachi embarked upon a certification of ISO 8573-1:2001 Class 0 for the Hitachi DSP Series Oil Free Rotary Screw Compressor (15-240kW). To validate our findings for consumer knowledge, third party laboratory testing was contracted with a positive result to standards, which enables Hitachi to provide a variety of Innovative, Technologically Superior, and Value Oriented Product for our Customers.

HITACHI AMERICA, LTD. AIR TECHNOLOGY GROUP
5808-Q Long Creek Park Drive, Suite Q; Charlotte, NC 28269
Tel: 704.494.3008 ext 28 www.hitachi-america.us/airtech; airtechinfo@hal.hitachi.com
Hitachi Industrial Equipment Systems Co., Ltd.

HITACHI
Inspire the Next

SUSTAINABLE MANUFACTURING FEATURES



COLUMNS

FROM THE EDITOR | Chemical Plants

Compressed air energy savings opportunities are still prevalent in most facilities. It's simply the "forgotten utility". We often say that if compressed air was water, most factories would be drenched due to the air leaks!

In this issue we review two case studies from chemical plants. These types of sites are very complex with acre after acre of piping. It's easy to play the armchair quarterback while those on the ground have to make their products with who knows what challenges being thrown at them.

Having said that, these types of plants usually offer significant opportunities to save energy. Mr. Paul Edwards, from Compressed Air Consultants, provides us with a case study where a petrochemical plant was able to save $750,000 per year in rental and energy costs related to their compressed air system. Annual costs for the oil-free rental air compressors were over $400,000 but the plant had air pressure reliability issues and the rental compressors solved the problem. The system assessment solved both problems.

Mr. Hank van Ormer provides us with another case study where a chemical plant found $2.8 million of annual energy savings by moving away from steam turbines for their centrifugal air compressors. They were replaced with more efficient electric-driven three-stage centrifugal compressors with inlet guide vanes and they also found significant savings ($400,000 per year) by switching to heat-of-compression air dryers.

We hope you enjoy our Show Reports from the PepsiCo Sustainability Summit and from the NPE 2012 International Plastics Showcase. The NPE Report has a great example of ingenuous product development and design for sustainability at KRONES where they have increased stretch blow molding capabilities by 12% while reducing compressed air related energy costs by at least 30%.

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

ROD SMITH
Editor
Contact: 412-980-9901, rod@airbestpractices.com

COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

Sullair Identified For Sale by United Technologies

In a March 2012 meeting with investors and analysts, United Technologies Corp. updated its financing plan for the proposed $16.5 billion cash acquisition of Goodrich Corp. including expected proceeds of approximately $3 billion from net divestitures and $1.5 billion from mandatory convertible instruments.

UTC businesses identified for sale include Pratt & Whitney Rocketdyne, Clipper Windpower and the Hamilton Sundstrand Industrial businesses: Milton Roy, Sullair and Sundyne. These businesses are treated as held for sale and have been moved to discontinued operations in UTC's financial statements. Gains realized at the time of closing are expected to be greater than impairment charges in discontinued operations.

"We are taking the opportunity to re-evaluate our portfolio as we enter a transformational stage with the proposed acquisitions of Goodrich and Rolls-Royce's share in the International Aero Engines joint venture," said UTC Chairman & Chief Executive Officer Louis Chênevert. "The proceeds from divestitures of non-core businesses will help minimize the equity issuance and reduce dilution from the Goodrich transaction. www.utc.com

SULLAIR® Always air. Always there.

Atlas Copco Appoints Tom Poot as Business Line Manager

Atlas Copco Compressors has appointed Tom Poot as business line manager for oil-free products in the United States. Poot began working in this new role during the first quarter of 2012. Poot joined Atlas Copco in 1998 as a project engineer. He was promoted to project leader within the same group in 2002 before serving as engineering manager, oil-free air from 2004 to 2008. Poot returned to Oil-Free Air marketing in 2008 as the product marketing manager for Atlas Copco's line of large Z compressors.

"Tom has as thorough an understanding of this business line as anyone with Atlas Copco and he will be a tremendous addition for our customers in the United States," said Mikael Andersson, acting general manager at Atlas Copco Compressors. "He has continually demonstrated an adept ability to find ways to showcase our oil-free air products throughout the years and we're excited about the opportunities he brings to the US market." www.atlascopco.com.

Atlas Copco

ASCO Numatics Announces 2012 Industrial Automation Engineering Scholarships

ASCO Numatics, the world's leading manufacturer of comprehensive fluid automation, flow control, and pneumatics solutions, today announced the 2012/2013 ASCO Numatics Industrial Automation Engineering Scholarship program. The program awards two $5,000 scholarships to U.S. engineering students pursuing careers in industrial automation-related disciplines. ASCO Numatics will also make $1,000 grants to the engineering departments of the colleges in which the winners are enrolled. The application deadline is May 25, 2012.

"The industrial automation industry is constantly evolving and it is imperative that we evolve with it. Today's engineering students will lead companies into the next-generation of industrial automation and we are proud to support their efforts," said Robert W. Kemple, Jr., executive vice president, sales and marketing — Americas, ASCO Numatics. "As we enter the fourth year of offering this scholarship, it is gratifying to see our past scholarship winners beginning to graduate and advance in their respective careers." http://www.asconumatics.com/scholarship.

ASCO numatics™

COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

SMC to Expand Facility 600,000 Square Feet

SMC Corporation is expanding their North American corporate headquarters, in Noblesville, Indiana, by 600,000 square feet. Officials said the expansion cost is approximately $19 million.

The 600,000-square-feet addition will be constructed at both the east and west sides of the building. Chad Bosler of SMC said 360,000 square feet would be used for production space and 240,000 square feet would be for warehousing.

"We have 900,000 square feet under roof now, and after the addition, it will be 1.5 million square feet," Bosler said.

As part of the construction, Bosler said SMC plans to add 163 new jobs by 2017. He said the average wage with benefits for those positions would be $62,732. SMC, a global pneumatic technology developer and manufacturer, moved its headquarters to Noblesville in 2008. At the time, the company had 458 employees in its $30 million 627,500-square-foot building. In September, the company purchased approximately $5.5 million worth of new equipment as employment increased to 610 people. Bosler said construction is expected to begin in May and completed by September. Jobs created will continue through 2017. www.smcusa.com

SPX Acquires Seital

SPX Corporation announced that its Flow Technology segment has acquired Seital S.r.l, a leading supplier of disk centrifuges (separators and clarifiers) to the global food and beverage, biotechnology, pharmaceutical and chemical industries. The terms of the transaction were not disclosed.

Founded in 1983 and based in Santorso, Italy, Seital has approximately 50 employees and exports its products to more than 80 countries. Seital's disk centrifuges (separators and clarifiers), rotary brush strainers and hydrocyclones, and standardizers are used primarily by customers in the food and beverage industry. Applications include dairy, wine, beverages and essential oils, as well as oils and fats.

"Seital is a very well-respected manufacturer of high quality separators, clarifiers and other components that play a critical role in a wide array of food and beverage processing systems and other flow processes," said Don Canterna, segment president, SPX Flow Technology. "When combined with SPX's global resources and market capabilities, this acquisition creates growth opportunities across our food and beverage systems and product portfolios." Seital's core technologies cover the clarification of liquids, separation of liquids, concentration, recovery of solids, and extraction of substances. www.spx.com

SPX®

To read more *Industry News* articles,
visit www.airbestpractices.com

THE SYSTEM ASSESSMENT

Open-Minded System Assessments Part 1

Petrochemical Plant Optimizes Centrifugal Compressors

By Paul Edwards, Compressed Air Consultants

May 2012 System Assessment of the Month

Where: North America
Industry: Petrochemical Industry
Audit Type: Supply and Demand Side

System Assessment Win/Win Results*

Energy Savings per year:	$267,000
Rental/Maintenance Savings:	$476,000
Total Savings Per Year:	$743,000
Project Investment:	$1,150,000
Simple ROI:	19 months
Result:	Stable Pressure Year-Round

*Source: CO_2 Calculator on www.airbestpractices.com

The Facility

This large petrochemical facility employs 400 employees and contractors. The site covers an area of almost 900 acres. Natural gas liquids are used as a feedstock at the plant to manufacture ethylene, the world's most widely used petrochemical. The ethylene is then converted into polyethylene and polypropylene plastic resins. These resins serve as building blocks for countless products that provide the necessities of modern life, such as leak-proof and shatter-proof containers for industrial and household chemicals, packaging that protects our food from spoilage and contamination, and children's toys that are safe and durable. The plastic resins produced at the facility are sold to manufacturing companies, in the plastics industry, who typically produce a finished product.

Over the past year, the company had experienced thirty (30) "close-scrapes" with having entire sections of the plant shut down to pressure losses in the instrument air system. This is why our firm was engaged to conduct a compressed air system assessment. The experience we had, during this assessment, reaffirmed our belief that every system must be approached with an open mind. There is no single, cookie-cutter, system assessment approach that works for all facilities.

This petrochemical facility was spending $1,110,000 annually to operate their compressed air system. The blended rate for electricity at this site was $0.03 per kWh. Electrical energy costs were $471,000 and compressor rental/maintenance costs were $639,000 per year. The system assessment identified a yearly savings opportunity totaling $743,000 per year with an investment of $1.15 million. The simple ROI on the project was 19 months.

This system assessment exhaustively examined the supply and demand-sides of the compressed air system. Due to article length space constraints, Part 1 of this article will detail the improvements made to the supply-side and Part 2 will cover the demand-side projects.

Supply-Side System Overview

The main compressed air system consists of five (5) air compressors supplying both Plant and Instrument air to the site. There are two (2) main compressor rooms located in the Utilities Area and the Polymers Area.

The Utilities Area Compressed Air System

The Utilities compressor room contains three (3) compressors (C2, C3, and C4) that include two (2) 1,500 Icfm 3-stage and one 2,770 Icfm 4-stage centrifugal. All compressors in the system are oil-free and water-cooled. C3 compressor is equipped with a steam driven turbine which lets down steam required for the process. The after-coolers on some compressors are remotely mounted away from the compressor package while some are integral to the package. The quality of the cooling water is poor and therefore the coolers are susceptible to fouling. The units are installed in compressor trains where the plant air dryers are dedicated to a specific compressor.

The plant air dryers (to be covered in Part 2 of this article) are conventional heatless desiccant dryers using activated alumina as the media and compressed air for regeneration. Each dryer operates on a fixed 10-minute fixed cycle and therefore the purge requirements do not change as system demand varies. Each desiccant air dryer has a coalescing pre-filter and particulate after-filter. The pre-filters remove liquids and oils to prevent the desiccant beds from prematurely fouling. The particulate after-filters are designed to remove desiccant fines that will carry over from the dryer chambers.

The piping downstream of the dryers combines into a common 6" dry header feeding both the plant air header and the guard dryer which supports the instrument air header. The header branches to the main plant air line which is equipped with a single back pressure control valve which is designed to modulate closed in the event the Instrument air pressure falls to unacceptable levels. The back-pressure control valve does not operate automatically and has been manually closed to a 50% position. Another branch line downstream of the Plant Air dryers feed the Utilities Guard dryer arrangement. The Utilities Guard dryer is manually switched between vessels and uses nitrogen for purging. The Utilities compressor room feeds two (2) 3" Instrument air headers which connect to the Polymers area of the plant. 3" and 4" Plant air headers are run from the Utilities Compressor area to the Polymers area of the plant.

The three (3) compressors in the Utilities compressor room operate on their own local controls using inlet modulation. The set points are slightly staggered and therefore operate at various part load conditions.

THE SYSTEM ASSESSMENT

Petrochemical Plant Optimizes Centrifugal Compressors

The Polymers Area Compressed Air System

The Polymers area contains two (2) compressors (C5 and C6) located in individual buildings. C5 is a 4-stage centrifugal rated for 2,770 Icfm and with an air end identical to the C4 compressor. C5 is equipped with a steam driven turbine and is used to let down steam for the process. The entire demand consumed by the steam turbine on C5 is not required and therefore is not always efficiently utilized. During certain times of the year, the excess steam sent to the deaerator is vented to atmosphere (up to 10,000 lbs/hr). The air produced by C5 is dried by the Plant air heatless desiccant air dryer. A molecular sieve desiccant dryer is installed downstream of the plant air dryer in order to further suppress the dew point down to -80 ºF using nitrogen as purge. A branch line downstream of the plant air dryer feeds the two main plant air headers (3" and 4"). The compressors are water-cooled with water from an open evaporative tower. Each dryer has a coalescing pre-filter and particulate after-filter. The pre-filters remove liquids and oils to prevent the desiccant beds from prematurely fouling. The particulate after-filters are designed to remove desiccant fines that will carry over from the dryer chambers. The compressor operates on its own local controls and has the ability to modulate its inlet valves based on the prevailing discharge pressure (constant pressure).

#1: System Demand

During the study amperage loggers were installed on the three (3) electric driven air compressors in order to get a better understanding of the dynamics of the system load. The loading of the two (2) steam driven compressors was closely observed through the week and well documented. The performance curves for the air compressors were obtained from the factory in order to understand the power versus flow output of the air compressors based on ambient inlet conditions. During the study, compressed air consumption did not vary plus or minus 15% from the average demand of 6,173 scfm.

The collective supply side capacity of the air compressors at the prevailing ambient conditions (62 ˚F, 35% inlet) during the study was 10,945 scfm leaving excess capacity of over 4,700 scfm. Under worst-case operating conditions in the summer months, the compressed air system has 3,375 scfm of excess operating capacity. The discharge mass

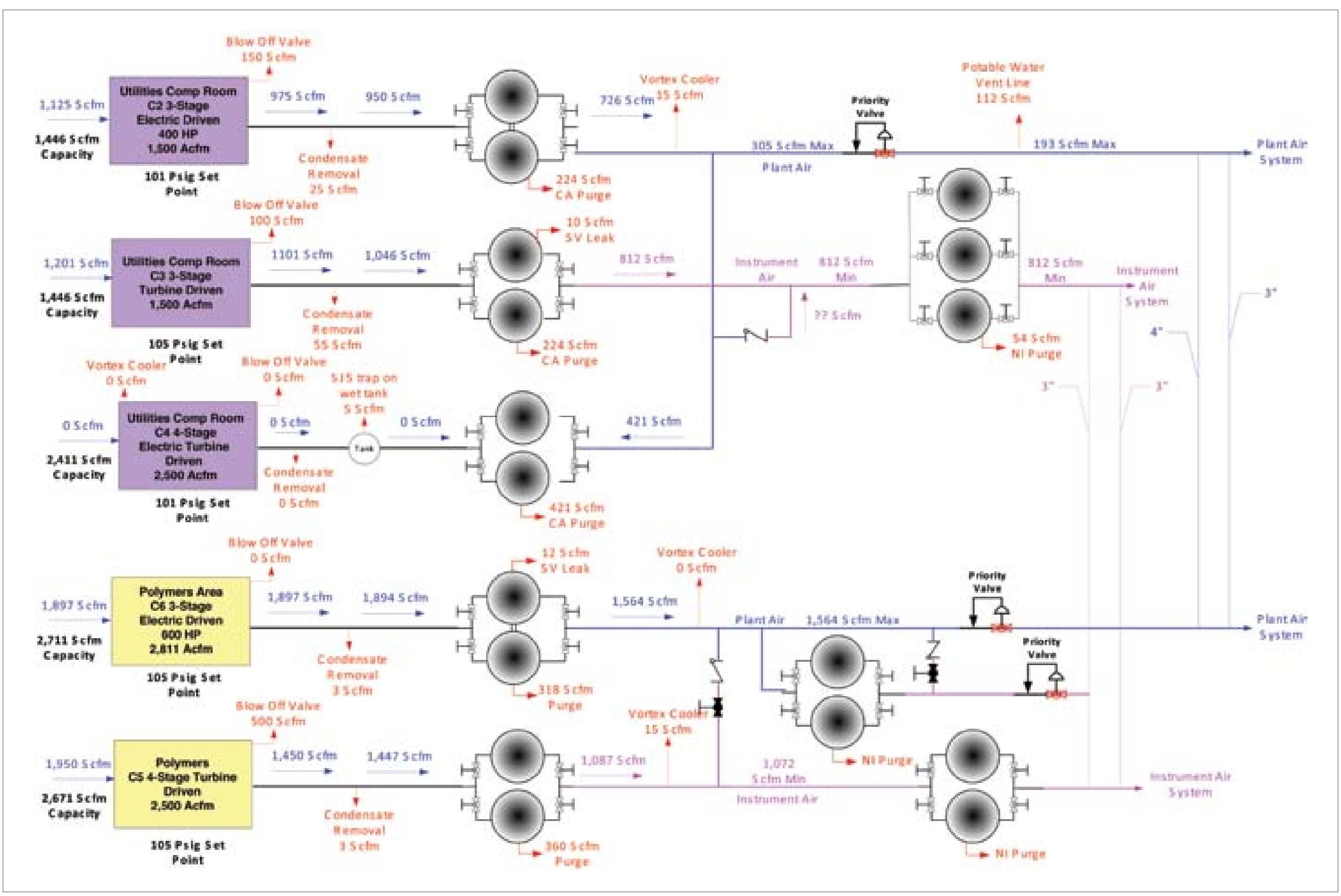


Figure 1: Installation Before the System Assessment

of the centrifugal compressors will change based on the prevailing intake conditions and cooling water supply temperatures. 38% of the total compressed air generated is consumed in the compressor room areas. With modifications to the system, a majority of the compressor room consumption can be eliminated providing additional off line capacity for the system.

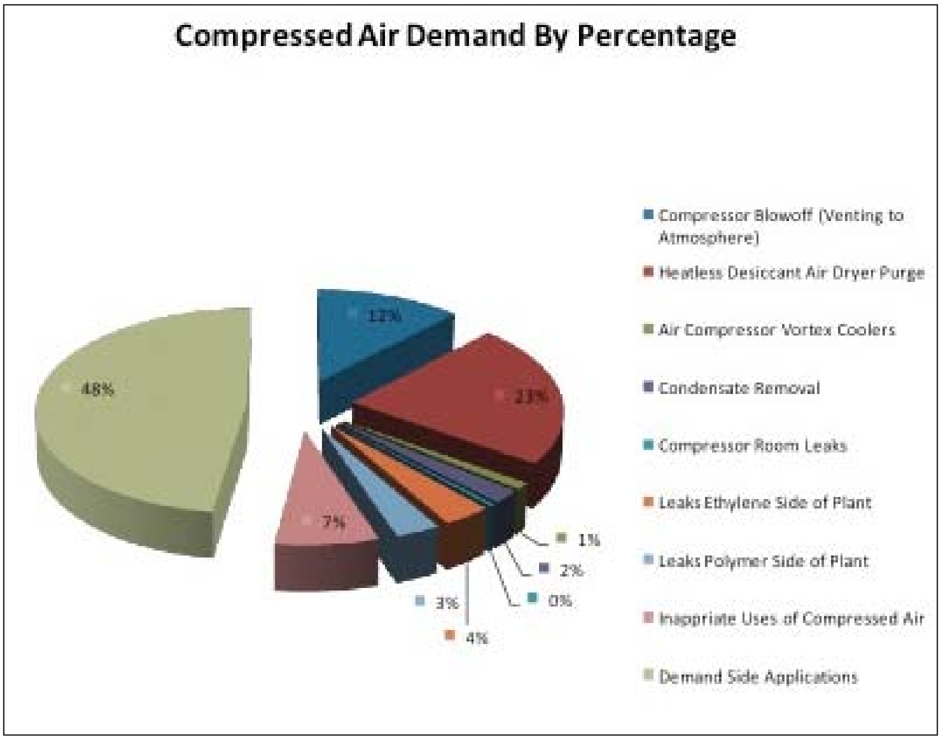
Historically the site operates all five (5) air compressors if they are in operating condition. For a portion of the study, C4 compressor was down and still in the process of being commissioned after being upgraded with a refurbished airend. Operating all five air compressors at one time is not an indication of the need for compressed air. For example, when C4 was started, **it proceeded to deliver un-needed compressed air** to the system. As a result, several of the on line compressors removed a portion of the air generated by C4 by further opening their blow off valves which vent to atmosphere.

Completing all supply and demand side actions (covered in Part 2 of this article) will reduce the system demand by over 2,700 scfm

System Before Assessment		System After Assessment	
Energy Costs per year:	$471,000	**Energy Costs per year:**	$204,000
Rental/Maintenance Costs:	$639,000	**Rental/Maintenance Costs:**	$163,000
Total Costs Per Year:	$1,110,000	**Total Costs Per Year:**	$367,000
Operating Hours:	8700 hours	**Operating Hours:**	8700 hours
Power Cost $/kWh:	$0.03	**Power Cost $/kWh:**	$0.03
Issue:	Multiple "close scrapes" with insufficient pressure makes rental compressors necessary. Insufficient and unreliable air pressure is the main issue.	**Situation:**	Rental compressors no longer required

THE SYSTEM ASSESSMENT

Petrochemical Plant Optimizes Centrifugal Compressors



— leaving 6,000 scfm of excess available off line capacity under worst-case operating conditions in the summer months. We project that the future demand for the system will be less than 3,800 scfm which can be supported by one machine in the utilities area and one unit in the Polymers area.

Rental Compressors

It is common for compressed air system to operate with limited monitoring points. However, the lack of collective information which can be analyzed can be costly to the site since it is difficult to make sound informed decisions. Historically, the site has rented oil-free air compressors when one of the permanent machines was either broken or being maintenance. **Historical data collected from the site indicates that over the last three (3) years, the site has spent an average of $208,500 annual on rental fees. In addition, it has cost an average of $255,500 a year to fill the diesel engines with fuel to support the rental units. Collectively the plant has spent an average of $464,000 a year for rental compressors and fuel.**

In the short term, the plant should review the performance capabilities of each compressor based on site conditions to determine the proper course of action when a compressor is out of service. In the long term, the reduction in demand will enable the site to operate without the need of a rental compressor as long the plant does not lose more than two units at the same period of time.

Optimizing the Centrifugal Air Compressors

The age of the installed air compressors varies between six (6) and forty-one (41) years and need to be assessed for long term planning. As demand is stripped from the air system, fewer compressors will be needed in order to support the system. However, there are limitations in adequately delivering air to the entire system at a predictable and stable pressure due to the limitations of the distribution piping for the instrument and plant air systems. The cross connects between the Utilities and Polymer systems consist of the following:

- Two (2) 3" lines for the IA system
- One (1) 3" line and one (1) 4" line for the Plant Air System

The distribution piping can be upgraded in order to minimize pressure drop throughout the system. However, this option is very costly and not the best option for the site. On a reliability perspective, it makes sense to operate a minimum of one compressor in each of the respective areas (Utilities and Polymers) which will ensure a constant pressure in the main distribution headers. Since the Polymers area on has two compressors, it is critical that there is a reliable backup unit. However, C5 compressor historically has been unreliable due to the steam driven turbine and therefore should be addressed first. C3 compressor also is equipped with a steam turbine and is used to let down stream to a lower pressure for the process. The process uses the entire let down steam from C3 compressor and therefore only power cost associated with this machine is associated with the seal losses during let down. However C3 (and C2) are the "weak links" in the system since they are rated for 105 psig discharge and contain well worn aluminum impellers. **For these reasons, changes to C3 are warranted and are a priority in the short term plan.**

C5 Compressor

C5 compressor has experienced reliability issues due to the steam-driven turbine. We estimate that the turbine is consuming 35,000 lbs/hr and consumes about 2,000 lbs/hr in seal losses. The process requires the let down steam for a majority of the year. However, for about 1,500 hours a year a portion of the let down steam (about 10,000 lbs/hr) is not required for the process and therefore is returned to the dearator where it is vented to atmosphere. Including the seal losses, the losses are 12,000 lbs/hr. At a steam generating cost of $5.48/1000 lbs, the annual cost to vent excess steam due to C5's steam turbine is $98,550. Over the last three years, the average annual cost to maintain and repair the steam turbine has been $49,194. The annual cost to operate C5 compressor including wasted steam, maintenance, and repairs is $147,744.

There is some variation in the volume of let-down steam from the compressor turbine and therefore can affect the production operation. In the future it is critical that the compressor is configured to automatically start and stop in the event of a primary compressor failure which will be difficult and expensive with the steam turbine. The cost to operate an electric driven compressor will be less compared to the C5 steam driven compressor. For process stability, system reliability, and operating costs, it does not make sense to keep this compressor on a steam driven turbine.

In the long term, the system will require operating one of the compressors in the Polymers area. In order to maintain a high degree of reliability, we propose replacing this compressor with an electric driven compressor. The existing compressor can be converted to an electric driven compressor but will require extensive modifications that have been estimated to cost close to $200,000. The airend on C5 is identical to the C4 compressor — which is a newly refurbished 4-stage unit. Years down the road, there is a high likelihood that C4 compressor will have to be re-worked. The cost to repair a damaged 4-stage unit can be over 50% of a new compressor and therefore will most likely not make sense to complete. Under the sites unique circumstances, we believe it makes sense to remove the existing C5 compressor and replace it with a similar sized 3-stage, centrifugal compressor rated for a discharge pressure between 115 psig and 125 psig. The capital cost to purchase a 500 hp electric driven centrifugal compressor will be less than $200,000. The closest MCC was inspected during the study and it was determined that it could support the electrical needs of an electric driven compressor. We have been told that an electric driven compressor previously operated in the area before the steam turbine was installed. In the future, the new C5 compressor will be rotated with C6 compressor automatically in order to equalize the operating hours. The airend for C5 compressor should be set aside in a storage area outside of the

THE SYSTEM ASSESSMENT

Petrochemical Plant Optimizes Centrifugal Compressors

elements. The airend should be set up for long term storage to include installing desiccant bags as recommended by the OEM. The airend should be turned on a monthly basis to ensure the bullgear is properly lubricated. The ports on the compressors should be covered.

C3 Compressor

The C3 compressor is equipped with a steam-driven turbine that lets down steam to the process. The process uses 100% of the low-pressure steam from the discharge of the compressor's turbine. The plant has estimated that there are seal losses in the magnitude of 2,000/lbs per hour based on the length of the plume observed. At a steam generation cost of $5.48/1000lbs, the annual cost associated with the seal losses on the steam turbine is $92,265.

The compressor's airend is designed for a discharge pressure of 105 psig and therefore is the limiting factor which dictates the maximum operating pressure delivered to the system. The compressor has also suffered from high stage and oil temperatures due to fouling. Presently the quality of water is poor which is contributing to the fouling of the coolers. The plant has indicated that the compressor has a tendency to surge in the summer months and therefore it is difficult to operate the machine fully loaded during these periods of time. Since the process requires the let-down steam from this unit, it makes sense to operate this machine in the future. However, the design discharge pressure of the machine and its' age limit its' capabilities. Based on the supplied performance curves, this compressor should be able to operate without concern of surging at design inlet conditions of 95 ºF since the natural surge is 125 psig. The installed orifice flow meter installed at the discharge of the compressor indicates the compressor is generating close to 1,200 scfm — within the expected discharge of the machine based on its prevailing operating condition.

In order to improve system pressure stability, we believe this airend should be converted to a higher pressure unit which can reliable produce full flow at 115 psig to 125 psig. The compressor is over 40 years old and has reached the end of its life cycle. Operating at a slightly higher pressure in the future will only minimally impact the operating cost of the compressed air system. The greatest energy savings in the compressed air system will be achieved by shutting off air compressors that are not required which compressor automation will address. The stage assemblies in the existing compressor can be upgraded with higher head aeros; however this approach would be costly and the plant will still have an old compressor. We propose pursuing purchasing a new air end that is rated for 1,500 Icfm and a discharge head pressure design of 125 psig. The shaft horsepower of the compressor will have to be reviewed to make sure it does not exceed the capabilities of the steam turbine in the winter months. In the future, this compressor will be used as a base load machine operating at 100% capacity.

C4 Compressor

C4 compressor is an electric driven compressor with a newly refurbished airend from a 1974 L-frame, 4-stage, centrifugal air compressor. The compressor is equipped with a CMC controller which will enable the future automation system to monitor its health and operating point. There are no recommendations related to modifying this machine at this point. However, it is important to note that this machine has favorable turndown capabilities. Turndown is considered to be the amount of flow the compressor can reduce relative to full load before the machine is forced to vent air to atmosphere (to prevent a throttle surge). Therefore this machine may be effectively used at some point as a part load machine. We do not recommend retrofitting this compressor with inlet guide vanes (IGV's) at this point but should be assessed at certain intervals.

C6 Compressor

C6 compressor is the machine with the largest discharge capacity in the entire system. The greatest attributes of this compressor are that it is relatively new; it operates on clean cooling water, and most importantly has the greatest turndown capability of any machine in the system. Based on the machine's throttle limit (TL) setting and its surge indexing value, we estimate that this compressor has turndown capabilities are presently in the range of 700 scfm to 800 scfm at the prevailing discharge pressure. In the future, this compressor will be designated as the primary part load machine

"The system assessment identified a yearly savings opportunity totaling $743,000 per year with an investment of $1.15 million. The simple ROI on the project was 19 months."

— Paul Edwards, Compressed Air Consultants

due to its generous turndown. However, the compressor is equipped with an inlet butterfly valve (IBV) which creates a restriction at the inlet and is a destruction of energy. An IBV will consume anywhere from 0% (full load) to 4% (throttled to TL set point) more energy compared to an Inlet Guide Vane (IGV). Even more importantly, the stability of an inlet butterfly valve (IBV) is inferior compared to an optional inlet guide vane (IGV) since its flow characteristics are not linear. In order to improve the overall reliability and operating cost of the system, we propose retrofitting C6 compressor with an inlet guide vane. In the future, this compressor will be monitored via Modbus and therefore the operating position of the machine will always be known. If the compressor becomes severely part loaded and starts to vent to atmosphere using the blow off valve, the automation may make a decision to start a smaller compressor and shut off this machine in order to supply to become more aligned with demand.

#2: System Storage

Adequate storage for large decentralized systems is critical as it provided pressure stability and stored air for use during the loss of an online air compressor. During the study the capacitance of both the PA and IA systems was measured. Capacitance is considered to be the collective volume of all piping and storage tanks in the system. The IA system has 8,378-gallons (77.6 scf/Psi) and the PA system contains 10,984 (101.8 scf/Psi). Collectively the compressed air systems contain 19,362-gallons or 179 scf per psia.

In other words, if you remove 179 scfm out of the system, the pressure in the piping will drop by 1 psig. This value is needed to predict the system dynamics during the largest event in the system which is the loss of a primary online air compressor. In your case it will be the loss of C6 which is 2,700 scfm rate of flow or 45 scf per second. With the use of compressor automation, it will take about 60 seconds to detect a failure, start a backup machine and produce full flow to replace the failed unit. We assume that the acceptable temporary pressure drop (relative to the prevailing set point) in the system is 10 psig. Therefore the system capacitance must be able to supply 2,700 scf (45 scf/sec x 60 seconds) during the event to act as a buffer until the backup machine produces full flow.

THE SYSTEM ASSESSMENT

Petrochemical Plant Optimizes Centrifugal Compressors

The system's storage value must be at least 270 scf/psig (270 scf/psig x 10 psig drop) in order to support the largest event in the system allowing a 10 psig pressure drop. Since the system already contains 179 scf/Psi, an additional 91 scf/Psi (about 10,000 gallons rated for 150 psig minimum) of storage is needed for the system. If the plant cannot withstand a 10 psig pressure drop during a compressor failure, then the storage will have to be increased according based on the calculations provided above. A single storage receiver makes the most sense as it will be the most cost effective to purchase and install and will have the smallest footprint. The storage tank can be installed anywhere in the system where there is a main distribution header 4" or larger. The tank could also be teed into two (2) 3" lines if a 4" line is not available. The exact location of the new 10K minimum receiver can be determined during the engineering design phase of the project. The receiver tank can be new or used. Due to the size requirements of your system, you may be able to procure a used propane tank for such service. A propane tank can often be cost effective allowing the site to purchase a larger tank than the minimum requirements.

#3: Back-flushing Compressor Coolers

The quality of the cooling water affects the performance of the compressor inter and after-coolers which negatively impact their operating surge points. Fouled coolers will also increase the discharge temperature of the air compressors increasing the moisture load on the PA dryers. Each compressor should be piped so that it can be back-flushed in place when the cooling temperature differential (CTD) increases to unacceptable levels. CTD is considered to be the difference between the entering cooling water and discharge air temperature of the heat exchanger. Typical performance for the inter and after-coolers is a 15 ºF CTD. For example, the prevailing cooling water supply temperature is 80 ºF. The expected discharge air temperature for the exchanger should be close to 95 ºF if the cooler is not fouled. C5 and C6 compressor are equipped with a 4-port valve which can be adjusted in order to reverse the flow of cooling water through the air compressor coolers. We proposed retrofitting C2, C3 and C4 with a similar 4-port valve so that they can be back-flushed based on operating temperatures.

#4: Compressor Controls

It is difficult to set up multiple compressors to operate efficiently using their own local controls. The complexity becomes even greater when the air compressors are located in different areas. Compressors can be "cascaded" by staggering set points on the individual machines. If a compressor fails in this scenario, the pressure in the system will fall until the next compressor loads or ramps up. Since there is insufficient storage to support the failure of a primary air compressor, the plant typically operates all compressors at a part loaded condition. This approach can be effective but results in a very high cost of operation since waste is created through compressor blow off (venting to atmosphere) and modulation of inlet valves.

An efficient compressor supply should be designed to operate all on line compressors, if possible, base loaded at 100% capacity and operating at the lowest acceptable discharge pressure. Operating a centrifugal compressor fully loaded at 100% capacity is desirable since it is the most efficient operating point that delivers the maximum scfm per kilowatt hour of electricity and is the furthest operating point from the surge line. Typically it is not possible to operate all compressors fully loaded since demand will vary during the course of a day. An effective control scheme will limit the number of part-load compressors to a single unit in most instances. Large decentralized compressor systems are difficult to optimize using the local compressor controls or with only partial automation. Compressor automation that coordinates the sequencing of the air compressors is the most effective way to maintain peak efficiency on the supply side of the system when cost effective. In your case it is imperative that automation can monitor the exact operating position (percent loaded, amps, etc) in order to determine the most appropriate mix of online compressors.

We propose installing an automation system that can automatically start and stop the five (5) primary air compressors in the system. The compressors will operate using operating pressure points located at the discharge of each compressor room. The automation will have the ability to monitor the condition (on, off, and percent loaded) of each unit.

> "Each client has different priorities and circumstances. In this case, the elimination of the "close-scrapes" with insufficient pressure was the priority. The energy and rental/maintenance savings realized were just an added bonus."
>
> — Paul Edwards, Compressed Air Consultants

In the event an on line compressor fails, the automation will detect a negative system rate of pressure change simultaneously with a signal that there is a loss of power at one of the air compressors (by monitoring amperage for the electric driven compressors and auxiliary contacts for the steam driven units). The automation will pre-emptively load the next available air compressor before the pressure decays to a level unacceptable to production. The automation will be programmed with the knowledge of the capacitance value of the system (total volume of tanks and piping in the system) in order to determine the rate of change (ROC) or the difference between compressor supply generated and actual demand. Once the next compressor is added to the system, the automation must be able to wait and determine if the pressure recovers in an acceptable period of time. One of the keys is to be able to tune the logic so that it does not under or over-react to system transients.

After all action plan items have been completed, the system will be able to operate on two (2) air compressors. We propose running C3 fully loaded at 100% capacity in the Utilities area with C2 and C4 in automatic backup. Either C5 or C6 will act as the incremental trim machine for the system. Since C6 has the largest turndown, it will be the most efficient machine to operate. A PLC based processor will be installed in each compressor room to manage the air compressors. The processors will communicate with each other by either communication wiring, wireless, or using a fiber optic backbone. The new compressor automation logic should be provided by a group that strictly deals in compressor automation to ensure there is complete knowledge of the capabilities and shortcomings on each piece of equipment.

#5: Conclusion

Keeping an open mind is critical in all system assessments. Each client has different priorities and circumstances. In this case, the elimination of the "close-scrapes" with insufficient pressure was the priority. The energy and rental/maintenance savings realized were just an added bonus. In this article, we have focused on the supply-side of the system and how the centrifugal compressors could be made to supply the system reliably — without the need for rental air compressors. In Part 2, we will focus on the demand-side of the system and the actions realized to reduce compressed air demand. BP

Contact Paul Edwards; tel: 704-376-2600, email: paul.edwards@loweraircost.com, www.loweraircost.com

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

Centrifugal Compressors and HOC Dryers

Reduce Energy Costs by $2.8 million

By Hank van Ormer, Air Power USA

Project Overview

This chemical plant spent an estimated $3,153,022 annually on energy (steam and electricity) to operate the compressed air system at their facility. The plant staff established their energy costs as 5.3 cents per kWh and $9.00 /1,000 lbs of steam per hour. The set of projects implemented in this system assessment reduced energy costs by an estimated $2,841,946 or 88% of current use. In addition, these projects reduce demand on the boiler systems and add reliability and back-up to the compressed air system. The capital investment for completing the projects totalled $1,782,400, providing a simple payback period of 8 months.

This was a demand-side and supply-side system assessment. Due to article-length constraints, this article will discuss the supply-side optimization part of the project. This is where the majority of the energy-savings were realized. The first significant supply-side projects was to replace the existing air compressors, one of which was using a steam turbine, with new electric-driven air compressors. The second significant supply-side project was to replace the externally-heated blower-purge compressed air dryers with heat-of-compression compressed air dryers.

TABLE 1: TOTAL PROJECT SUMMARY					
PROJECT	SAVINGS PROFILE	ENERGY AND OTHER SAVINGS			TOTAL PROJECT COST ($)
		AVG KW	KWH	SAVINGS ($)	
SUPPLY-SIDE SYSTEM					
1. Replace existing steam-driven and electric air compressors with two new electric-driven units	Boiler energy-use savings by eliminating steam	54	473,040 kWh + 100% of Steam Use	$2,390,271	$1,358,000
2. Replace existing dryers with heat-of-compression (HOC) desiccant dryers	Eliminate dryer blowers and heaters	871	7,629,960	$404,327	$423,000
DEMAND-SIDE SYSTEM					
3. Several Demand Reduction Projects	806 cfm	102	878,979	$47,348	$25,000
TOTAL	**806 scfm**	**1,027 kW**	**8,981,979 kWh**	**$2,841,946 per year**	**$1,782,400**

The Centrifugal Air Compressors

Compressed air is supplied by three centrifugal air compressors using Inlet Butterfly Valves. The load profile, or air demand, of these three units is relatively stable during all shifts. The average actual air flow, supplied to the plant, is 5,132 scfm. Air compressor units #1 and #2 are operating at 67% and 47% of full flow capacity while unit #3 is running at 95% of full flow capacity. Average outlet air pressure is 110 psig and the plant is running 8,760 hours per year.

Annual plant energy costs related to the air compressors, were $2,748,695 per year. These estimates are based upon a blended electric rate of $0.053 /kWh.

Air compressor unit #1 is a steam-driven turbine that consumes 30,000 lbs of steam per hour — according to plant personnel. The average cost for this 600 psi steam is $9.00 per 1,000 pounds per hour. The total energy costs to operate this unit is 9 x 30 or $270 per hour x 8,760 hrs or $2,365,200 per year. The main objective of the project is to eliminate the use of steam as a power source and to replace the current compressors with new efficient units.

The project installed three new electric-driven, three-stage, centrifugal compressors: one 700 hp units in the South Plant and one 500 hp unit in the North Plant. The units are water-cooled.

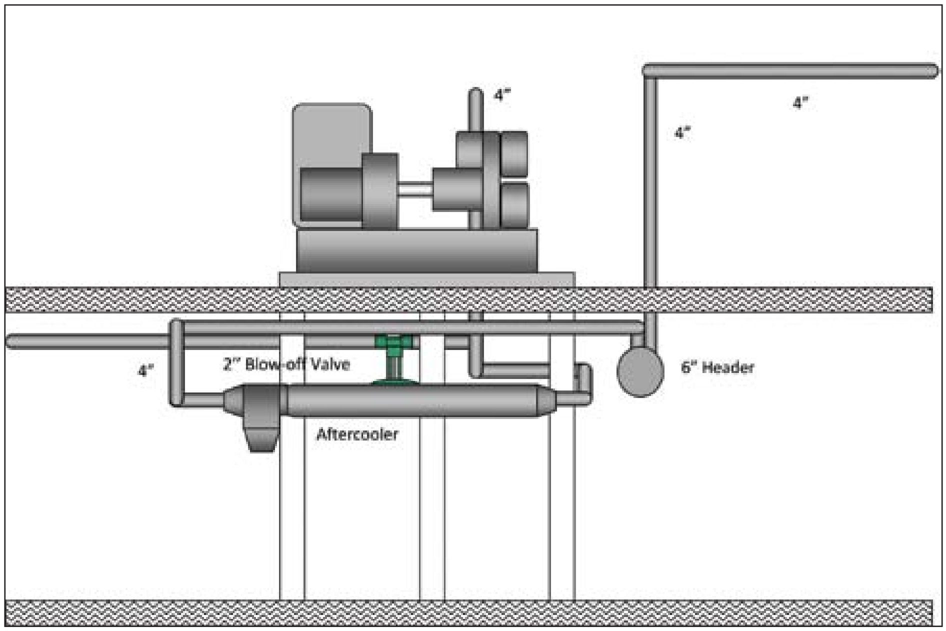


Figure 1. Steam-Turbine Centrifugal Air Compressor with 2" Blow-off Valve

The two most common control methods used for centrifugal compressors are **modulation** and **blow off.** Modulation is relatively efficient at very high loads but is usually limited to a total turndown of 10-40%. (This can vary dramatically among various compressor models.) After "modulation" or "turn-down", the compressor will just "blow off" excess air. The basic power draw at the blow-off point will stay the same regardless of the load. The existing system has inlet butterfly valve control with blow off.

There are modern electronic control systems today that can be applied which will close off the inlet and idle the unit more efficiently. This approach can significantly reduce the unit's kW draw. Inlet guide vanes can also increase the efficiency of the turn down (about equal to full load efficiency) but they will not extend it. The new units take advantage of both of these features.

The new units deploy Inlet Guide Vanes (IGV) to allow them to turn-down efficiently under partial load conditions. The main idea, however, is to have the 700 horsepower unit running at close to full load where it can deliver a specific power ratio of 6 scfm per kW. The 500 horsepower compressor will run at roughly 57% load and deliver a specific power of 5.74 scfm per kW. This will represent a significant improvement in specific power over the existing electric air compressors that are delivering 5.22 and 5.02 scfm per kW due to their older design, inlet butterfly valves, pressure requirements, and load conditions.

CENTRIFUGAL COMPRESSORS AND HOC DRYERS REDUCE ENERGY COSTS BY $2.8 MILLION

TABLE 2: COMPRESSOR USE PROFILE – CURRENT SYSTEM

UNIT #	COMPRESSOR DESCRIPTION	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (SCFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL
Production Shift: Operating at 110 psig discharge pressure for 8,760 hours							
1	Steam Turbine	NA	2,825	—	—	67%	1,890
2	Electric Centrifugal	541	2,825	80.8%	437	47%	1,328
3	Electric Centrifugal	401	2,015	97%	389	95%	1,914*
			TOTAL (Actual):		**826 kW**		**5,132**

TABLE 3: COMPRESSOR USE PROFILE – NEW SYSTEM

UNIT #	COMPRESSOR: MANUFACTURER/MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW ()	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL SCFM
Production: Operating at 100 psig discharge pressure for 8,760 hours							
1	New 700 hp	541	3,244	94%	510	94%	3,059
2	New 500 hp	387	2,223	67.7%	262	57%	1,267
			TOTAL (Actual):		**772 kW**		**4,326 cfm**

TABLE 4: SUMMARY OF KEY COMPRESSED AIR SYSTEM PARAMETERS AND PROJECTED SAVINGS

SYSTEM COMPARISON	CURRENT SYSTEM	NEW COMPRESSORS AND LOWER DEMAND
Average Flow (cfm)	5,132 cfm	4,326 cfm
Compressor Discharge Pressure (psig)	110 psig	100 psig
Average System Pressure (psig)	105 psig	95 psig
Electric and Steam Cost per cfm	**$535.59 /cfm/yr**	**$82.83 /cfm/yr**

Optimizing the Compressed Air Drying System

South Plant

There are two externally-heated blower-purge desiccant compressed air dryers. Unit #2 has an electric heater and Unit #1 dryer has a steam regeneration heater.

Dryer Unit #2 has a 15 hp blower and a 75 kW heater, while Unit #1 dryer uses 130 psi steam for heat. Plant personnel calculate the energy cost of the 130 psi steam cost at $9.00 /1,000 lbs steam/hr. We estimate that this dryer uses 6,000 lbs/hr to operate at 75% of the time.

There are some operational issues with Unit #1 dryer in the blower system. During our site visit, the safety relief valve was being opened several times per minute. Plant personnel believe this is caused by the 4-way valves that are leaking past, allowing high pressure air into this system. There is also a pressure control valve which is not closing and causing a significant amount of compressed air to escape. This valve is connected to a 1" metal pipe that vents to the atmosphere and along with this, a manual valve with a 1/4" stainless steel tube exhausting air.

TABLE 5: ENERGY COST COMPARISON OF DESICCANT AIR DRYERS:

MANUFACTURER	EXISTING UNIT #1	EXISTING UNIT #2	EXISTING UNIT #3	PROPOSED UNIT #1	PROPOSED UNIT #2
UNIT TYPE	EXTERNAL HEAT (STEAM REGEN)	EXTERNAL HEAT (ELEC REGEN)	EXTERNAL HEAT (BLOWER REG)	HEAT-OF-COMPRESSION	HEAT-OF-COMPRESSION
Rated Flow @ 100 ºF / 100 psig / 100 scfm	3,000	3,000	2,000	3,000-cfm class**	2,500-cfm class**
Purge air scfm	0	0	0	0	0
Full Load Heater kW	NA	75	50	0	0
Full Load Blower kW	13	13	7.46	0	0
Total Full Load kW / 1,000 lbs steam/hr	13/6	88	57.46	0	0
8-hour Cycle Time	9.75 (blower @ 100)	56.25 (blower @ 13)	37.5 (blower @ 10)	0	0
Net Electric Demand (kW)	9.75	69.25	44.96	0	0
Total Annual Operating Cost ($)	**$359,306**	**$27,298**	**$17,723**	**0**	**0**

* Based upon a blended electric rate of $0.053 per kWh and operation of 8,760 hours per year.

**Specific size of dryer should be selected in cooperation with OEM.

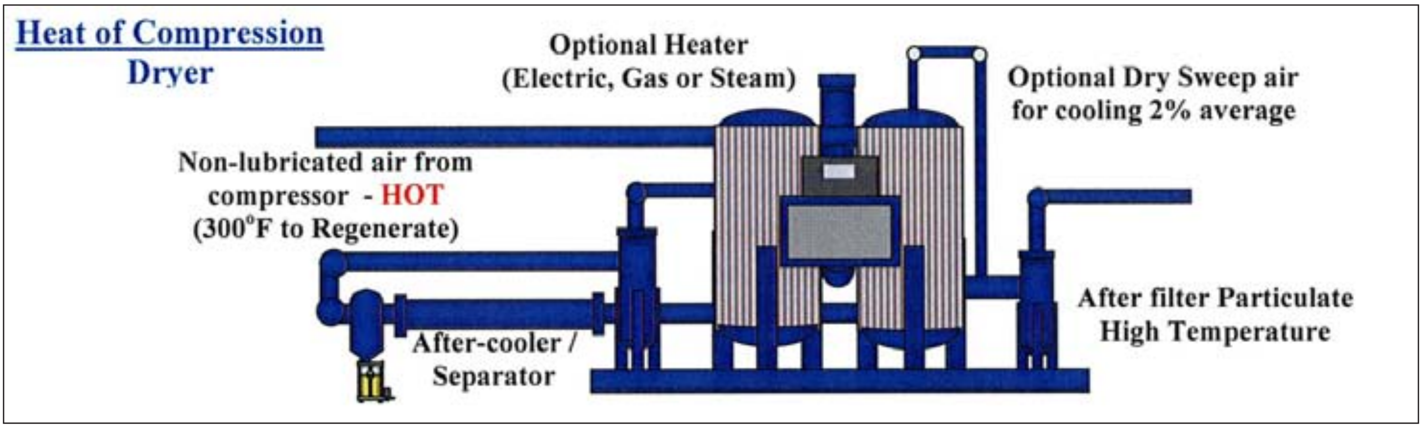


Figure 5. Typical Heat-of-Compression Layout

We estimated the air loss through the 1" pipe to be 100 cfm, while the 1/4" stainless tube to exhaust air loss to be 50 cfm. This issue of over-pressurizing the blower system not only wastes air, but could raise a safety issue. These air losses are listed in the Demand-Side of the System Assessment.

North Plant

The North Plant operates an externally-heated blower-purge desiccant compressed air dryer (Unit #3). It appears to be operating correctly. According to information provided by plant personnel who track and log historical data in the computer system, the North Plant's dryer does have a history of performing well (dew point) and is the most consistent of all three dryers.

Theory of Operation of the Heat-of-Compression Dryer

The system assessment recommended the installation of two new heat-of-compression (HOC) compressed air dryers to accompany the new compressors. They replaced all three of the existing external steam and heat-regenerated desiccant air dryers in the South and North Plants. The air compressors and dryers can be bought as a package unit due to special piping requirements of HOC systems. The unique design of HOC dryers capitalizes on the "free heat" generated by the oil-free centrifugal air compressor. The annual energy savings, related to compressed air drying, will be $404,327.

Compressed air enters the dryer directly from the second stage of the compressor.

CENTRIFUGAL COMPRESSORS AND HOC DRYERS REDUCE ENERGY COSTS BY $2.8 MILLION

TABLE 6: ENERGY SAVINGS AND PROJECT COSTS				
AIR SYSTEM COMPONENT	CURRENT ANNUAL ELECTRIC AND STEAM COSTS	NEW ANNUAL ELECTRIC COSTS	ANNUAL ENERGY SAVINGS	ESTIMATED PROJECT COST
Compressor System Operations	$2,748,695	$358,424	$2,390,271	$1,358,400
Ancillary Air Equipment (dryers, etc.)	$404,327	$0	$404,327	$423,400
Total Compressed Air System	**$3,153,022**	**$358,424**	**$2,794,598**	**$1,781,800**

It is directed into the regenerating tower, where the heat-of-compression removes the moisture from the desiccant. The air then flows back into the third stage of the compressor and then to the after-cooler, into the coalescing-type moisture separator, and into the drying tower where the air is dried to its final low dew point.

The towers switch every half hour. With a dew point demand system, the cycle is extended until the drying tower reaches saturation. At tower shift, a small temperature and dew point bump occurs, as with most other heat-reactivated dryers. The small amount of high dew point air blends in with the previously dried air to maintain a lower overall dew point.

The dew point demand system turns off the timer and switches the towers only when the dew point at the outlet of the dryer rises to a preset level indicating the desiccant in the dryer tower is saturated. Switching towers on demand uses the full capacity of the desiccant, reduces the number of tower shifts, reduced blower run and compressed air flow. The dew point demand system allows the dryer to be operated at 0 to 100% capacity.

Conclusion

The savings potential of the over-all project totaled $2.8 million per year. The primary project was to eliminate the use of steam in both the air compressors and the air dryers. The plant is now set up to run much more efficiently and will see other benefits, such as reduced maintenance costs, derived from operating two rather than three air compressors. The project cost was $1.8 million resulting in a simple ROI of 8 months. BP

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

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

Show Report: The PepsiCo National Fleet/OG&S Sustainability Training Summit

By Compressed Air Best Practices® Magazine

The 2012 Edition of the PepsiCo National Fleet/OG&S Sustainability Training Summit and Trade Show took place in San Antonio, March 19-22. Held in the San Antonio Convention Center, over 700 PepsiCo fleet and operations personnel attended. Led by *Compressed Air Best Practices® Magazine's* Editorial Board Member, Eric Battino, over 150 people involved with Resource Conservation at PepsiCo also attended.

The Conference portion of the event provided a training opportunity and time was reserved for *Compressed Air Best Practices*. Rod Smith, the Editor of Compressed Air Best Practices® Magazine and Hank Van Ormer, President of Air Power USA, both made presentations on the topic.

Mr. Smith's presentation was titled, "Advanced Trends in Compressed Air Best Practices." The attendees had, in the majority, already conducted system assessments on their compressed air systems and the presentation challenged them to take it to the next level.

The first part of the presentation described "level 1" as creating a box diagram of the compressed air system, establishing the energy consumption baseline through air compressor data-logging, and having the air compressor controls installed that permit demand-reductions to be translated into energy-savings.

"Level 2" actions — or the "Advanced Trends" were then described. The first action was to measure air flow (cfm) in front of production areas in order to establish a "Best Practice" air flow for a process or group of machinery. A case study from a Verallia glass plant was referenced. The second part to this topic was to charge production areas for their compressed air consumption. An example from Honda of America was provided.

The second action covered was "shut-down optimization". Bottling and packaging machines were cited as machines that often use compressed air when idle. Using valves and sensors to isolate these machines, when not in production, was presented as the solution. The second part to this was identifying compressed air users, like an airlock on chemical tanks, that require small amounts of compressed air during non-production periods. An example was provided on how a Visteon plant installed a 5 horsepower compressor for an airlock and stopped a 100 horsepower compressor from turning on and off all night as it had been.

Heat Recovery was the third advanced trend mentioned. Certainly this includes using the exhaust air for HVAC systems but this is nothing

Keith Jenkins and Hank van Ormer, from Air Power USA, and Eric Battino (PepsiCo) discuss different techniques to measure compressed air flow (left to right)

Chester the Cheetah (Cheetos) and Rod Smith (Compressed Air Best Practices® Magazine) discuss the latest issue on bottling!

new. What is newer in application, although not a new invention, is the use of heat exchangers to warm process water with the hot lubricant in the air compressors. The compressed air industry is starting to issue standard oil heat recovery packages to make this easier for factories to execute.

The fourth action is to analyze the energy costs associated with the air quality specifications in a plant. Many, many plants have a -40 ˚F (-40 ˚C) pressure dew point because 25% of their demand requires it. This can cause inflated energy costs for 75% of the plant that would not be incurred with a + 38 ˚F (+3 ˚C) dew point. The advanced trend is to split dew point requirements and supply them with the lowest energy cost air treatment technologies.

Creating and managing different compressed air pressure sub-zones was identified as the fifth advanced trend/action. A stretch blow-molding facility, for example, may require 7 bar (100 psi) for plant air, 20 bar (294 psi) air for their ½ liter bottles, and 30 bar air (441 psi) for the carbonated soft drinks and juices in < 1 liter bottles. Rather than producing compressed air at 35 bar (515 psi) and regulating down, plants are now creating separate systems to significantly reduce their energy costs.

The sixth trend has to do with "engineering for lower plant pressure." Compressed Air Best Practices® Magazine Editorial Board Member Doug Barndt, from Ball Corporation, was quoted as using engineering solutions to allow them to keep lowering plant pressure. All too often a plant has lowered pressure to 85 psig, for example, and then a new machine like a can printer arrives requiring 125 psig. This is where an engineered solution, like the use of a 2-1 amplifier, can provide the cylinder with the required pressure and allow over-all pressure to remain at 85 psig.

Adrian Messer, from UE Systems, demonstrates the ultrasonic leak detection devices

THE PEPSICO NATIONAL FLEET/OG&S SUSTAINABILITY TRAINING SUMMIT

Dusty Smith and Scott Gillesby, from Pneu-Logic, presented their compressed air management automation systems (left to right)

Optimizing pneumatics, to reduce compressed air energy costs, was identified as the seventh trend. A case study was used, again from the Verallia plant, where a 2-position valve was replaced with a 3-position valve on a series of unitizing machines. This low-cost action reduced idle compressed air consumption from 75 to 25 cfm — on twenty machines each.

Blow-off air optimization was identified as the eighth and final trend. In so many applications, 100 psi compressed air is used for a 3-5 psi application. The use of high-efficiency air nozzles and blowers are used as highly effective replacements in bottle-drying, bakeries, metalworking, and printing applications to name a few. BP

For more information contact Rod Smith, Compressed Air Best Practices® Magazine, rod@airbestpractices.com, www.airbestpractices.com

To read more ***Industry News*** articles,
visit www.airbestpractices.com/industry-news

Oil Exploration… in the Food & Beverage Industry

By Chris Kelsey, Geosynthetica

In the 1970s, the use of filtration in air quality management in pharmaceutical production, hospitals, and medical device manufacturing facilities became increasingly important and increasingly of interest to regulatory agencies. The air quality field was growing. From the air moving into and out of clean rooms to the protection of surgical environments to the expansion of the global medical drug industry, compressed air began to play a larger role — a role that continues undiminished (and, in fact, has increased substantially) today. This helped spur larger growth in the compressed air field, including the use of air testing, which was already expanding due to attention in SCBA fire fighting and SCUBA diving air management and NFPA's work with healthcare facilities moving into the 1980s.

However, one of the key aspects of compressed air management rests in understanding that there is a huge difference between how the use of compressed air is overseen in pharmaceutical or other facility types and how breathing air quality is regulated. Breathing air requirements can be defined narrowly by guidelines such as OSHA 1910.134 and CGA Grade D + Moisture. But the compressed air quality needed for operations like bottle blowing is not the same as for a facility that manufacturers implantable devices.

Today's plant engineers must recognize this necessary inability to establish a "hard and fast" air quality standard beyond personal safety. And they must develop site-specific quality management and testing protocols that keep them in compliance with standards, even in the absence of exact standards for their applications, and operating efficiently. The pharmaceutical industry's development has really provided a good template here.

The food and beverage industry has had a very similar arc in its compressed air usage. It too exists in something of a gray zone, despite the heavy quality controls in modern manufacturing. In food and beverage, the need for compressed air is enormous and the compressed air is or can be used in all aspects of production, transport and storage.

The site-specific nature of product-production air quality, however, has put food and beverage companies in a state of question. Compressed air is a significant source of facility energy consumption, which impacts

TABLE 1: SUGGESTIONS FOR FOOD AND BEVERAGE AIR TESTING

GENERAL GUIDELINES FOR:	EMPLOYEE	INDIRECT	DIRECT	NON-CONTACT
	BREATHING AIR CGA GRADE D + MOISTURE *(OSHA 1910.134)*	PRODUCT CONTACT COMPRESSED AIR *(NITROGEN OR CO_2 EXTRA COST)*	PRODUCT CONTACT COMPRESSED AIR *(NITROGEN OR CO_2 EXTRA COST)*	PRODUCT CONTACT COMPRESSED AIR *(NITROGEN OR CO_2 EXTRA COST)*
Oil Mist & Particulate (matter)	5 mg/m³ (Oil Mist)	1 mg/m³	0.1 mg/m³	5 mg/m³
Moisture/Dew Point	10 ˚F Lower than ambient temp.	1267ppmv/0 ˚F	See Note 1	1267ppmv/0 ˚F
Gaseous Hydrocarbons (minus methane)	N/A	5ppm	2ppm	25ppm
Halogenated Hydrocarbons	N/A	5ppm	1ppm	N/A
Oxygen %, CO ppm, CO_2 ppm, NO, NO_2, SO_2	O_2 19.5-23.5%, CO 10ppm, CO_2 1000ppm,	N/A	N/A	CO 10ppm CO_2 1000ppm
Order TRI test item #	A3	B1	A82 or C23	C65

The air used in manufacturing processes should be evaluated by a competent technical individual to determine the appropriate, current good manufacturing practices, cGMP, to protect the safety of the employees and the integrity of the products. For FDA regulated operations in the United States, HACCP compliance is regulated by 21 CFR part 120 & 123. TRI Air Testing suggests performing a baseline, no specification comparison, testing on new or untested systems to help determine the appropriate specification requirements.

Note 1: The user should select an appropriate value typically in the range of 0 ˚F(1267ppmv) to -50 ˚F (67ppmv) depending on sensitivity of the product to water vapor. A dew point of 0 ˚F requires a refrigerated drier. A dew point of -50 ˚F requires a desiccant drier be installed in the compressed air system. Other gases such as nitrogen may have different system requirements. Table courtesy of TRI Air Testing, Inc.

OIL EXPLORATION…IN THE FOOD & BEVERAGE INDUSTRY

operational efficiency and cost. It is also a point at which facility owners must evaluate the level of risk involved in any compressed air quality levels they use. In the absence of clear rules, beyond needing some repeatable protocol, they often shoot higher than needed.

Setting the Bar Too High

Mark Fenstermaker, Qualification Services Division Manager of Bethlehem, Pennsylvania-based Micro-Clean, Inc., notes that the questions about compressed air quality, particularly for issues such as oil and other non-viables, have grown as the FDA has dedicated more time to learning about compressed air practices in food and beverage facilities. Essentially, the FDA is looking at how facilities are monitoring their compressed air quality — what guidelines are plant engineers consulting, what guidelines are available to them, how are they gathering samples, how are they verifying the compressed air quality, etc.

It's the same challenge as in the pharmaceutical field.

Fenstermaker says he's seen an uptick in recent years in the number of food and beverage companies seeking out additional support for compressed air quality analysis. In addition to various testing services, Micro-Clean also provides training to multiple industries about the standards and guidelines available to them and how others in their sector are responding.

"If a company is involved with something like SCUBA gear," Fenstermaker says, "they're looking at positive pressure or suits or something like that. They have to do breathing air. They fall under certain regulations. But if they are a large beverage company — now the FDA is asking 'Do they test?'"

They do, but the degree to which they test varies wildly. The FDA is looking at air that blows out bottles, for example, and making sure no contamination emanates from that compressed air source. But there's no regulation specific enough to the application to follow.

"They have to determine their risk analysis," Fenstermaker says. "What level of testing do they really want to perform at their location? A lot of them are taking the most stringent regulation they can find, like 8573-1, and they are using those recommended levels and testing to the lowest possible limit."

This decision is increasingly common, but puts these operations at a fairly inefficient level of operation. ISO 8573-1, even at its lowest levels in oil and particulate control, is still far higher than food and beverage facilities generally need.

"In terms of oil testing," Fenstermaker says, "they don't have to be '0.000001' or anything like that. For what they do, 0.01 may be perfectly appropriate, so long as the oil from their system is not contaminating the product."

For food and beverage right now, oil contamination identification and prevention are key areas of air quality focus.

But Where Is Your Oil Coming From?

Oil contamination can be an extremely difficult contaminant to pinpoint when it is discovered in your compressed air system. Even brand new systems can yield oil contamination upon more detailed air analysis. Some common sources for potential contamination include:

- **Piping.** "If it's cast iron, for example," says Fenstermaker, "maybe there was oil coating on the cast iron to protect it in storage….And if it wasn't cleaned properly before assembling, now they have a contaminant in the line." The fittings used to connect pieces of a compressed air system might have some sort of oil on them as well. As the flow continues through from the compressor system, the actual generator, it can release those contaminants. "That's one of the main ways," Fenstermaker says
- **Oil-based compressors.** Some compressors are oil compressors that require the input of oil for lubrication. Usually these are food grade-based or food-based oils,

"In terms of oil testing, they don't have to be '0.000001' or anything like that. For what they do, 0.01 may be perfectly appropriate, so long as the oil from their system is not contaminating the product."

— Mark Fenstermaker, Qualification Services Division Manager of Micro-Clean, Inc.

so they may be considered edible. "That oil can get into the system if there's a breakdown in the compressors," Fenstermaker says. With the constancy of this oil's addition to the system, it increases contamination potential. Ways to test for it include Draeger tubes, air testing kits supplied by independent laboratories, and various analytical methods

- **Lack of filtration.** If the appropriate filtration, such as a point-of-use filter that may be beneficial to achieving an air quality goal, is not installed, oil can get pulled right into a compressor. It may sound simple, but it's less so. Again, issues such as the type of piping or fittings and how they were stored may impact performance here. If the contamination is already in the pipes but you haven't looked for it before, it may take you some time to figure out the source

- **Contamination in the tanks.** When you are dealing with massive industrial tanks at a food and beverage operation, it's entirely possible that some contaminant is present in the tank. In this situation, even installing a new system will not correct the contaminants you are finding in your testing. The investment in new, clean piping, new compressors, new desiccant driers, and everything else will not yet help you meet your goals if turning the system on stirs up the pre-existing contaminants in your tanks

The systems used on a commercial scale in food and beverage operations can be incredibly elaborate. From 200 gallon tanks to 5000+ gallon tanks, multiple compressors, multiple driers to lower dew points, etc., there are many points at which oil mist and particulate contamination can enter a system.

This is exactly why the FDA is asking about how facilities in this industry test the vast compressed air networks necessary to production.

Outside Influence

While independent compressed air testing laboratories and consultants cannot tell you what you should do, their outside perspective can significantly help plant engineers identify where in the process the system is wasting energy and operational time or money to achieve a level of air quality that is well beyond industry practices. These independent partners can also help identify what type of contaminants, such as a particular level or type of oil has gotten into the product.

Sampling kits, such as those distributed by TRI Air Testing, Inc. in Austin, Texas help plant engineers economically acquire samples right at the source that are sent out for independent verification to a lab. Micro-Clean's business model, in fact, provides not just its own testing capabilities but a close network of additional independent labs when analyses sought by companies require particular levels of analysis or an additional independent check.

TABLE 2: SUGGESTED MEASUREMENT RANGES OF DIFFERENT GASES

ANALYTE ANALYZED	TYPICAL RANGE MEASURED BY GC
Oxygen	0.5% to 99+%(In H_2 or He extra cost)
Nitrogen	0.5% to 99+%
Nitrous Oxide	99+% (special 0.5ppm extra cost)
Carbon Dioxide	25ppm to 99+% (1 to 25ppm extra cost)
Carbon Monoxide	1ppm to 1000ppm
Halogenated Hydrocarbons	1ppm and up in air and most gases
Total Gaseous Hydrocarbons	1ppm and up in Air, N_2 or Ar (In O_2, N_2O, or CO_2 extra cost)
Methane	1ppm and up
ANALYTE ANALYZED	**TYPICAL RANGE MEASURED GRAVIMETRICALLY**
Oil Mist & Particulate	5.0 mg/m^3 Results reported combined
Oil Mist & Particulate	0.1 mg/m^3 Results reported combined
Oil Mist & Particulate	Results always reported separately (Extra cost)
Analyte Analyzed	Typical Range Measured with Detection Tubes
Moisture	2ppm (-95 °F) to >3900ppm (22 °F)
Sulfur Dioxide	0.1ppm to 3ppm
Nitrogen Dioxide	0.5ppm to 2ppm
Nitric Oxide	0.5ppm to 2ppm
Halogenated Solvents	0.1ppm to 10ppm
ANALYTE ANALYZED	**TYPICAL RANGE MEASURED BY CULTURE**
Mold & Bacteria, Viable	<50 CFU/m^3
TRI Test Equipment	
Champion 35 Test Kit	Champion 35 Test Equipment (one time purchase)

This information has been shared courtesy of TRI Air Testing, Inc. (www.airtesting.com).

It's all part of fine-tuning in the food and beverage field, just as pharmaceutical facilities have done over the past 40 years.

"Oil is a big issue right now [in food and beverage]," Fenstermaker says. "Industry-wise, pharmaceutical is still the biggest area. But we are starting to get more calls from soft drink companies and other companies like that." BP

Chris Kelsey writes for Geosynthetica on energy, engineering, and the environment. He would like to thank Mark Fenstermaker (www.microcln.com) and Dr. Ed Golla (www.airtesting.com) for sharing their time and insight.

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

THE IMPORTANCE OF CONDENSATE DRAINS ON AIR SYSTEM EFFICIENCY

By Ross Orr, Scales Industrial Technologies, for the Compressed Air Challenge®

Condensate drains are possibly the least glamorous and most ignored component of a compressed air system but nevertheless, a most important part. No matter how much you spend on that fancy new compressed air system, VFD'S pin-stripes and flashing lights notwithstanding, not spending a little effort with your drain choice could cause you no end of headaches and increased operating costs for years to come.

Contaminants can enter a system at the compressor intake or be introduced into the airstream by the system itself. Lubricant, metal particles, rust, and pipe scale are all separated and filtered out, but it's the drains that have to operate properly for the filters and separators to be successful in completing their task.

Drains can be found on an intercooler, aftercooler, filter, dryer, receiver, drip leg, or at point of use. Drains come in many types and variants for all these applications, some quote fancy, but they fall into these basic categories. No air waste — timer operated — open tube — none (yes that is a drain choice).

How do your drains improve system efficiency? Besides the obvious savings of compressed air with a no-waste drain choice, there are other less obvious ways drains can save energy or cost you energy if not properly maintained. They are key components in the quest for system efficiency and reliability.

When a drain fails to eject all of the condensate collected, oil and/or water will collect, affecting — filter efficiency — causing carry over into the system — allowing freeze-up in the winter. On multiple stage compressors moisture carry over from the intercooler may allow liquid into the next stage causing premature wear and possibly a catastrophic failure. On your refrigerated dryer the temperature indicator may still read 38 °F, but if your drain has failed you'll have plenty of water downstream. Slugs of water due to drain failure can cause major problems in a desiccant dryer. Drains stuck in the open position can be a major source of wasted energy in some plants.

Figure 1: Manual valves left open waste huge amounts of energy.

Fundamentals of Compressed Air Systems WE (web-edition)

Learn more about condensate drains and other consumers of compressed air in our *Fundamentals of Compressed Air Systems WE* (web-edition) coming in September or one of our many in person seminars being held in the coming months. Please visit www.compressedairchallenge.org for more information about the training.

If you have additional questions about the new web-based training or other CAC® training opportunities, please contact the CAC® at **info@compressedairchallenge.org.**

Drain types

No drain. Whether you choose to not install a drain, not repair a failed drain, or install a manual drain, the outcome is the same and falls into this category.

We see this all the time. Think about it. You purchase a filter for a reason. If it is only to collect dry contaminants (a desiccant dryer after filter or carbon adsorber for instance) then not having an **automatic drain** may be acceptable, but if there is the reasonable expectation of any liquid collecting, then why don't you allow for that liquid to be ejected? Done manually on every shift change you say? Very doubtful, and besides, the amount collected can change with load and season and needs to be ejected at irregular times.

An additional problem with the "no drain choice" is pressure drop. If your filter really isn't working because everything it collects is carried over, why do you have it at all? You are only adding pressure drop and as we know, in a 100 psi system, every 2 psi at the compressor requires 1% energy. Either install a drain so the filter works as designed, or remove the filter, then readjust your system controls accordingly to take advantage of the lower pressure drop.

Open tube. We find this "drain" in many places…the solenoid drain that is stuck open and throttled back with a ball valve so it's not quite so noisy…the receiver with a very carefully adjusted ball valve…the drip leg out on the factory floor, left open because "we used to have problems, and still do in the summer"…the float valve that is stuck open because it cannot reseat itself.

Costs of use. Because so many factors have to be taken into account, this isn't so easy to calculate, but anything up to 20 cfm continuous compressed air loss is common to find. More than that and I wouldn't call this valve "cracked open"

Timer operated drain. These types of drains are a very popular option. Easy to install, cheap to purchase, and usually quite reliable if installed with a strainer on the inlet. Standard on many small refrigerated dryers, these drains come with an adjustable on-time and interval between drain events. Maintenance consists of pressing the "test" button to check its operation, making sure it is plugged in (quite often they are not!!) and cleaning the inlet strainer. A slightly different type of timer drain installed in larger systems is a motorized ball valve with timer.

Figure 2: Pressure fluctuations from timer drains can start compressors.

THE IMPORTANCE OF CONDENSATE DRAINS ON AIR SYSTEM EFFICIENCY

CAC® Qualified Instructor Profile

Ross Orr
Scales Industrial Technologies, Inc.
PO Box 820
339 Clark Street
Milldale, CT 06467
800-627-9578 x3115
fax: 203-630-5550
rorr@scalesair.com

Ross Orr is presently a Sales Manager for Scales Air Compressor, one of the nations' leading air compressor distributors. He has worked for Scales in the sales and engineering department for over 20 years now.

Ross has experience with all types of air compressors and compressed air systems, vacuum systems, process cooling systems, energy management strategies, as well as complete system design and installation. In his time with Scales Air Compressor Corporation he has performed hundreds of walk-through evaluations and system assessments, as well as a number of full system audits. His experience has allowed him to show manufacturers significant energy savings and increased system quality and reliability.

He has attended and passed CAC Level One and Level Two classes, and is a qualified Level One instructor, is AIRMaster+ qualified, as well as contributor to the CAC Manual, Best Practices for Compressed Air Systems — Second Edition.

As nice as this solution seems, except for some very special applications, timer operated drains should be considered a quick fix only. Problems include…not opening long enough to eject all the condensate…staying open too long wasting compressed air…, oil particles contained in the condensate can undergo change partly because of high velocities and direction changes, forming stable emulsions and causing problems with proper condensate separation and ejection.

It is recommended that the operator adjust the drain times to match the seasons, but just like the manual drain, we cannot rely on our operators taking care of this chore reliably and additionally we still have daily ambient conditions to contend with. Gone (hopefully) are the days of installing timer drains on each receiver, separator, pre-filter dryer, and after-filter, ending up with a wall full of drains, possibly all firing at once.


Figure 3: Float drains should be replaced annually

How much compressed air does a timer drain use?

For instance, a ¼" timer drain with a ¼" orifice and 100 psi at the inlet will move approximately 108 cfm. However, they don't have a perfect orifice, so we have to apply a coefficient, 60% would be reasonable (but this can be calculated out). Taking this into account, this drain now moves 108 x 60% = 64.8 cfm. If this drain were open for 10 seconds and off for 3 minutes. 64.8 x 10/180 = 3.6 cfm average flow. If you know how to calculate your compressed air cost then you are all set. If not, use $180 per cfm as an average ($0.10 per kWh) In this case we have the potential savings of $648.00 per year, even more in the northeast where we pay $0.15-20/kWh.

Other considerations that may affect this drain flow calculation are… length and ID of inlet pipe to the drain…pressure at the orifice while moving air…orifice size…orifice coefficient…length and id of the discharge line to drain, and more.

Which leads us to the less obvious energy cost of timer drains… like any other system demand, timer drains use air and that air has a cost. However, the firing of a drain (or two, or three) could cause enough of a pressure drop in the compressor room (or just in front

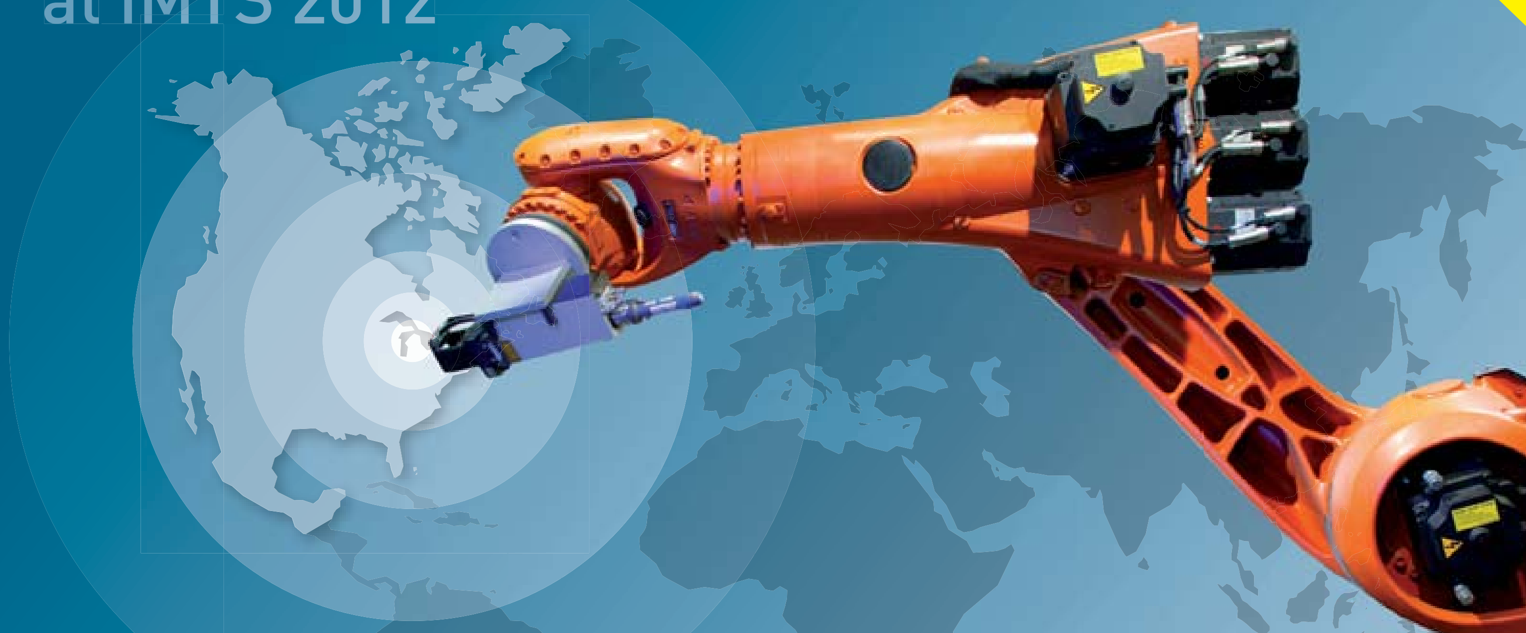
"On the factory floor, make sure you put a quality drain on any drip leg. That way you might prevent manufacturing personnel from opening up a valve just because that is what they have always done."

— Ross Orr, Scales Industrial Technologies

INDUSTRIAL AUTOMATION NORTH AMERICA

at IMTS 2012

MARK YOUR CALENDAR!



International Trade Show for Factory, Process and Building Automation Systems and Solutions

September 10 - 15, 2012
McCormick Place, Chicago, Illinois

HANNOVER MESSE'S global reach in manufacturing tradeshows extends to the USA in 2012!

IANA will be THE crossroads for automation innovation and productivity, where you can . . .

- Engage top industry decision makers and solution providers.
- Explore the latest advances in automation systems and technology.
- Gain competitive edge by comparing best practices across diverse platforms.
- Reap the collective expertise of more than 80,000 industrial peers.

IANA, the automation counterpoint to IMTS, will mechanize your approach to peak productivity in 2012.

To register for IANA and IMTS, please click visit www.imts.com/show/reg.html

Industrial Automation NORTH AMERICA at IMTS 2012

www.ia-na.com

Organized by: Deutsche Messe Worldwide
Hannover Fairs USA, Inc.

Partner: AMT The Association For Manufacturing Technology
Over 100 Years of Building Global Productivity

For more information, please contact
Aryan Zandieh at (312) 924-1688 or azandieh@hfusa.com.

THE IMPORTANCE OF CONDENSATE DRAINS ON AIR SYSTEM EFFICIENCY

Figure 4: Float style external drain expels only condensate

of a compressor pressure transducer) to require an off-line compressor to start up. Now we have added electrical cost to run that compressor, as well as added maintenance (I'm sure this doesn't happen just once) and a fluctuating downstream pressure.

No Waste drains. This is a big category. A no-waste drain is one which will eject the collected condensate without also blowing compressed air, but will also automatically keep up with changes in the system.

A float drain can be considered no-waste, in fact they can be considered a good choice for many filter applications. Filter bowl floats seem to be more reliable than they used to be. Today some come with a built-in particulate screen to prevent small particles from getting stuck under the seat, but maybe the use of cleaner piping becoming more prevalent (copper, aluminum) has helped this drain type's reliability. As for maintenance, I would suggest replacing the float yearly, they really aren't that expensive. Some filters come with an external float drain that could also be used elsewhere in the system. These can be mechanical floats, or small electronic drains, and all tend to be more reliable still. The mechanical floats include some very old designs that are great choices still today and can be rebuilt over and over.

The electronic choice comes in various sizes and works with a magnetic reed switch or capacitance device. The need of a power source can be a challenge, but these are commonly available with an alarm or alarm contacts. Rebuild kits are available for periodic maintenance, one manufacturer will have you swap out all "inards" as a module in one clean click.

The last no-waste drain type is a hybrid of each of these drains. Available with a float mechanism that triggers (directly or via a magnet) either an electronic solenoid, closing before any air is lost, or the float triggers a pneumatic piston that opens a ball valve of some sort.

Although considered no-waste drains, these last types can in fact use a very small amount of air. Some install these models with a balance line that prevents air-lock but because we quite often find these closed off by Mr. Helper, a popular installation choice is to put in a small air bleeder instead. The pneumatic piston model also has the piston volume to account for. These are all extremely small "air leaks" but it is air use nonetheless.

Special considerations

Make sure your drains are rated for the pressure you are running at.

On an oil-free system you may see more rust from a non coated receiver, and oil free air tends to be more acidic, so chose a drain with that in mind.

Many drain types are available with high level or unit failure alarms, as well as Teflon-type coatings, special materials of construction, even heating elements. Some even make drains for use on vacuum systems.

Top, side, bottom inlet are all available to fit most installations. Just make sure your installation doesn't leave a liquid level in the vessel you are trying to keep clear. Some compressor manufacturers want their compressor elevated so the drains work properly.

Installation. It's just a drain right? Who needs instructions? Well, quite often we find drains that were installed incorrectly.

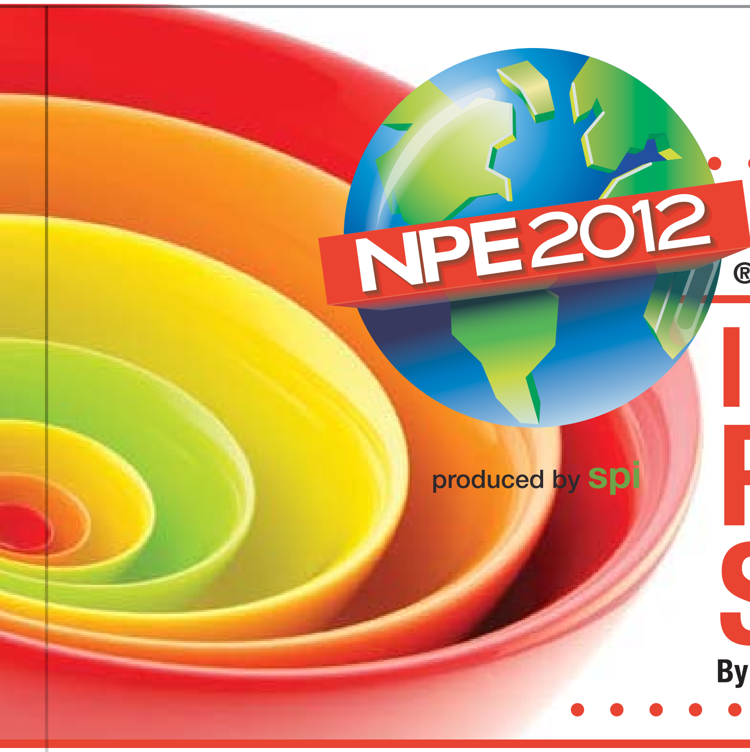
Your drain might need a balance line from a specific pressure location, there may be special fittings included to prevent becoming air bound, strainers with service valves should be considered, drain leveling is always important.

Avoid connecting two drain points to one drain. There is likely to be different pressures at these two points and because air will take the path of least resistance, the lower pressure side will not get drained. In fact in a filter installation, you will have a direct path from the wet side of the first filter, totally bypassing the filter media and straight into the second filter or "dry" receiver.

On the factory floor, make sure you put a quality drain on any drip leg. That way you might prevent manufacturing personnel from opening up a valve just because that is what they have always done. BP

For more information contact the Compressed Air Challenge® at www.compressedairchallenge.org

To read more ***Technology*** articles, visit www.airbestpractices.com/technology/air-treatment



SHOW REPORT: INTERNATIONAL PLASTICS SHOWCASE

By Rod Smith, Compressed Air Best Practices® Magazine

David Raabe, Director of Blow Molding Technology, Krones Inc., showing the innovative Contiform 3 Mold Carrier Station capable of blowing 2,250 bottles per hour.

The NPE 2012 International Plastics Showcase was held at the Orange County Convention Center in Orlando, Florida, April 2-5. More than 1,900 companies exhibited -including Compressed Air Best Practices® Magazine whose "Plastics Blow Molding March 2012 Issue" was in the literature bins at all the hall entrances. Over 920,000 square feet of exhibition space was used and while the visitor numbers are still preliminary, it's expected that registrations to attend the NPE 2012 ended up well over 50,000.

The compressed air, blower and vacuum industry was very well represented displaying technologies for all the pressure (positive and negative), flow, air quality, and measurement requirements of the plastics industry. Pneumatic products were present in all the production equipment present in almost every booth. We apologize in advance to any technologies we don't cover in this article. I spent four full days at NPE and was still only able to talk with a small percentage of all the exhibitors. Here are the highlights:

Krones PET Stretch Blow Molding Technology

The most interesting visit I had was with Mr. David Raabe of Krones Inc. Mr. Raabe is the Director of Blow Molding Technology, in the U.S., and he took the time to explain the advancements, in design, of the new Contiform 3 stretch blow molding machine.

The Contiform 3 not only can range from sizes of 8 to 36 blow-molding stations (and thereby produce up to a record 81,000 containers per hour!) but it was designed with compressed air energy efficiency in mind. It is designed for the production of PET containers with a volume of 0.1 to 3.0 liters. A high-speed machine, the Contiform 3 operates according to the two-stage process in which PET preforms are blown to form bottles. To do so, the prefabricated preforms are first carried through the modular linear oven where they are heated up to their optimum processing temperature by infrared radiation. From here they are transferred to the blowing wheel, where they are placed in molds to be molded into containers by compressed air.

The heart of the technology is the new blowing station, the Counterform 3 Mold Carrier Station. This new blowing module achieves an output of 2,250 containers per hour per blowing station. This represents an increase of 12.5% in total output — for the same machine size.

The Contiform 3 Mold Carrier Station was also designed to reduce compressed air flow consumption, air pressure requirements, and pressure losses. Compressed air flow requirements were reduced 20% through the development of an electromagnetically controlled stretching system. The first stage of stretching the performs is now done with absolutely no compressed air and this delivers a striking reduction in compressed air use.

A second important advancement has been made in the valve manifold. The valve manifold, that feeds compressed air into the mold carrier station, was also redesigned to reduce the dead space volume to only 56 milliliters — down from 750 milliliters in most designs ten years ago! Dead space volume is the term, in the blow molding industry, for the proportion of compressed air that does not contribute to added value.

The most remarkable development, for me, is the Air Wizard Plus air recycling system. In the past, PET bottles were simply blown at one pressure between 30-40 bar depending upon the container type. The Contiform 3 now, due to the new valve manifold circuit, is able to recycle lower pressure compressed air and blow the

Tim McDonald, Jim Felty and Dave Conley, from Gardner Denver, displayed Bellis & Morcom high-pressure, Gardner Denver rotary screw and reciprocating, and Hydrovane rotary vane air compressors (left to right)

Joe Mashburn and Matt deLesdernier, from AF Compressors, in front of the Model CE46B AF Compressor capable of up to 1800 cfm at 40 bar (588 psi)

"The Contiform 3 not only can range from sizes of 8 to 36 blow-molding stations (and thereby produce up to a record 81,000 containers per hour!) but it was designed with compressed air energy efficiency in mind."

— Rod Smith, Compressed Air Best Practices® Magazine

THE NPE 2012 INTERNATIONAL PLASTICS SHOWCASE

Kevin Casserly, J. Howard, Tim Sohnlein, from Cameron Compression Systems discussed the Turbo-Air® 2030/2040 4-stage centrifugal compressors rated for 610 psig.

Steve Gilliam and Joseph Cebula, from Becker, discussed their new dry rotary vane application with plastic extruders.

Ricky Henderson and Yani Bettencourt, from Vaisala, demonstrate the DSS70A portable dew point measurement device.

bottle in three blows at three different pressures. In the time span of 1.5 milliseconds, the bottle is receives the first blow pressure (P1) of 5-8 bar. Then comes the "Intermediate Blow" (Pi) at 15-18 bar followed by the final blow pressure (P2) of 30-40 bar. The first two blows (P1 and Pi) are done using recycled compressed air from P2. Remarkable engineering. The result is that the Air Wizard Plus air recycling system can deliver compressed air related energy savings of 35-40%.

Last but not least, the Air Wizard Pro air recycling system is able to return compressed air, at 5-7 bar, to the air compressors supplying the station. Working together with some high-pressure air compressor manufacturers, this design returns the compressed air after the first-stage of the air compressor.

Retrofit packages, for compressed air recycling, are also available to operators of Krones blow molding stations. This engineering work is truly an example of a OEM who has figured out how to produce more product while using less compressed air related energy.

PET Air Compressor Technology

Bellis & Morcom high-pressure, reciprocating PET air compressors were on display at the Gardner Denver booth. National Sales Manager, Tim McDonald, showed me the 536 horsepower, 40 bar, oil-free unit in the booth. Bellis & Morcom continues to be one of the leading 40 bar air compressor suppliers in the world.

Matt deLesdernier and Joe Mashburn, in the AF Compressor booth, told me they shipped four hundred 40-bar air compressors last year — making them the #1 global brand. They said that their recently launched "Refurbishment Program", allowing clients to have AF rebuild their units, has been very well received by the market.

ABC Compressors, from the Basque Region of Spain, also had a booth where they discussed their ability to recycle compressed air (as we described above) from the blow stations into their 40-bar air compressors. ABC is strong in Europe, Mexico and Latin/South America and their Director of Sales in Mexico, Hugo Davila, said the company is studying the U.S. market.

One thing I didn't know (ok I admit it) was that Cameron Compression Systems (yes-formerly known as Cooper Turbo and JOY) manufactures an oil-free, centrifugal air compressor for 610 psig (42 bar) applications. Kevin Casserly, Cameron Western

Regional Sales Manager, took the time to describe the Turbo-Air® 2030/2040 centrifugal compressor using a four-pinion design capable of delivering 1,500 to 1,800 cfm at pressures up to 42 bar.

Becker Pump Tackles the Extrusion Market with Dry Rotary Vanes

Compressed Air Best Practices® Magazine Editorial Advisory Board Member, David Brittain of Becker Pumps, offered me one of the learning highlights of the trip by introducing me to an application engineering project they have done together with MGM Industries. MGM is a plastics extrusion facility, located in Tennessee, where they manufacture custom painted vinyl windows and doors for homes. John MacKorell, the Process Improvement Engineer from MGM, and David Brittain, the Director of Engineering and Marketing at Becker Pumps, both made an effort to explain this six-year project in the layman's terms I could understand. Trust me, I made it difficult for them.

Vacuum plays an important role in the plastic extrusion process. The primary applications are at the throat of the extruder, in the calibrators, and in the tank plates. Historically, this application has been served by liquid ring vacuum pumps. Back in 2006, MGM was running out of cooling capacity from their centralized cooling system. They were looking at a $150,000 investment into a new chiller. In order to avoid this capital outlay, they decided to look into innovative ways to reduce their cooling requirements.

Steve Gilliam, from Becker Pumps, was called in to see if a vacuum technology existed that could replace the liquid ring pumps. They estimated that the liquid ring pumps required roughly 0.15 tons of cooling capacity per horsepower. Replacing these pumps would provide the plant with the cooling load reduction they were looking for.

The process that Becker and MGM Industries followed to engineer around the obstacles presented (how do we keep water out of the dry rotary vane pump?) will be the subject of an upcoming article. The sneak preview we will write about here is that Becker has developed an innovative 3-valve system taking care of the water problem.

As a result, the plant has been able to replace the liquid ring vacuum pumps with the Becker dry rotary vane pumps. Not only has the cooling load requirement been reduced significantly, but the vacuum pump horsepower requirements have been reduced

Andrew Nachtigall, Scott Woodward, and Kaus Korzeng, from BOGE Compressors, displayed the SRHV Series Boosters and the C Series rotary screw air compressor (left to right)

Rod Smith, from Compressed Air Best Practices® Magazine, working to increase subscriptions from the plastics industry.

Gene Sofran, from Compressed Air Systems Inc., reviews the Kaeser Aircenter SM10 rotary screw air compressor.

THE NPE 2012 INTERNATIONAL PLASTICS SHOWCASE

Tracy Gibbs, Anthony Russell, Marc Piccinini, and Bob Demers, from CPI PET Group, display their aftermarket products for PET high-pressure air compressors.

Dorothy Samuel and Robert Eshelman, from Atlas Copco, next to the Full-Feature GA11FF rotary screw air compressor.

by 36% — from 50 horsepower to 32 horsepower. The new installation uses two 10 horsepower dry pumps with one being a trim variable speed drive unit. A 12 horsepower blower is also part of the system design.

Dew Point Testing After the Pellet Dryers

Ricky Henderson, from Vaisala, spent some time explaining the use of their DSS70A portable dew point testing device in the plastics industry. If you ever visit the NPE Show, one of the most prevalent pieces of equipment on display is the "hoppers" where plastic resins and pellets are dried. These pellet dryers form a critical step in plastic processing to prepare the plastic raw material before it is extruded, injected, or blown into a shape or form.

Vaisala sells a lot of their dew point testing devices to plants wanting to avoid product spoilage costs due to insufficient dew points — in the hoppers. Production personnel will test dew point at the inlet and outlet of the pellet dryers. The Vaisala DSS70A is designed to make this process easy to realize and accurate.

Boosters and 100 psig Air Compressors

The "glamour girls" of the plastics industry are the PET applications with all their high-speed, high-pressure stretch blow molding machines. The "locomotive" of the plastics industry, however, is the 100 psig extruders and injection molders. This is what makes the plastics industry the 4th largest manufacturing industry in the U.S.

Increasingly, compressed air system designers are realizing significant energy savings by creating different supply systems for the different air pressure requirements in a plant. This is where a combination of 100 psig air compressors and boosters may improve system efficiencies.

"Not only has the cooling load requirement been reduced significantly, but the vacuum pump horsepower requirements have been reduced by 36% — from 50 horsepower to 32 horsepower."

— Rod Smith, Compressed Air Best Practices® Magazine

THE NPE 2012 INTERNATIONAL PLASTICS SHOWCASE

Larry Cooke, from Hitachi America, next to the Hitachi SRL Series Oil-less Multiplex 16.5 kW scroll air compressor.

Robert McEvoy, from Busch Vacuum Pumps, in front of the Busch Dry Claw (Mink) pump.

Displaying options and technologies in this area was BOGE Compressors. General Manager Scott Woodward introduced me to Klaus Korzeng, who had flown in all the way from Dubai to attend the show, due to his expertise in applying boosters in the plastics industry. The BOGE SRHV Series Booster can supply pressure requirements up to 600 psig and is a convenient and cost-effective solution for factories requiring multiple pressure levels.

The Kaeser booth also had multiple technologies on display for the plastics industry. Shane Smith, a Kaeser Blower Application Engineer, reviewed the Omega CompaK Plus Blower used for pneumatic conveying and also reviewed the Kaeser booster product for 600 psig pressures.

Atlas Copco displayed their new ES360 Air Optimizer Master Control Panel. Explained to me by Dorothy Samuel and Robert Eshelman, I found this Control Panel interesting as it provides so many new capabilities to create "sub-zones" within a factory to manage compressed air pressure and flow requirements.

The new Atlas Copco ZH350+ oil-free centrifugal air compressor was also on display. The company touts the product as the first "medium-pressure" three-stage centrifugal air compressor to be commercialized with high-speed motors and without a gearbox. Interestingly, Atlas Copco says the ZH350+ is "the most energy-efficient oil-free compressor ever created at Atlas Copco." Product features include:

- The new three-stage turbo design reduces average lifecycle costs by 3% compared to an oil-free screw design and by 18% compared to a two-stage turbo design
- The gearbox has been eliminated. Transmission losses, associated with a gearbox, can reduce energy efficiency by up to 9% in compressors in the 350 kW range
- The cumulative design innovations result in a compressor that is 4% more efficient than Atlas Copco's top-performing oil-free air compressors. Now that's saying something

Hitachi America, the manufacturer of the world's largest scrolls, had their oil-less scroll compressors on display. The unit on display was a SRL Series oil-less multiplex unit featuring three 5.5 kW scroll compressors with multi-drive control that permits users to off-load the compressors in stages in partial load conditions. Hitachi's Larry Cooke said that the company had also recently launched the new DSP NEXT Series of 132-240 kW water-cooled, oil-free, rotary screw air compressors featuring new airends optimized for energy efficiency. BP

For more information contact Rod Smith, Compressed Air Best Practices® Magazine, rod@airbestpractices.com, www.airbestpractices.com

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

POWER TRANSMISSON AND CONTROL 2012

Oct 29–Nov 1

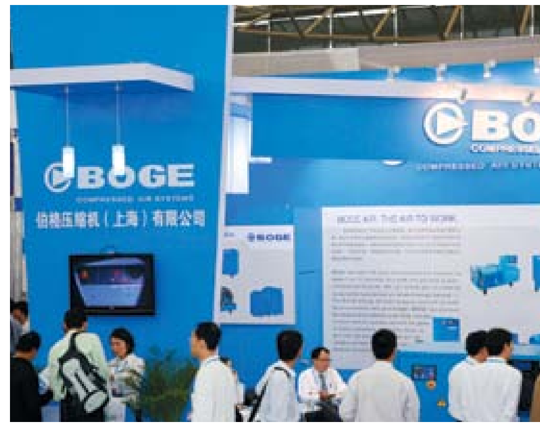
Shanghai New International Expo Centre,
Shanghai, China

Certified by

U.S. COMMERCIAL SERVICE
United States of America
Department of Commerce

Asia's Premier Event for Compressed Air & Vacuum Technology

PTC
MDA
ASIA



2011 Statistics

- **56,525** qualified buyers from over 81 countries
- **1,499** exhibitors
- **1 million** sq ft display area

Full-Time and Real-Time Global Marketing Coverage

- By **over 20** industrial and public media portals
- By **over 50** logistics industry media platforms
- By **over 100** user industry media publications
- By **over 20** user industry organizations

Your participation at PTC ASIA will be reported in 72 countries and regions across the globe!

www.ptc-asia.com

For more information, please contact Aryan Zandieh at
(312) 924-1688 or azandieh@hfusa.com

2011 Exhibitors

Compressed Art Technology

AtlasCopco, IngersollRand, Fusheng, SULLAIR, Kaeser, GardnerDenver, Compair, Quincy, MATTEI, Shinko, Boge, WoyoSuperdo, Hanbell, Kaishan, UnionTech, Screw, Feihe, GHH RAND, ROTORCOMP, AERZEN, TMC, ELGI, Donaldson, Mann+Hummel, Sotras, Fuma, Airfilter, ALUP, BEKO, RENNER, Hoerbiger, ODE, Dynamic, Anderol, etc.

Product Categories

Compressed air technology

- Compressors for compressed air production
- Compressor accessories and components
- Vacuum technology

Deutsche Messe
Worldwide

Hannover Fairs USA, Inc.

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

ASCO Numatics Introduces New Vacuum Products

ASCO Numatics, introduced a new line of improved Numatics vacuum products for applications in the automotive, packaging, plastics, and glass industries. The line includes highly reliable vacuum generators, suction cups, mounting elements, switches, specialty grippers, and related accessories that create cost-effective solutions with the longest life and fastest production cycles

"Numatics now offers the industry's widest range of vacuum components that allow customers to select cost-effective solutions for their specific material handling applications," said Robert W. Kemple, Jr., executive vice president, sales and marketing — Americas, ASCO Numatics. "With our deep application expertise, we size components to the customers' vacuum requirements and provide a total solution — where vacuum generators and suction cups are optimized for the longest life, greatest reliability, and highest throughput."

The Numatics vacuum control product line (http://www.numatics.com/vacuum) consists of the following components:

- **Vacuum generators** that include single-stage ejectors for non-porous materials such as metal, glass or plastic; multi-stage ejectors to handle porous materials such as wood or cardboard; and compact ejectors that integrate a sensor, valve, filter, I-O link, and compressed air intelligence into one compact assembly
- **Electric vacuum pumps** to handle applications where there is not enough compressed air available or when the application requires its own vacuum source
- **Suction cups,** including flat and bellows-style, for a wide range of applications and materials — porous, non-porous, corrugated, fabrics, and food-related products

For automotive applications such as press room/stamping and body assembly, Numatics' automotive style suction cups are optimized to handle sheet metal with oily surfaces at maximum cycle rates without slippage.

For packaging lines, Numatics solutions generate high production rates through the use of a specially formulated cup material. These cups last four to eight times longer than conventional components, providing a highly cost-effective vacuum gripping system.

Contact ASCO Numatics
Tel: 1-888-NUMATICS (1-888-686-2842)
http://www.numatics.com/vacuum

Dual High Temperature Cabinet Cooler® Systems For Large Enclosures

EXAIR's new Dual High Temperature Cabinet Cooler® Systems purge and cool overheated electrical control panels in harsh environments up to 200 °F (93 °C). Cabinet Coolers keep electrical enclosures cool with air as cool as 20 °F (-7 °C) air to eliminate high temperature malfunctions and protect sensitive electronics from hot, dirty locations, such as foundries, glass plants or steel mills. The high cooling capacity up to 5,600 Btu/hr. is ideal for large electrical enclosures and high heat loads. Models with lower cooling capacities for NEMA 12, 4 and 4X enclosures are also available.

Cabinet Coolers incorporate a vortex tube that cools ordinary compressed air to cold air without the use of refrigerants. They mount through a standard electrical knockout while maintaining the NEMA 12, 4 or 4X rating of the enclosure. Systems with thermostat controls minimize compressed air use, keeping the enclosure at ± 2 ºF of the temperature setting. An automatic drain filter separator

TECHNOLOGY PICKS

ensures no moisture passes to the inside of the electrical enclosure. There are no moving parts to wear out.

Dual High Temperature Cabinet Coolers are available with cooling capacities of 4,000, 4,800 and 5,600 Btu/hr. and are UL Listed and CE compliant. Applications include variable frequency drives, programmable controllers, industrial computers, motor controls, microprocessors and robotics. Prices start at $1,129.50.

Contact EXAIR Corporation
Tel: (800) 903-9247
E-mail: techelp@exair.com
www.exair.com/dualhtcc.htm

EPA Compliant Particulate Monitor

Continuous particulate emission monitor and baghouse leak detector incorporates Automatic Self Checks (Zero and Span) to eliminate manual calibration audits as required by the US-EPA for MACT. The company's field-proven technologies provide enhanced reliability over older opacity and triboelectic technologies particularly in difficult applications such as coal, cement, carbon black, chemical plants and pharmaceutical spray dryers. Benefits include EPA compliance, eliminating cleanup costs and protecting downstream equipment.

Contact FilterSense
Tel: 978-927-4304
www.filtersense.com

Ashcroft Introduces New Compact, Multi-Application Pressure Switch

A tough operating environment is no match for Ashcroft's new A Series pressure switch. All 316 stainless steel construction, a weatherproof IP67 enclosure and an operating temp from -40 °C to 100 °C (-40 °F to 212 °F) make this compact switch the ideal choice for a wide variety of industrial and OEM installations. Visit the Ashcroft website to learn more about the specifications and agency approvals.

Contact Ashcroft Inc.
Tel: 1-800-328-8258
www.ashcroft.com

New Extra-Large Suction Cups for Vacuum

Piab introduced a new line of extra-large flat suction cups that has been designed to handle various product sheets safely and securely in manufacturing environments.

The XLF line of suction cups is available in four different diameter sizes 150mm, 200mm, 250mm and 300mm. All sizes are similarly designed with an aluminum plate molded into the durable and long lasting 60° Shore Nitrile-PVC rubber. This strong material that is PWIS/Silicone-free does not leave behind any marks on the handled product so no extra cleaning is required. The cups are ideal for sensitive surfaces as the soft material will not chip or damage the material being handled.

As certain sheets sometimes have sharp edges or corners that can mar or cut a suction cup, leaving a possibility of diminished lifting capacity and a chance of products dropping, the XLF unique double lip design (inner and outer) increases safety in case of tear or overload.

It is possible to use these cups in a customized mounting frame or lifting device. The build-in dimension of the four cups is identical as they are all of the same height. It is also possible to add features such as vacuum sensing and quick product release. The built-in cleats provide maximum suction cup gripping and these cups can handle weights up to 1,100 lbs. as well as up to 880 lbs. of shear force during vertical handling.

Contact PIAB
Tel: 800-321-7422
www.piab.com

COMPRESSED AIR BEST PRACTICES®
www.airbestpractices.com

ADVERTISER INDEX

Company	Page	Web Site
Kaeser Compressors	Outside Back Cover	www.kaeser.com/CABP
Association of Energy Engineers	Inside Back Cover	www.energyevent.com
Atlas Copco	Inside Front Cover	www.atlascopco.us/michelleusa
Hitachi	3	www.hitachi-america.us/airtech
FS Elliott	7	www.fselliott.com
Chicago Pneumatic	9	www.cp.com
BOGE	11	www.boge.com/us
Vaisala	13	www.vaisala.com/dewpointsensor
JORC Industrial	15	www.jorc.com
BEKO Technologies	17	www.bekousa.com
CompAir	19	www.discovercompair.com
AIRCOM	21	www.aircom.us.com
Parker Zander	23	www.parker.com/faf
ThermaSys	25	www.thermaltransfer.com
Adsens	27	www.adsens.net
Association of Facilities Engineers	28	www.afe.org/benefits
Industrial Automation North America	35	www.ia-na.com
PTC Asia	45	www.ptc-asia.com

THE MARKETPLACE

JOBS

industrial air centers, inc.

Regional Sales Manager

Industrial Air Centers, Inc. is looking for a Regional Sales Manager to be based in Cincinnati, Ohio. The chosen candidate will be responsible for developing profitable sales of our products and services, as well as meeting company objectives through the management of a team Area Managers. Experienced in the compressed air field for at least 5 years is preferred with industrial sales management experience required.

We provide an attractive salary and bonus plan contingent on experience, education and performance. Benefit plan includes group health insurance, 401(k) plan, paid vacation and holidays, laptop, smartphone, mileage reimbursement, and expense account.

Send resumes to sstreet@iacserv.com

A well-established Compressor manufacturer is looking for energetic technical Outside Sales candidates to fill a variety of openings throughout California & the Pacific Northwest.

- Must have a high technical aptitude with experience selling a mechanically engineered product.
- Rotating equipment experience is preferred.
- Looking for those who are hungry for success and willing to make a long term commitment to the company.
- This position offers a lot of upward mobility and many opportunities for travel.

To find out more about this opportunity, please call Joe Bertolami at **440-684-6150 X 3007** or email **jbertolami@grsrecruiting.com**

GRS Fluid Handling specializes in recruiting professionals in the Compressor, Pump and Filtration Industries.

View more jobs online at **grsrecruiting.com**

edmac

INSIDE SALES ASSOCIATE

Energetic, well spoken, punctual and reliable w/min. 2 yrs. inside sales or B2B telemarketing experience; compressor aftermarket parts experience a plus.

For more information please visit www.airbestpractices.com/node/260.

Edmac Compressor Parts is headquartered in Charlotte, NC operating alongside the North American Service Center.

Contact: Clara Dodd, Inside Sales Supervisor at clara.dodd@edmac.com

COMPRESSED AIR BEST PRACTICES®
www.airbestpractices.com

Advertising & Editorial: Rod Smith
rod@airbestpractices.com
Tel: 412-980-9901

Subscriptions & Administration: Patricia Smith
patricia@airbestpractices.com
Tel: 412-980-9902

A Publication of: Smith Onandia Communications LLC
217 Deer Meadow Drive
Pittsburgh, PA 15241

Compressed Air Best Practices® is published monthly by Smith Onandia Communications LLC., 217 Deer Meadow Drive, Pittsburgh, PA 15241. Phone 412-980-9902, email patricia@airbestpractices.com. Compressed Air Best Practices® is a trademark of Smith Onandia Communications, LLC. Publisher cannot be held liable for non-delivery due to circumstances beyond its control. No refunds. Standard postage is paid at 233 Jefferson Street, Greenfield, Ohio 45123. Canadian and international distribution: IMEX International Mail Express, 1842 Brummel Drive, Elk Grove Village, IL 60007. POSTMASTER: Send address changes to Compressed Air Best Practices,® 217 Deer Meadow Drive, Pittsburgh, PA 15241. SUBSCRIPTIONS: Qualified reader subscriptions are accepted from compressed air professionals, plant managers, plant engineers, service and maintenance managers, operations managers, auditors, and energy engineers in manufacturing plants and engineering/consulting firms in the U.S. To apply for qualified reader subscriptions, please fill in the reader response cards herein and mail or fax or go to www.airbestpractices.com. To non-qualified subscribers subscriptions are $65 in Canada and $95 for other countries. When available, extra copies of back issues are $4 plus shipping. Contact Patricia Smith for subscription information at Tel: 412-980-9902 or email: patricia@airbestpractices.com. REPRINTS: Reprints are available on a custom basis, contact Patricia Smith for a price quotation at Tel: 412-980-9902 or email: patricia@airbestpractices.com.

THE MARKETPLACE

TECHNOLOGY

www.energyevent.com

30 years EMC
West Coast Energy Management Congress

2012 • Seattle • Washington

May 23 - 24, 2012
Washington State Convention & Trade Center

The **West Coast Energy Management Congress (WCEMC)**, is the largest energy conference and technology expo held on the U.S. West Coast specifically for business, industrial and institutional energy users. It brings together the top experts in all areas of the field to help you set a clear, optimum path to both energy cost control and energy supply security.

West Coast EMC's Pacific Northwest Green showcase, co-presented by the **U.S. EPA's ENERGY STAR®**, will also be a prominent part of the event for 2012. Here you can examine firsthand the latest green / sustainable / environmentally friendly energy technologies now available for both new design and retrofit projects. Conference presentations will facilitate your understanding of these technologies, covering such topics as:

» green building design and retrofit
» EPA's online energy measurement and tracking tool for buildings, Portfolio Manager
» LEED certification and building commissioning
» high performance facilities
» latest developments in renewable energy
» reducing carbon emissions
» transportation solutions for the future
» green/sustainable project success stories.

Presented by
35 Years of Achievement aee The Association of Energy Engineers

Hosted by
PSE Puget Sound Energy

Featuring
Pacific Northwest Green Showcase with EMC Sponsored By Energy Star — Learn more at energystar.gov

Platinum Sponsor
Seattle City Light

Silver Sponsor
Snohomish County PUD Public Utility District No. 1

Bronze Sponsors
BetterBricks — An initiative of the Northwest Energy Efficiency Alliance.
Tacoma Power — Tacoma Public Utilities
NEEC Northwest Energy Efficiency Council
McKinstry — For The Life Of Your Building
North America Power Partners LLC — The Energy Demand Response Resource

www.energyevent.com • 770-447-5083 • info@aeecenter.org