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

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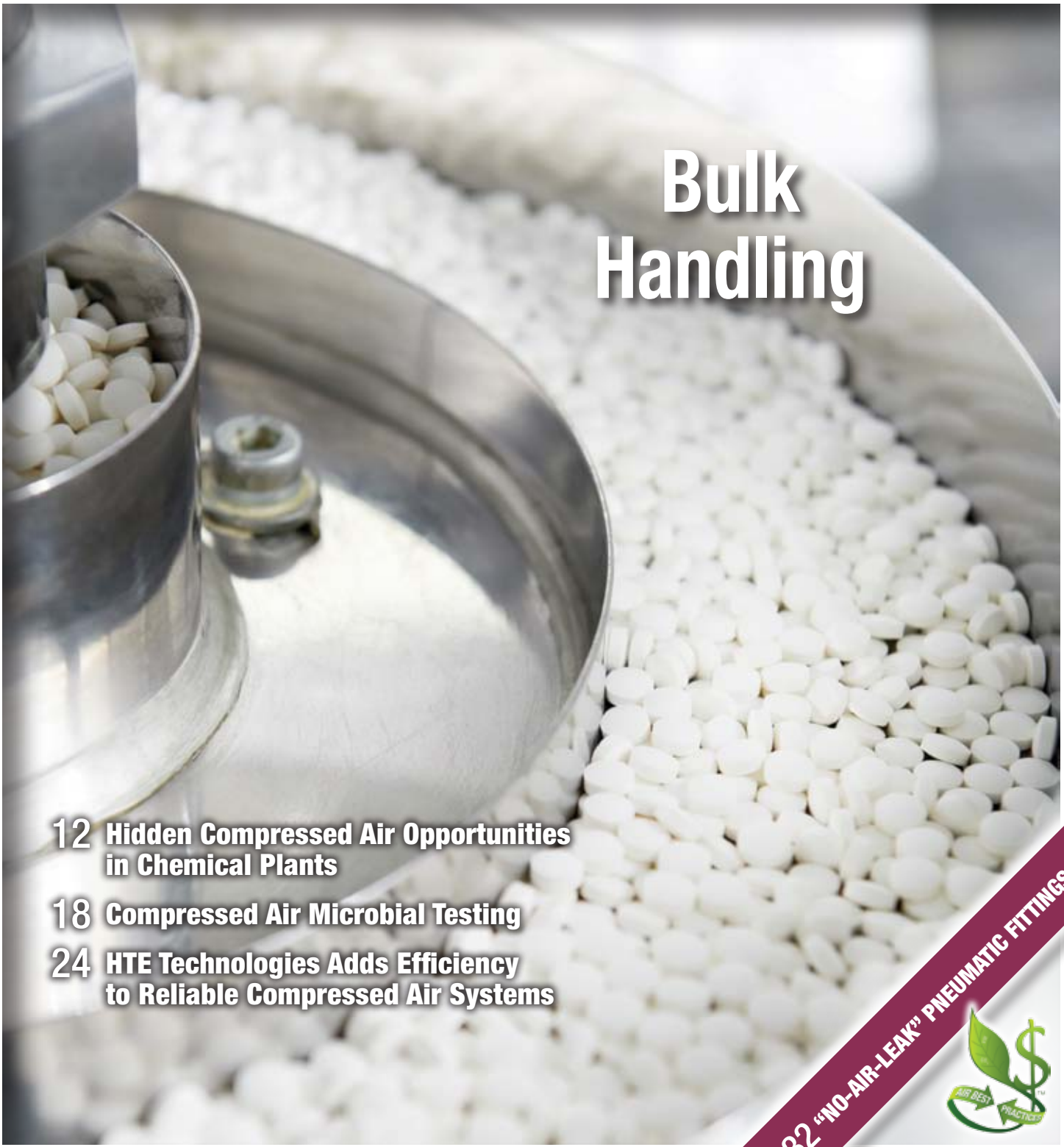

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FROM THE EDITOR | Bulk Handling

Our editorial criteria, at Compressed Air Best Practices® strives to meet the challenge of this question, "Would a veteran user or provider of compressed air systems learn something from this article?" I learned quite a bit putting this issue together and hope you will as well.

Our first article features an interview with veteran compressed air system auditor, Chris Beals from Air System Management, Inc. The article is titled, "Hidden Compressed Air Opportunities in Chemical Plants" as Chris raises field-experience issues such as the need for more stainless steel inlet piping to compressed air dryers (to reduce pressure drop losses).

How can food and pharmaceutical users of compressed air monitor microbial content? Parker Hannifin has introduced an interesting new on-site, portable microbial testing unit and had some research done on test procedures. They share a white paper with us titled, "Comparison of the Compressed Air Microbial Testing Unit (CAMTU) to a Standard Method of Bioaerosol Sampling."

I have been collaborating with some in-person and webinar training sessions for the customers of the ActOnEnergy® utility incentive programs delivered by Ameren Illinois and Ameren Missouri. A Registered Program Ally of the ActOnEnergy® program is St. Louis and Decatur-based HTE Technologies. Their veteran auditing guru and Certified Energy Manager, Walter Deeken, shares several case studies focusing on how they add energy efficiency to systems already delivering reliability.

Why do compressed air leaks often reappear? Veteran auditor Don van Ormer provides one of the answers in his article, "Choosing Durable "No-Air-Leak" Pneumatic Tubing Fittings." He recommends factories review the quality of the fittings, on all their production equipment, with a qualified vendor.

Pneumatic conveying provides an essential production for all kinds of process industries. For a compressed air person like myself, the technology is rather unfamiliar. For our education, VAC-U-MAX has provided the article, "From Pharma to Coffee: Pneumatic Conveying Design Basics."

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

ROD SMITH
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INDUSTRY NEWS & SUSTAINABILITY REPORTS

FS-Elliott Begins Manufacturing in Saudi Arabia

FS-Elliott Co., LLC, a leading manufacturer of oil-free centrifugal air and gas compressors, set an industry milestone this past year by shipping the first centrifugal compressor manufactured in the Kingdom of Saudi Arabia.

Inaugurated in April 2010, FS-Elliott Saudi Arabia Ltd. began as a joint venture between FS-Elliott Co., LLC, and GAS Arabian Services Co., Ltd. with the goal of providing locally packaged, reliable, and energy-efficient air solutions to customers in the Middle East. As a result of the joint venture, FS-Elliott Saudi Arabia Ltd. has provided local support to over 250 operating installations.

In December 2013, FS-Elliott Saudi Arabia Ltd. completed the packaging of three FS-Elliott Polaris industrial compressors for Saudi Airlines. The Polaris units marked the first centrifugal air compressors manufactured in the Kingdom of Saudi Arabia. The first API style engineered units manufactured in the Kingdom of Saudi Arabia are scheduled to ship within the next few months. This order includes two engineered PAP Plus A-Frame compressors for Saudi Arabia Basic Industries Corporation (SABIC) affiliates; Al Bayroni and Ar Razi.

"Temperatures in the Middle East often rise to 120 degrees Fahrenheit in the summer months. We are pleased to be able to offer our customers like Saudi Airlines and SABIC a locally built compressed air system they can count on to keep their operations running smoothly, especially during conditions of extreme heat and humidity," said Aref Al Dabal, Managing Director, FS-Elliott Saudi Arabia Ltd.

FS-Elliott Saudi Arabia, Ltd. is in the process of a major equipment upgrade project with two SABIC affiliates. The SABIC affiliates will receive the Regulus Control System, a proven Programmable Logic Control (PLC) based system designed with cutting-edge processors and memory capabilities providing performance, reliability and convenience. The Regulus Control System allows operators to monitor and manage the performance of one or multiple compressors, at the unit or remotely, to meet air demands while maximizing energy savings.

Aside from adding packaging and assembly capabilities, FS-Elliott Saudi Arabia Ltd. is responsible for servicing FS-Elliott's PAP Plus and Polaris product lines. Services include rotor repair and balancing, air end overhaul, equipment upgrades and rerates, and long-term maintenance programs. "Our dedicated engineers and technicians are fully trained and qualified to offer efficient installations and startups, auxiliary upgrades, technical support, and equipment training," said Al Dabal.

FS-Elliott Saudi Arabia Ltd. has improved in-house capabilities by adding machining and painting centers to their service and manufacturing facility. "The expanded operations enable us to deliver quality and prompt services to our customers and underscores our commitment to the region," added Al Dabal. For companies looking for extensive, hands-on training, the FS-Elliott Saudi Arabia Ltd. facility has recently added a control panel simulator, along with turbine and compressor cutout models. Customized, on-site training programs designed to help customers maximize the effectiveness of their air compressor system, are also available.

About FS-Elliott Co., LLC

FS-Elliott Co., LLC is a leading manufacturer of centrifugal air and gas compressors with sales, service, and manufacturing locations around the world. First introduced to the market nearly 50 years ago; their energy-efficient machines incorporate the latest aerodynamic and control system technologies to ensure optimum performance.

For more information, visit www.fs-elliott.com

Atlas Copco Ranked Among World's Most Sustainable Companies

Atlas Copco, an industrial group with world-leading positions in sustainable productivity solutions, ranks 46th among the 2014 Global 100 Most Sustainable Corporations in the World index — a list presented on Jan. 22 at the World Economic Forum in Davos, Switzerland. This is the eighth time that Atlas Copco has appeared in the Global 100 rankings.

"Atlas Copco has always incorporated sustainability initiatives into global business and manufacturing practices because it creates value for our customers and

shareholders and makes good business sense," said Jim Levitt, president, Atlas Copco North America LLC. "Being included in the Global 100 list for the eighth time shows that our social and environmental efforts really do make a difference."

Creating business value through sustainability is at the core of Atlas Copco's products and service. Atlas Copco sustainability initiatives, both globally and in the U.S., include:

- Boosting customer energy-efficiency by at least 20 percent between 2010 and 2020
- Decreasing CO_2 emissions
- Working actively to eliminate corruption
- Promoting access to clean drinking water in countries in need

Also, in 2012, the Atlas Copco Group invested approximately $330 million into research and development to ensure that products remain at the leading edge of energy efficiency, safety and ergonomics.

The Global 100 Most Sustainable Corporations in the World index evaluated 3,641 publicly listed global companies, which are measured against key sustainability indicators such as safety, performance and revenues in relation to consumption of energy and water. For more information, visit http://global100.org

Atlas Copco operates 116 locations and employs more than 4,800 people in the United States. Globally, Atlas Copco had revenues of approximately $12.8B in 2013. The United States represents the largest single-market for Atlas Copco globally.

Jim Levitt, President, Atlas Copco North America

Learn more at www.atlascopco.us

INDUSTRY NEWS & SUSTAINABILITY REPORTS

Pacific Air Compressors Named Oregon Energy Trust Trade Ally of the Month

More than eight years ago, Pacific Air Compressors became an Energy Trust trade ally contractor to help small industrial and commercial business customers use less energy and save money. Operating in Portland for the last 25 years, Pacific Air Compressors specializes in installation and maintenance of compressed air systems, filtration systems and refrigeration in commercial and industrial facilities. The company's sixteen staff members complete as many as thirty Energy Trust projects per year through the Existing Buildings and Production Efficiency programs.

In 2013, Pacific Air Compressors helped Galvanizers Inc. upgrade its compressed air system. Within six months, Galvanizers Inc. was already spending less on energy costs, and the company now saves an average of $4,000 per year — paying for the project through energy savings in just four years.

Energy Trust incentives and technical assistance help Pacific Air Compressors attract customers and promote projects. "[Energy Trust] incentives are great and extremely helpful," said Paula Dahlstrom, partner, Pacific Air Compressors. "Our company and our customers love it."

Visit www.pacificaircompressors.com and www.energytrust.org

EPA ENERGY STAR Releases Energy Treasure Hunt Guide Book

The US Environmental Protection Agency's ENERGY STAR program is providing a new energy management resource, *Energy Treasure Hunts: Simple Steps to Finding Energy Savings.* This new guide book draws upon the best practices of ENERGY STAR partner organizations that use energy treasure hunts to engage employees in finding low cost energy saving opportunities from behavioral, operational, and maintenance oriented actions. By using internal resources already among a business' assets, an organization is able to use the Energy Treasure Hunt process to build energy teams and internal processes for managing energy with a focus on continuous improvement.

Prior to the release of this guide book, the Energy Treasure Hunt process was tested with a variety of companies, including small companies and facilities without formal energy programs. All companies reported finding numerous no and low cost savings opportunities with payback periods under 6 months and quick implementation rates.

Many of these companies were able to quickly achieve 4 to 10 percent reductions in intensity and substantial savings in energy costs. But most importantly, the companies reported that the process of organizing and executing an Energy Treasure Hunt in combination with the ENERGY STAR Guidelines for Energy Management has created better site energy

teams, introduced better management practices, and secured upper management support for the energy program to continue to identify ways to improve performance.

To read this new guide visit www.energystar.gov/treasurehunt. To find complementary resources and tools, visit www.energystar.gov/industry and www.energystar.gov/buildings

Volvo Recognized for Leadership in Energy Efficiency

The Department of Energy recognized Volvo Group North America for its leadership in energy efficiency at the New River Valley assembly plant near Roanoke, Va. As a Better Buildings, Better Plants partner, the Volvo Group has already achieved 16 percent savings across its U.S. plants and continues working toward its goal of becoming 25 percent more energy efficient within ten years.

"Partners in the Better Buildings, Better Plants program, such as Volvo, are committing to real change — breaking through barriers to achieve greater energy efficiency and improving their bottom lines," said Kathleen Hogan, Deputy Assistant Secretary for Energy Efficiency. "The investments made by partners through the Better Plants program are helping to cut energy waste, to increase the competitiveness of U.S. manufacturers and protect the environment."

Volvo Trucks' New River Valley assembly plant is the company's largest truck manufacturing plant in the world, covering more than 1.6 million square feet. At the Volvo Trucks plant, energy efficiency has become part of the facility's core business practices, with an energy team member reviewing and approving every purchase made by the plant. Volvo also asked employees to suggest energy efficiency projects and has committed to reinvesting the savings from these projects —

INDUSTRY NEWS & SUSTAINABILITY REPORTS

about $1.2 million to date — into future efficiency efforts.

In 2012, the New River Valley facility was one of the first facilities in the U.S. to be certified under the Energy Department's Superior Energy Performance program for facilities. The Superior Energy Performance program helps facilities establish energy baselines and savings goals, and provides certifications when facilities achieve significant savings. New River Valley achieved a 26 percent improvement in energy efficiency in three years. As a partner in the Better Buildings Industrial Superior Energy Performance Accelerator, the Volvo Group is now implementing the Superior Energy Performance program at facilities nationwide.

"Our partnership with the Department of Energy through the Better Buildings, Better Plants program has provided us with a goal we can rally our entire organization around," said Lars Blomberg, Vice President and General Manager of Volvo's New River Valley plant. "At the same time, the Superior Energy Performance program is driving results at the plant-level to help us meet our company-wide goals. We are fully engaged in these programs in support of our core value of environmental care and encourage our people to actively conserve energy for future generations."

The Better Buildings, Better Plants Program is a national partnership initiative to drive significant improvements in energy efficiency across U.S. manufacturing plants. Through Better Plants, manufacturers partner with the Department of Energy to reduce their energy intensity by 25 percent over ten years, develop energy management plans, and track and report their annual progress. The Department works with each partner to establish key energy performance metrics, evaluate energy-saving opportunities, and organize plant-level training events.

Find more information about how the Better Buildings Initiative is helping partners like Volvo save money and energy at www.energy.gov/betterbuildings

Atlas Copco Ethics Honored by the Ethisphere Institute

Atlas Copco was named one of the World's Most Ethical Companies by the Ethisphere Institute for the second consecutive year. The prestigious ethical ranking, presented at the Global Ethics Summit in New York, recognizes companies that demonstrate leadership in ethics, corporate responsibility, sustainability and governance.

"Atlas Copco emphasizes a value-based culture that prioritizes long-term, ethical and sustainable business development, not only because it is the right thing to do, but because it also makes good business sense," said Jim Levitt, president, Atlas Copco North America LLC. "We are honored to be recognized by the Ethisphere Institute for our dedication to ethical practices."

Ethical business practices are a key element in Atlas Copco's operations. It starts with a culture of compliance to a clear policy governing business practices, including a zero tolerance policy against corruption, a comprehensive education program for employees and an extensive evaluation of the company's suppliers and their safety, health and environmental practices. Atlas Copco also provides an annual corruption-awareness training program in which thousands of

employees have participated, and employees and managers are expected to adhere to the company's Business Code of Practice.

As part of the company's dedication to business ethics and standards, Atlas Copco is a signatory to the UN Global Compact, a strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles in the areas of human rights, labor, environment and anti-corruption.

To learn more about the Ethisphere Institute and to see the full list of the 2014 World's Most Ethical Companies, visit www.ethisphere.com

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and service focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 180 countries. In 2013, Atlas Copco had revenues of BSEK 84 (BEUR 9.7) and more than 40 000 employees. Learn more at www.atlascopco.com

Atlas Copco operates 116 locations and employs more than 4,800 people in the United States. Globally, Atlas Copco had revenues of approximately $12.8B in 2013. The United States represents the largest single-market for Atlas Copco globally.

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THE COMPRESSED AIR SYSTEM ASSESSMENT

Hidden Compressed Air Opportunities in Chemical Plants

By Rod Smith, Compressed Air Best Practices® Magazine

Compressed Air Best Practices® Magazine interviewed Chris Beals, President of Air System Management, Inc.

➤ Good afternoon! What do you mean by hidden opportunities in compressed air systems?

Good afternoon. Hidden opportunities is a term I use to describe less-than-obvious losses in performance and energy efficiency in compressed air systems. I've been conducting compressed air system assessments, at chemical plants located in the southeast and southwest regions of the U.S., for many, many years. The reliability, of the compressed air system, has always been the major issue and focus for my clients, but in the past assessments were undertaken to reduce energy consumption. Over the past three years, however, as the cost of energy continued to drop, the assessments are undertaken only to improve system reliability. They don't mind if they also save energy, but that's not the focus of the assessment.

How would you describe the challenges to reliability at a chemical plant?

Chemical plants, due to their size and complexity, pose many challenges to the efficient and reliable operation of a compressed air system. There are so many places for hidden opportunities to be found in these large industrial complexes. We are normally dealing with several large centrifugal and rotary screw air compressors scattered across the complex. We encounter sites with well over thirty (30) desiccant air dryers of different types. Compressed air leaks can be found almost at will across the vast lengths of compressed air piping. Add to this the fact they are outdoor installations exposing all compressed air system components to the extremes of summer and winter. As you can imagine, it is a big task to simply understand the system.

You've said that installing stainless steel inlet piping to the compressed air dryers would make a huge difference. Please review.

The first mistake the industry makes is not installing schedule 10 stainless steel pipe upstream of the compressed air dryers. Carbon steel pipe, in an oil-free compressor

> "Hidden opportunities is a term I use to describe less-than-obvious losses in performance and energy efficiency in compressed air systems."
>
> — Chris Beals, President, Air System Management

system creating aggressive condensate, creates a lot of rust particulates that plug the pre-filters on the compressed air dryers and plug up condensate drain lines. I think the engineering contractors, who design these systems, either don't think about the need for stainless steel piping upstream of dryers in an oil-free system or they falsely perceive there to be a big price difference.

Installing schedule 10 stainless steel piping upstream of the dryers would improve system reliability by increasing the life of pre-filter elements and auto drains. For example, one plant I visited had a 15 psi pressure drop on the dryer pre-filter and the filter element had been changed only one week earlier! Another chemical plant, while retrofitting their system, took a 16 inch diameter header down and found sheets of rust inside that you could peel off in 3 foot sections.

Another hidden opportunity is excessive pressure loss across the inlet filter and inlet piping to centrifugal compressors. We have found inlet piping with "witches hats" restricting the inlet flow to compressors. In one case, after removing the witches hats

THE COMPRESSED AIR SYSTEM ASSESSMENT | Hidden Compressed Air Opportunities in Chemical Plants

from the inlet piping to two compressors, the power was reduced by 200 kW.

What are the most common hidden opportunities associated with centrifugal air compressors?

One of the most common hidden opportunities on the supply side of a system is centrifugal compressor blow-off, often called "venting" in the chemical industry. While venting is an obvious air loss, eliminating blow-off in the chemical industry is complicated by the fact that they often don't want to unload or shut off a compressor. The reason they provide for not wanting to unload or shut off a compressor is they aren't confident it will load or start back up when needed. During one system assessment, I showed a refinery how to shut down all their compressors and dryers. Their response was they just wanted them to remain unloaded (and consuming energy) because they weren't sure if they would start back up. Lastly, it's hard to get chemical plants and refineries to build trim stations due to capital being too tight.

The compressor industry has addressed this issue by developing compressor automation that has the ability to load-share across centrifugal compressors. One can manually load-share across centrifugals if at least one control panel allows the pressure to be adjusted by 1/10th of a psi; however, manual load-sharing often ends when the pressure differentials change Load-sharing is better addressed by installing new control panels on each compressor that have the ability to load-share or by installing a master controller. Many of the new control panels and master controllers have the capability for remote access, which reduces maintenance costs by allowing trouble-shooting to occur over the phone.

How effective are compressed air leak surveys at chemical plants?

Compressed air leaks are a hidden opportunity in plain site for everyone to see. It is not difficult to amass a long list of compressed air leak locations with the appropriate estimation of compressed air lost. I have done many leak surveys identifying costly compressed air leaks that the customer

> "While venting is an obvious air loss, eliminating blow-off in the chemical industry is complicated by the fact that they often don't want to unload or shut off a compressor."
>
> — Chris Beals, President, Air System Management

never got around to fixing. Now I only do a survey if the customer is willing to assign an operator that can make a first attempt to fix them while I'm doing the survey. That action alone pays for the leak survey.

Chemical plants are outdoors in the sun, snow and rain. You can't install a lubricator with a plastic dome - it has to be metal or it will leak. Most compressed air filters have internally mounted automatic condensate drains inside the housings. Over time almost all of these condensate drains will leak compressed air as they get stuck in the open position. We recommend replacing them with a filter that has a manual drain that has a thumb screw - these don't leak. With a well maintained -40 ˚F dryer no moisture will collect in the filters so there's no need for an automatic drain. Sight glasses on the filter housings are regularly found to be leaking. Don't purchase a filter with a sight glass if you can avoid it. Copper tubing is also a big source of compressed air leaks. Control valves should be installed with stainless steel (not copper) tubing. In a chemical plant this January, I did a leak survey finding a significant number of compressed air leaks on control valves installed with copper tubing.

Please discuss your findings with desiccant air dryers.

While they can provide a steady and reliable -40 ˚F (and lower) pressure dew point, heatless and even heated desiccant air dryers can often offer significant opportunities on the supply side of the system. Dryer purge on heatless desiccant dryers can be the largest compressed air leak source in a chemical plant. Often the purge air may be turned up unnecessarily or partially loaded dryers are operating in a fixed cycle because the purge-saving controller hasn't been maintained. The biggest purge rates (leaks) occur when a valve fails and you dump air from one side to the other and it goes out the purge exhaust valves. During one compressed air system assessment, I found one failed valve on a desiccant dryer causing a compressed air leak of 1200 cfm. In a huge chemical complex, these kinds of leaks can go unnoticed for years unless you have a flow meter on the inlet and outlet of the dryer

Replacing heatless and heated desiccant dryers with blower purge dryers can often recover a significant amount of compressor capacity. For example, one chemical plant was able to recover 5,000 scfm by replacing their heatless dryers with blower purge dryers, which saved energy while improving reliability by giving them a backup compressor.

One chemical plant had forty-two (42) point-of-use heatless desiccant air dryers scattered across the complex. It took me five days to analyze them all. Out of the forty-two, only twelve (12) were working.

The problem here was they had wet air piping-headers and they would slug all the dryers with moisture. It took them five years to find the capital to put in two 15,000 cfm internally heated desiccant dryers- one serving as back-up. This significantly reduced compressed air pressure drop and leaks in the system – while delivering quality compressed air. A lot of chemical plants and refineries prefer internally heated desiccant dryers over blower purge type dryers because they're easier to install in Class 1 Div II classified areas.

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Hidden Compressed Air Opportunities in Chemical Plants

Heated desiccant dryers often use compressed air (purge air) to cool the desiccant in order to minimize the temperature and dewpoint spikes that occur at tower switchover. Depending on the manufacturer the cooling air flow is equal to between 7.5 and 14.5 percent of the dryers rated capacity and it can last for between 30 and 90 minutes. In the southern part of the United States we routinely shut off the cooling air, while in the Northern states we only turn it on during the winter months.

What impact does being outdoors have on these compressed air systems?

The larger chemical plants I visit, in the southeast and southwest, are all outdoor installations. I was just down in Houston this winter and we saw 30 ˚F ambient temperatures. The air compressor's aftercooler outlet temperature was 80 ˚F and the compressed air dryers were 500 feet away. A lot of condensate was forming across this distance due to the temperature differential and the distance to the dryers. This is an example of why we recommend stainless steel inlet piping and a receiver upstream of the compressed air dryers, along with insulating the piping between receiver and the prefilters and the prefilter and the dryer inlet.

Another time I was in a metallurgical plant in Texas. They were using 1300 cfm in the plant and had significant issues with moisture in the compressed air lines. We suggested a 2600 cfm blower purge desiccant dryer, which they installed along with a Mist Eliminator. After installing the new dryer they could still only get a -20 ˚F pressure dew point. Upon further review we found the air compressor discharge was 117 ˚F on a day with a 95 ˚F ambient temperature. We found that moisture was condensing in the pipe upsteam of the Mist Eliminator, between the Mist Eliminator and the prefilter, and between the prefilter and the dryer inlet, which resulted in condensate hitting the desiccant . We put a precooler in front of the Mist Eliminator to cool the air down to 100 ˚F degrees, and the problem went away.

Any final thoughts?

Yes. It's worth taking the time to thoroughly understand your compressed air system. Another hidden opportunity is what we call "system events". System events puzzle many compressed air service providers who are only interested in the supply side of the system. I was asked by one compressed air service provider to figure out why the backup air compressors kept kicking on. After a thorough review, which included following the compressed air lines throughout the facility, I discovered a booster station (boosting plant air from 100 to 350 psig) that was causing the big demand event.

Thank you for your insights. BP

Chris Beals is president of Air System Management, Inc. Designated as an energy expert for compressed air by the U.S. Department of Energy, he is a founding member of the Compressed Air Challenge®. Contact him at cbeals@earthlink.net

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

Comparison of the Compressed Air Microbial Testing Unit to a Standard Method of Bioaerosol Sampling

By Lynne Landsborough Ph.D.

➤ Objective

Compressed air is used in a number of processes in the food industry. It is used as an ingredient in whipped products such as ice cream, to slice or cut soft products and to open packages before filling of product. Currently, food manufacturers are under pressure to validate the safety of all ingredients or processes for regulatory compliance, but unfortunately, there is currently no standard method to evaluate the microbial content of compressed air.

The challenge to sampling compressed air is it must be decompressed prior to sampling. The Andersen One Stage viable particle sizing sampler is an impactor developed with the National Institute for Occupational Safety and Health (NIOSH) and is an approved method for bioaerosol sampling of non-compressed air by the Environmental Protection Agency (EPA), Occupational Safety and Health Association (OSHA) and the Food and Drug Administration (FDA) (1). The Andersen single stage sampler has 400 holes with a cut off diameter of 0.65µm and designed to sample aerosols of bacteria from air at atmospheric pressures (Figure 1). By comparison, The CAMTU was developed by Parker Hannifin for direct testing of compressed air and collects bacteria due to positive pressure from the compressed air pushing the bacteria onto the plate (Figure 2). The level of impact stress has been shown to effect microbial recovery on agar and be dependent upon the impaction velocity of the cells into the agar as well as the design and operating parameters (3). For this reason, it's important to characterize the recovery efficiency of the CAMTU against a standard method such as the Andersen sampler.

The objective of this project was to compare the compressed air sampling capability of the newly developed Compressed Air Microbial Testing Unit (CAMTU) to a reference Andersen single stage viable particle sizing sampler for recovery of high pressure aerosolized *Micrococcus luteus* cells.

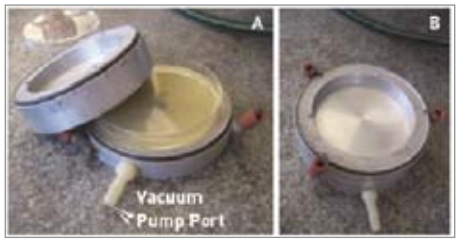

Figure 1: Andersen single stage viable particle sampler. (A) open device with petri dish (B) closed device with pin point holes in top. The device is attached to a calibrated vacuum pump which pulls air through the pin point holes onto the petri dish at a rate of 0.9994 CF/min (28.3 L/min).

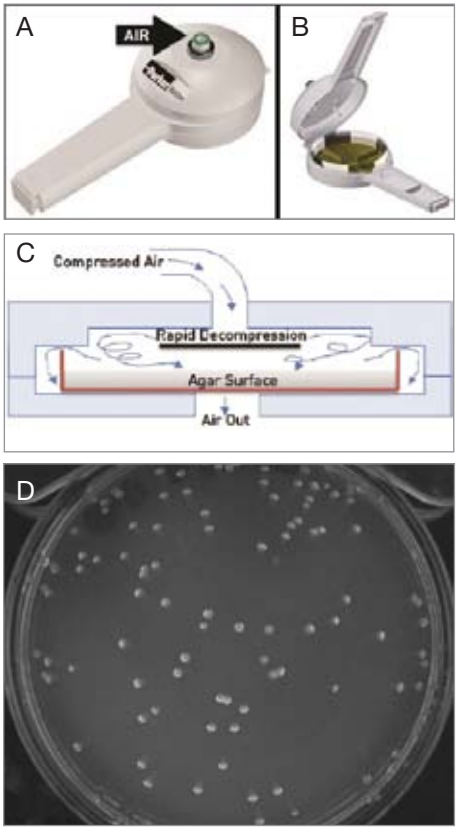

Figure 2: CAMTU Device. (A) Closed device arrow shows the inlet (B) Open devise shown with arrows indicating incoming air flow. Air exits device through channels located below the petri dish (C) Schematic of side view of CAMTU sampler showing proposed air flow within the sampling chamber (D) Colonies of M. luteus collected from aerosolized bacteria in compressed air with the CAMTU. For this study a pressure of 40 psig and an air flow rate of 1.6 CF/min were adjusted using an adjustable pressure regulator and a 0.007 inch orifice.

> "Food manufacturers are under pressure to validate the safety of all ingredients or processes for regulatory compliance, but unfortunately, there is currently no standard method to evaluate the microbial content of compressed air."
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> — Lynne Landsborough Ph.D.

Materials and Methods

Bacterial Cultures

The Gram positive, non-sporeforming bacteria Micrococcus luteus ATCC 4698 was used as a model organism for this study. This organism has been used by others to compare recovery of bacteria from aerosols (3) and in general has a round to slightly elongated round shape with a diameter between 0.5 – 1 µm (Fig 3A). Cells of this organism after growing in broth can exist as single cells, groups of tetrads (4 cells, arrows in Fig 3B) or clumps (Figure 3A and 3B). Bacterial stocks were stored at -80 ˚C in 10% glycerol. Each month, tryptic soy agar (TSA) slants were inoculated from frozen stocks and incubated at 32 ˚C for 18 h. These working culture slants were stored at 4 ˚C. Broth cultures for each experiment were prepared by inoculating a loopful of working culture into 50 ml tryptic soy broth (TSB) and grown with agitation (200 rpm) for 18 h at 32 ˚C. Initial cell numbers in the overnight culture were determined by dilution and spiral plating (Spiral Biotech1) onto TSA agar and incubated overnight at 32 ˚C. Cell numbers were determined using automated plate counting (Q-count, Spiral Biotech).

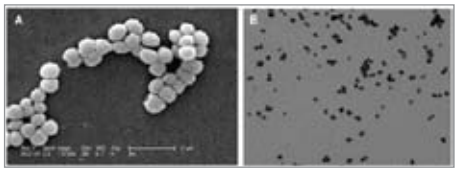

Figure 3: Gram stain of Micrococcus luteus cells. A) Scanning electron micrograph of Micrococcus luteus cells (enlarged 12,230x source: CDC Public Health Image Library image #9757) B) Light microscopy image of Micorococcus luteus cells after Gram staining. Arrows denote tetrad formation which is typical for this organism (enlarged 1000X, source: Dr. Scott K. Rose, Napa Valley College, used with permission)

Comparison of Andersen impactor sampling to CAMTU

The instrumentation set up as diagramed in Figure 1. An biological aerosol was generated using a high pressure nebulizer with 45 psi (310 KPa) air pressure moved over a container of DRIERITE gypsum desiccant (W. A. Hammond Drierite Co, Xenia OH) to remove excess moisture in the system and then connected back to 40 psi (275 kPa) of air moving through a bypass. Within the sampling box, two Andersen single stage viable particle sizing samplers were used at a flow rate of 0.9994 CF/min (28.3 L/min) (1) or by direct sampling of air using CAMPTU at a flow rate of 16.1 CF/min (456 L/min).

COMPARISON OF THE COMPRESSED AIR MICROBIAL TESTING UNIT TO A STANDARD METHOD OF

Figure 4: Set up of bacterial nebulization and sampling system

Each experimental day, a sterile nebulizer, flow rate meter and tubing was used. Sterile controls were always run first and then a single concentration of bacteria was added to the nebulizer and varying amounts of air was sampled. Depending on the experiment, bacteria were either diluted in buffered peptone water (BD) or used straight in TSB.

Prior to and after to each sampling, the weight of the nebulizer and inoculum was measured, to track total volume lost during each sampling run.

Samples were taken from sterile controls to least sterile:

1. Agar plate in sampling box without vacuum (plate sterility control)
2. Agar plate in sampling box, with vacuum sampling (max vol. sampled) (microbial load of background air control)
3. Sterile buffered peptone water (or TSB) in nebulizer, air sampled in sampling box (diluent sterility control)
4. Bacteria (either diluted in BPW or undiluted in TSG) in nebulizer, and air sampling from decompressed air in sampling box with the Andersen Impactor for various amounts of time (32, 64, 128 or 256 sec)
5. Bacteria (either diluted in BPW or undiluted in TSG) in nebulizer, and air sampling directly from compressed air for various amounts of time (20, 40, 80 and 160 sec) with CAMTU device.

TABLE 1: COMPARISON OF CAMTU TO ANDERSEN SAMPLER

COMPARISON OF SAMPLING UNITS			
SAMPLING TIME (SEC)	AIR VOLUME SAMPLED(CF)	AVERAGE CFU/PLATE	CFU/CF AIR
REPLICATE #1			
Andersen Sampler			
32	0.53	1.5	2.8
64	1.06	4.5	4.2
128	2.13	1.5	0.7
265	4.26	5	1.1
CAMTU			
20	0.53	74	139.6
40	1.06	74	69.8
80	2.13	105	49.3
160	4.30	75.7	17.6
REPLICATE #2			
Andersen Sampler			
32	0.53	3.0	5.7
64	1.06	0.5	0.5
128	2.13	2.0	0.9
265	4.26	4.5	1.1
CAMTU			
20	0.53	4.7	8.8
40	1.06	7.3	6.9
80	2.13	15.3	7.2
160	4.30	28.0	6.5

Sampling with Andersen Impactor

Sterile TSA plates were placed into ethanol sanitized Andersen impactor units. For each test, the compressed air was turned on and the system (air, nebulizer) was run for 1 min with a measured flow rate on 1.8 L/min, after which the vacuum pumps attached to the Andersen Impactors would be manually started, and then turned off at the desired time using a timed switch after 32, 64, 128, or 256 seconds. Two units were run simultaneously, to give duplicates for each sampling time. The air pressure and flow rates were recorded for each run. After sampling, agar plates were removed, and Andersen Impactors and sample box were wiped down with 70% ethanol, and fresh plates were added. Before and after each sampling run, the nebulizer was weighed to calculate the approximate volume of liquid nebulized in each run. After each run, the used liquid was removed and replaced with a fresh bacterial solution for the next sampling run. Plates were incubated at 32 ˚C for 24h. Colony numbers were determined using automated plate counting system (Q-count, Spiral Biotech).

Sampling with CAMTU

Sterile TSA plates were placed into ethanol sanitized CAMTU. The CAMTU setup as the same as the Andersen Impactor units, except rather than decompressing the air in the box, the compressed air was directly attached to

BIOAEROSOL SAMPLING

> "In order to sample compressed air, initially it must be decompressed to atmospheric conditions."
>
> — Lynne Landsborough Ph.D.

the CAMTU. The flow rate into CAMTU: 1.6 CF/min and timing was started at the initiation of air into the nebulizer. Sampling times on the CAMTU were adjusted to obtain similar volumes of air on to those sampled with the Andersen Impactor and were performed for 20, 40, 80 or 160 sec. After sampling, agar plates were removed and the CAMTU was wiped down with 70% ethanol, and fresh plates were added. Before and after each sampling run, the nebulizer was weighed to calculate the approximate volume of liquid nebulized in each run. After each run, the used liquid was removed and replaced with a fresh bacterial solution for the next sampling run. A single CAMTU unit was used and each sampling time was performed in triplicate, with fresh bacterial solution in the nebulizer for each run. Plates were incubated and counted in the same manner as described with the Andersen Impactor unit.

Results and Discussion

Compressed air is an essential component of food processing; however currently there is no standard methodology to determine the microbial load of compressed air. Ideally, any standard method to sample compressed air within a food processing environment should be accurate, reproducible, fast, and inexpensive, that requires minimum operator training to perform. This study compared the CAMTU, an agar impactor sampler designed to rapidly and easily sample compressed air used within the food processing environment to that of the Andersen single stage sampler unit.

In order to sample compressed air, initially it must be decompressed to atmospheric conditions. There are a several air sampling units commercially available, many of which have chambers decompress air then utilize pumps to sample the compressed air. These units are often large laboratory bench models, which limited their usefulness in food processing plant environment. The CAMTU is designed to have air de-compressed above a disk suspended over an open petri dish (Fig 2C) and the compressed air decompression propels the microorganisms onto the surface of the agar and eventually exits the unit through channels under the petri dish. The colonies recovered from the agar surface appear to be distributed over the entire agar surface rather than just at the edges (Fig.

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> "The CAMTU sampling device has the potential to be a highly valuable tool for testing the microbial load of compressed air."
>
> — Lynne Landsborough Ph.D.

2D), indicating that there is likely random, turbulent airflow during the microbial sampling.

It should be noted, that during preliminary testing of the CAMTU, we observed if moisture was accumulating in our flow meter (an indication of moisture in the aerosol), rather than discrete colonies on the agar surface, smears were observed after incubation. To remedy this issue, the aerosols were dried over desiccant to remove excess moisture, although some bacteria were likely to have been removed in this step. Based upon this observation, we believe the CAMTU is not is not suited to sampling compressed air with high levels of water or other liquids.

The efficiency of the CAMTU to the Andersen single phase sampler for sampling bacteria from aerosols was compared using M. luteus using a system outlined in Figure 4. The results from two replicates of this experiment are presented in Table 1. In the first replication, the CAMTU recovered approximately 17-50 more CFU than the Andersen impactor. In the second replicate, both recovery systems performed similarly.

BIOAEROSOL SAMPLING

One concern with the CAMTU was the possibility that the high pressure air impact with the agar would destroy and reduce the number of bacteria recovered, however, the results presented in Table 1 indicate the CAMTU has similar recovery of *M. luteus* to the Andersen impactor.

This study has shown similar recovery of *M. luteus* from compressed air using both methods. Since bacteria spores are more resistant to aerosolization stress, we assume that the CAMTU will also have similar recoveries of bacterial spores to other air sampling methods. One potential shortcoming of this study is that only one organism, a Gram positive vegetative bacterium was used for testing. In general, Gram negative bacteria vegetative are more sensitive to stress during aerosolization and to structural injury when collected on agar (3), it is currently unknown if there would be similar recovery from both the Andersen impactor and the CAMTU. Another potential shortcoming of this study was that the bacterial aerosols were not 'discharged' after aerosolization, therefore the airborne bacterial cells may be highly charged. When compressed air was discharged into the HDPE sampling box there is always the possibility that a portion of the aerosolized bacteria were lost due to adhesion to the box walls by electrostatic interactions (4) and could be a potential source of experimental error.

The CAMTU sampling device has the potential to be a highly valuable tool for testing the microbial load of compressed air. It has the advantages that it is simple and portable, in that is does not require a power source or external power source and can be used for sampling of compressed air on the food processing environment.

Since the CAMTU uses a standard petri dish for sampling , it can be used for performing different types of microbial isolation by, for example, using Rose Bengal-Streptomycin agar for selective collection of airborne for yeast and molds (2). BP

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HTE Technologies Adds Efficiency to Already Reliable Compressed Air Systems

By Walter Deeken, HTE Technologies

Compressed air reliability has been the obsession of both factory personnel and service providers for a number of years now. Constant availability of high quality air can be absolutely critical to maintaining efficient plant production. Most modern factories operate *reliable* compressed air systems — and more recently have also begun to focus on the *efficiency* of those systems. The objective of this article is to use a few real-life case studies of already reliable compressed air installations to illustrate the potentially huge economic benefits of also improving system *efficiency*.

These studies conducted by HTE Technologies involve low volume and high volume users, complex and simple systems, and recommended actions that range from minor changes to extensive reworking of existing systems. The end-users' financial benefits in the cited studies collectively include power savings equating to $370,000 annually, $500,000 in incentives for equipment improvements, and power savings of almost $58,000 annually on a smaller system.

Case Study #1: Large-Size System Improvement

Reliable Compressed Air: This large-scale manufacturing plant wanted to optimize a compressed air system located in three buildings and fed by two separate compressor rooms. The main building, another nearby, and a remote building were connected through insulated piping. The compressed air system consisted of six (6) electrically driven oil flooded rotary screw compressors and five (5) refrigerated compressed air dryers. Total air compressor horsepower exceeded 2,500.

Four of the air compressors were fixed speed and were networked together to coordinate their actions with two (2) variable speed drive (VSD) air compressors. The VSD air compressors ran stand-alone at times in order to trim and maintain plant pressure. The plant air system had no additional control system.

The main compressor room was equipped for heat recovery. The four (4) fixed speed compressors had a heat recovery package on their after/oil coolers. The heat recovery package recovered the heat of compression and re-circulated it to warm the compressor room during the winter. This utilized what

> "Constant availability of high quality compressed air can be absolutely critical to maintaining efficient plant production."
>
> —Walter Deeken, HTE Technologies

would otherwise be wasted heat, increasing overall plant energy savings. When not required, heat was rejected to the outdoors. This was an excellent application for waste heat recovery as the plant has no specific process that could benefit from the waste heat generated. The two (2) VSD compressors had coolers which were remotely located outside of the compressor rooms. Whether heat recovery could generate cost savings for these two compressors was evaluated, but no current cost justification for recovering the heat from these units was found.

Reliable and Efficient Compressed Air: Implementation of the HTE Technologies recommended measures ultimately exceeded the original estimated energy savings by thirty percent (30%), and accounted for a forty five percent (45%) reduction in electrical consumption as compared to the plant compressed air system's prior baseline usage, which equated to a total facility-wide reduction of nearly five percent (5%) annually.

A system wide strategy was employed to reduce energy consumption. Both the supply and demand side of the system were reviewed. The following energy reduction measures were employed.

- **Leaks Repaired:** 900 SCFM of leaks were identified and tagged throughout the facility. These leaks accounted for nearly twenty percent (20%) of the average system flow. Through leak repair, one air compressor was placed in standby.
- **Merged Compressor Line-Pressure Sensors:** The units in the main air compressor room were reading different system line reference pressures due to a variance in piping. The four fixed speed compressors were remotely piped to read pressure after the dryers, while the variable speed drive was reading pressure at the header (before the dryers). This disparity was forcing more units to operate than was required because the compressors were not reacting to the same pressure readings. HTE Technologies recommended unifying the pressure reference point for the variable speed drive and adjusting the compressors to a tighter control strategy. This allowed two additional compressors to be placed in standby mode, shifting the full load of the entire plant to the two 600 horsepower variable speed drive units.

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HTE Technologies is headquartered in St. Louis with a 6,500 ft² branch in Decatur, Illinois.

- **Implemented New Air Compressor Set-Point Strategy:** As is the case with many compressed air systems, the compressor pressure set-points were higher than necessary to deliver adequate pressure to end users. A pressure of 90 PSIG was needed for end users. Plant header pressure was lowered 5 PSIG and was still able to provide the required pressure to the plant. This reduction in pressure accounted for a 2.4% input power savings from the air compressors.

- **Replaced Pneumatic Diaphragm Vacuum Pumps with Electric Vacuum Pumps:** During the review of the demand side of the system, the plant's air driven vacuum pumps were identified as significant air consumers. Due to the inefficiencies of the dynamics associated with generating compressed air, end use vacuum generation, and pumping applications can be accomplished more efficiently with electric driven pumps. While these vacuums provided an excellent water lift, each one needed the equivalent of a 25 HP compressor to achieve this vacuum with ¾" hose connection. These vacuums used a minimum of 115 SCFM with optimal rating of 160 SCFM. The plant had seven of these vacuums. If all seven vacuums were in use, this would consume a minimum of 175 horsepower of compressed air. Replacing these vacuums with low consumption electric vacuums yielded a 4.6% savings of electrical cost.

- **Placed One Dryer in Remote Building to Standby:** Each dryer in the remote building had a refrigerant condenser located on a dryer skid. The location of the dryers caused the heated compressor discharge air to recirculate around both dryers. The recirculated air raised the ambient temperature in the area around the dryers, causing an artificially higher load. By relocating the shut off valves on each of the dryers in the remote building, one dryer was able to be easily relegated to back up status. For redundancy, each of these two dryers was sized to condition the full load of the associated compressor. Due to this redundancy, air quality was not impacted by placing the second dryer on standby. Placing this dryer on standby eliminated the power usage of that dryer, but also reduced the heat rejection into the ambient air, reducing an estimated 25% of the load on the online dryer. This action was expected to yield on average an additional 2% savings of electrical cost.

When these recommendations were implemented, the annual energy cost for this large-plant compressed air system was reduced from nearly 8,000,000 kWh to approximately 4,300,000 kWh. At an electrical rate of $0.10/kWh, this equates to a $370,000 reduction in electrical usage cost for the customer.

> "When these recommendations were implemented, the annual energy cost for this large-plant compressed air system was reduced from nearly 8,000,000 kWh to approximately 4,300,000 kWh."
>
> — Walter Deeken, HTE Technologies

Case Study #2: Producing 35 PSIG Air Reliably and Efficiently

Reliable Compressed Air: A company was using twelve (12) 300 horsepower, 100 PSIG, rotary screw air compressors for a low-pressure application. Pressure orifice plates were being used to decrease the pressure of 100 PSIG to 35 PSIG. The air compressors could not be adjusted down to supply this lower pressure directly due to their OEM design. If the 100 PSIG compressors were adjusted to 30 - 35 PSIG, the velocity of the air would increase to the point where the air/oil separator could no longer contain the oil in the compressor. This would cause each unit to discharge its oil into the air system header and result in compressor failure.

Reliable and Efficient Compressed Air: Eight (8) 350 horsepower, 35 PSIG, low-pressure air compressors were installed to replace the twelve (12) high-pressure units. These low-pressure air compressors supplied the same amount of flow directly at the 35 PSIG pressure required but with 800 less horsepower. This provided the process with the flow and pressure required without unnecessarily increasing and then decreasing pressure. The installation saved approximately 7,500,000 kWh annually, or forty percent (40%) of the electrical cost of the compressed air system for this process. This project was additionally eligible for the Ameren ActOnEnergy incentive program, which contributed nearly $500,000 as an incentive for the implementation of this energy saving measure.

Case Study #3: Small-Size System Improvement

Reliable Compressed Air: The existing compressed air system consisted of one 50 horsepower single-stage lubricated rotary screw air compressor supporting the compressed air needs of the plant and one 25 horsepower single-stage lubricated rotary screw serving as back-up. The system had a single refrigerated compressed air dryer with point of use storage totaling 600 gallons. Although the maximum flow of the 50 horsepower air compressor was utilized intermittently, the overall average was at forty percent (40%) of the machine's capacity. For an inlet modulation air compressor, this range of operation is very inefficient, requiring approximately 82% of power. In addition, this average flow is at the minimum turndown of a fixed speed air compressor. This means that the air compressor was cycling on and off to provide the fluctuating required flow. The frequent short cycling of the 50 horsepower air compressor was of particular concern due to energy inefficiency and mechanical stress to the air compressor.

Reliable and Efficient Compressed Air: To buffer short-term intermittent system demands, 620 gallons of storage were added. In addition, a variable speed drive compressor was modeled for the system. Replacing the main system fixed speed inlet modulation 50 horsepower air compressor with a variable speed drive 50 horsepower air compressor allowed greater turndown for

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Why Complete an Air System Audit with HTE Technologies?

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From 2010 to 2013, our specialists have helped our customers reduce electricity usage by over 30,000,000 kWh, accounting for an average of $2.7 million per year of reduced costs. On top of that, through the ActOnEnergy® incentive program, HTE has secured more than $2 million of utility sponsored energy incentives to assist with offsetting the capital costs of these projects.

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> "The reduced power usage of variable speed air compressors at partial loads allowed for significant energy consumption avoidance."
>
> — Walter Deeken, HTE Technologies

the compressor, which reduced short cycling during times of low compressed air needs. Also, the reduced power usage of variable speed air compressors at partial loads allowed for significant energy consumption avoidance. At forty percent (40%) of rated capacity, air compressors of this type use approximately forty one percent (41%) of the power used at full capacity. Through the upgrade of the air compressor, the customer cut their electrical usage for the compressed air system in half. In conjunction with the Ameren ActOnEnergy project, the customer was able to upgrade system performance with a minimal expenditure. The return on investment after the applied utility incentive was less than one and a half years.

Case Study #4: Food Processing System Re-Design

Reliable Compressed Air: A food processing plant wished to improve energy efficiency and performance of their compressed air system. The existing system consisted of four (4) 200 horsepower fixed speed, inlet modulation, rotary screw air compressors for the main plant and one 60 horsepower air compressor supplying the shipping area through branched piping. The main system had two wet receiver tanks totaling 1,800 gallons. The combined storage of the receiver tanks and the distribution system amounted to a storage ratio of 2 gallons per 1 CFM of trim compressor output.

Unreliable Compressed Air Quality: The contaminant removal system consisted of multiple point-of-use compressed air dryers. Without a system dryer, the condensate was dropping out into the distribution piping and being passed along to end uses of compressed air in production. To compound matters, the compressed air piping went through some refrigerated areas, causing more moisture to condense in the compressed air. The point-of-use dryers were drying the air before critical processes, but did not address moisture in the compressed air lines overall. Another area of concern with the point-of-use dryers was the general maintenance requirements of such a large number of units. The 60 horsepower fixed speed air compressor in the shipping

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> "Through the Ameren ActOnEnergy incentive program, the payback period for the upgrade from the basic equipment to the energy efficient option was reduced from 3.4 years to 1.8 years."
>
> — Walter Deeken, HTE Technologies

area did not incorporate storage and had one (1) 300 CFM desiccant air dryer. The dryer pre-filter had a malfunctioning timer drain which was cracked open, creating a constant compressed air leak. This dryer had a large pressure drop which caused the compressor to frequently cycle. In addition, the air compressor was running about 15 PSI above its design parameters.

Reliable and Efficient Compressed Air: A review and redesign of the compressed air system yielded the following improvements. A 200 horsepower variable speed drive air compressor replaced one of the fixed speed air compressors as a trim machine for the main system. A master controller was installed to sequence the air compressors so that the minimum number of baseload air compressors were in operation. A centralized dryer was added to replace the point of use dryers, saving energy and maintenance costs. To maximize energy savings, a heated purge desiccant compressed air dryer was selected with a control option to adjust regeneration cycles to actual moisture load. In addition, 5,000 gallons of dry storage were incorporated into the system downstream of this dryer to buffer pressure fluctuations. The piping distribution was redesigned for a looped configuration, allowing air to flow in two directions to end uses. Leaks were identified, tagged and repaired. This combination of the supply and demand side compressed air system improvements saved the customer $57,960 in electric costs annually.

Case Study #5: Medium-Size System Improvement

Reliable and Efficient Compressed Air: The customer was updating a compressed air system and evaluating proposals based upon lowest initial cost and lowest 10 year overall cost. The lowest initial cost option was one 200 horsepower fixed speed air compressor with a heatless desiccant dryer. Through modeling the system over 10 years, it was determined that using a variable speed drive compressor with a heat reactivated desiccant air dryer would save nearly 277,000 kWh annually. Through the Ameren ActOnEnergy incentive program, the payback period for the upgrade from the basic equipment to the energy efficient option was reduced from 3.4 years to 1.8 years. This additional monetary incentive convinced the customer to implement the energy efficient option. In addition to the incentive program savings, the customer will enjoy years of electric usage reduction. BP

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CHOOSING DURABLE "NO-AIR-LEAK" PNEUMATIC TUBING FITTINGS

By Don van Ormer, Air Power USA

➤ Introduction

Over many years of reviewing industrial compressed air production machinery, of many types and styles, there is one common thread or complaint; *"push-to-connect pneumatic tubing connections/fittings are a continual source of compressed air leaks and production interruptions."* Probably seventy-five to eighty percent of push-to-connect type tubing fittings use flexible tubing selected for lower material cost and assembly rather than an alternate appropriate hard metallic tubing.

Flexible tubing itself is much more prone to leaks from vibration, abrasion, chemical abuse, etc. than correctly selected and installed hard metallic tubing. The flexibility and constant transmission of vibrations and movement to the sealing area of the push-to-connect fitting tends to shorten its' effective life. The objective of this article is to contrast the operating benefits, under demanding operating conditions, of the typical push-to-connect fittings and the alternative two-piece ferrule sealing wedge fitting.

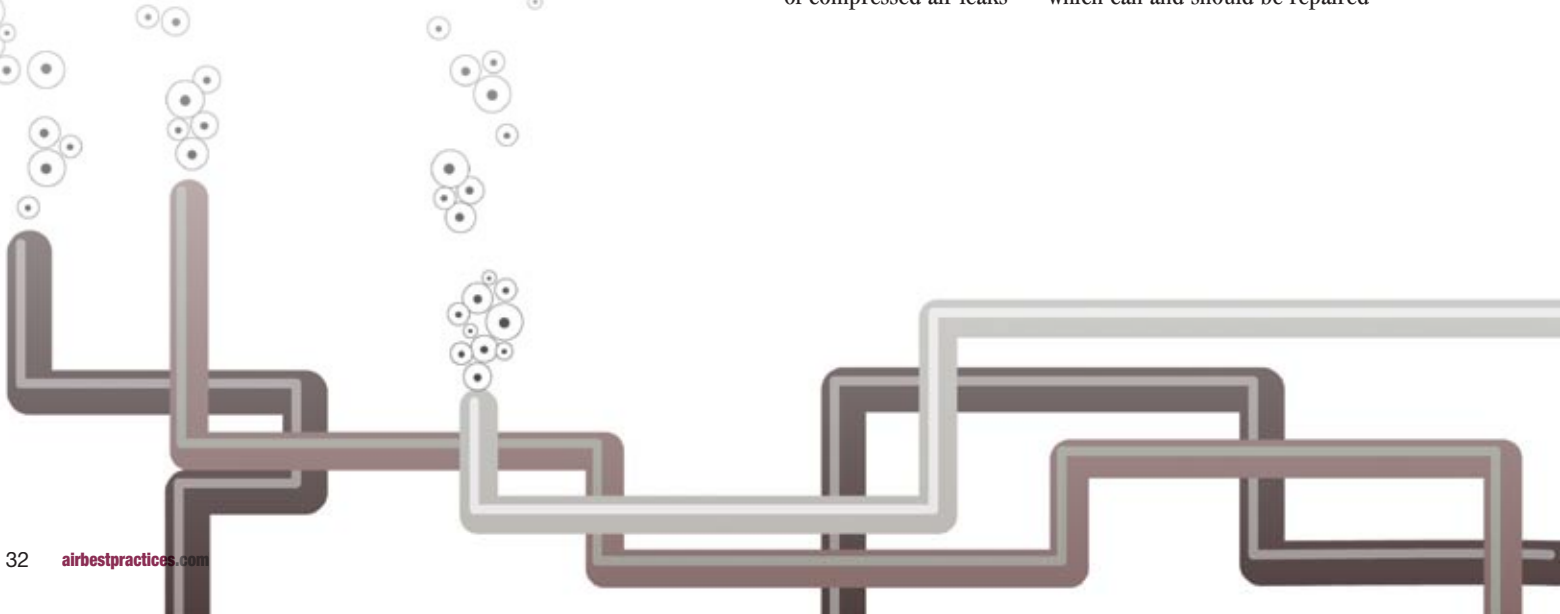
Fitting Fundamentals

When subjected to vibration, typical push-to-connect fittings can exhibit relative movement by the tube on the O-ring and retainer (also called grippers). This will accelerate wear issues leading to a higher propensity to leak. At some point, the fittings useful life is gone when both the retainer and seal areas are too worn. Some designs use ribbed seal material instead of O-rings.

The two-piece ferrule sealing wedge fitting design holds the tubing in place with the back-ferrule. The wedge seal on the tubing, is formed by the front ferrule, pushed by the back ferrule, as the fitting is tightened. There is very little (if any) relative movement between the fitting and tubing — so wear is minimal. This design exhibits reliable durability as any wear that may occur can easily be offset with a small amount of tightening.

Examining Pneumatic Fittings and Tubing on Production Machinery

It would be to any plants advantage to monitor the inlet compressed air flow and pressure to any production machinery using a significant number of tubing and fittings. If possible, set a "Best Practice" standard for compressed air use when new (or completely repaired). Then monitor compressed air flow and pressure for deviations from the "Best Practice Flow and Pressure". Any deviation will provide a good indication of compressed air leaks — which can and should be repaired



> "Probably seventy-five to eighty percent of push-to-connect type tubing fittings use flexible tubing selected for lower material cost and assembly rather than an alternate appropriate hard metallic tubing."
>
> — Don van Ormer, Air Power USA

In order to arrive at the above "Best Practice" scenario, the type and size of the operating tubing should also be reviewed. We have found cases where productivity was down or the pressure had increased because 1/4" copper tubing had been replaced with 1/4" nylon tubing and was not capable of delivering the same compressed air flow at the necessary pressure.

The cross-sectional area of standard 100 psig rated copper tubing is about 30 times larger than standard 1/4" polyethylene high flow tubing. Often you will have to up-size the nylon or poly-type tubing to replace 1/4" copper or other hard metal tubing. This data will vary by manufacturers and sources.

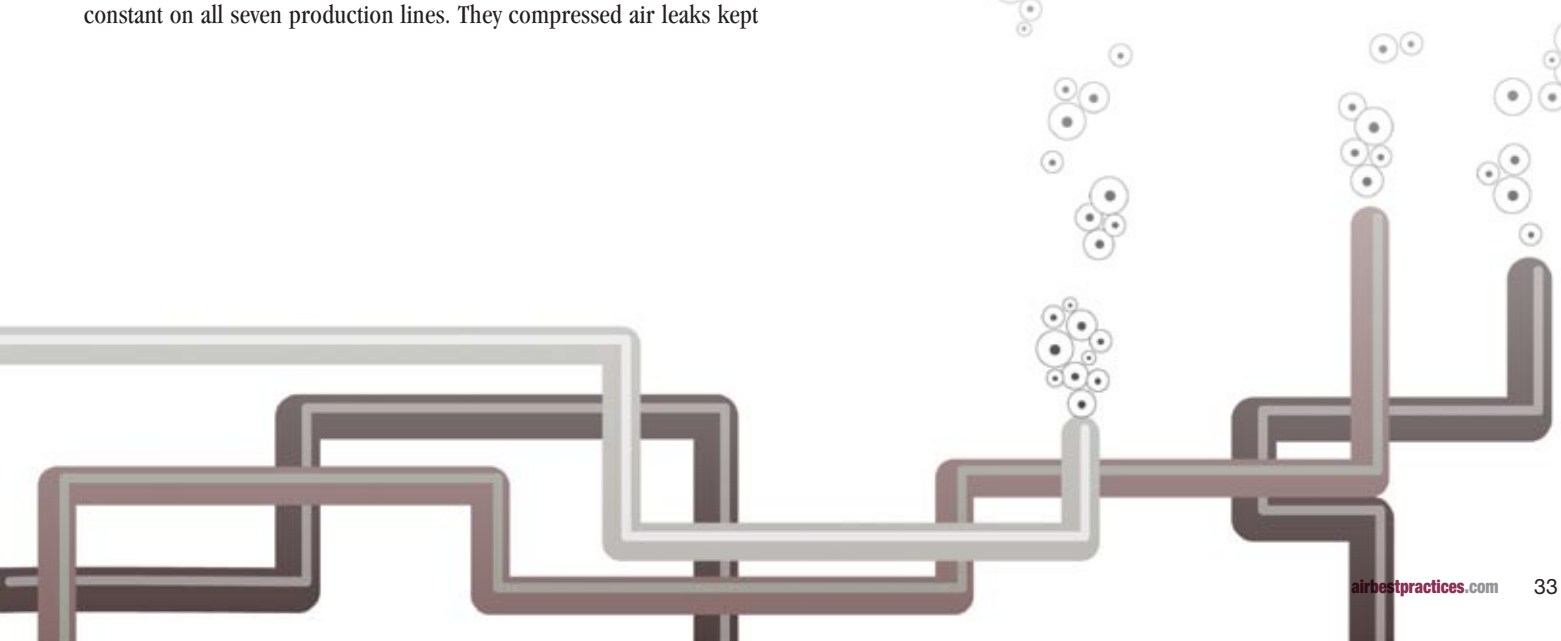
A Case Study

On a recent plant compressed air system review, Air Power USA was requested to do an in depth analysis of seven operating packaging lines. This plant felt the compressed air leak-load, on the packaging machines, continued to remain above acceptable levels.

These seven packaging lines had been operating for just over five years. Plant management indicated that identified leak repairs were almost constant on all seven production lines. They compressed air leaks kept appearing and it was impossible to have a "no air-leak" situation! The plant asked us to identify the magnitude of the compressed air leaks and what actions would be appropriate to permanently eliminate (or at least greatly reduce) the negative impacts: production down-time, scrap, and lost compressed air.

To begin, we held discussions with the plant personnel and discovered some interesting facts:

- Almost all leaks occurred at the fitting seal. Corrective action was to either just push it in again or cut the tubing end off and then reinsert it into the push-to-connect fitting.
- Maintenance personnel liked this aspect of the push-to-connect fitting style because it was quick and easy.
- Maintenance personnel confirmed that probably only half of their repairs were reported and logged. If this was accurate, then the management estimate of compressed air leaks was seriously understated.
- Only when a fitting could not be reset was replacement considered and then the production unit had to be shut-down longer for this to be implemented.



CHOOSING DURABLE "NO-AIR-LEAK" PNEUMATIC TUBING FITTINGS

TABLE: FITTING TYPE COST COMPARISON

QTY.	SIZE	WEDGE TYPE FITTING (EACH)	WEDGE-TYPE TOTAL	PUSH-TO-CONNECT FITTING (EACH)	PUSH-TO-CONNECT TOTAL
707	1/4"x 1/4" NPT	$2.90	$2,051	$2.69	$1,902
56	3/8"x 3/8" NPT	$3.90	$219	$4.44	$249
		Total	**$2,270**	**Total**	**$2,151**

TABLE: AVERAGE COMPRESSED AIR FLOW SAVINGS PER PRODUCTION LINE

PRODUCTION EQUIPMENT PER LINE	AIR FLOW BEFORE REPAIR	AVERAGE FLOW AFTER REPAIR	TOTAL SAVINGS
Inserter	128 scfm	64 scfm	64 scfm
Case Packer	83 scfm	43 scfm	40 scfm
Total	**211 scfm**	**107 scfm**	**104 scfm**

- There were no records kept of continued leaks at specific fittings.
- There had never been a planned project to replace all of the fitting at one time.

We then examined the seven production lines and focused on the seven inserter and seven case packing machines on each line. An inventory was made of the tubing and fittings on the pneumatic circuits of each machine.

Reviewing Fittings on the Seven Inserter and Case Packer Machines

The seven (7) inserter machines each deployed ten (10) double-acting pneumatic cylinders. Each machine had eight smaller pneumatic cylinders fed with 1/4" standard push-to-connect fittings and 1/4" nylon tubing. They then also had two larger pneumatic cylinders fed with 3/8" similar push-to-connect fittings and tubing. All fittings were supplied by the OEM machine manufacturer.

The total fitting count on the inserter machines was:

- 26 x push-to-connect fittings: 1/4" x 1/4" size
- 4 x push-to-connect fittings: 3/8" x 3/8" size

The seven (7) case packer machines each deployed fifty-one (51) double-acting pneumatic cylinders. Each machine had fifty smaller pneumatic cylinders fed with 1/4" standard push-to-connect fittings with polyurethane or nylon 1/4" tubing. They then also had one larger pneumatic cylinder fed with similar 3/8" push-to-connect fittings and tubing. All fittings were supplied by the OEM machine manufacturer.

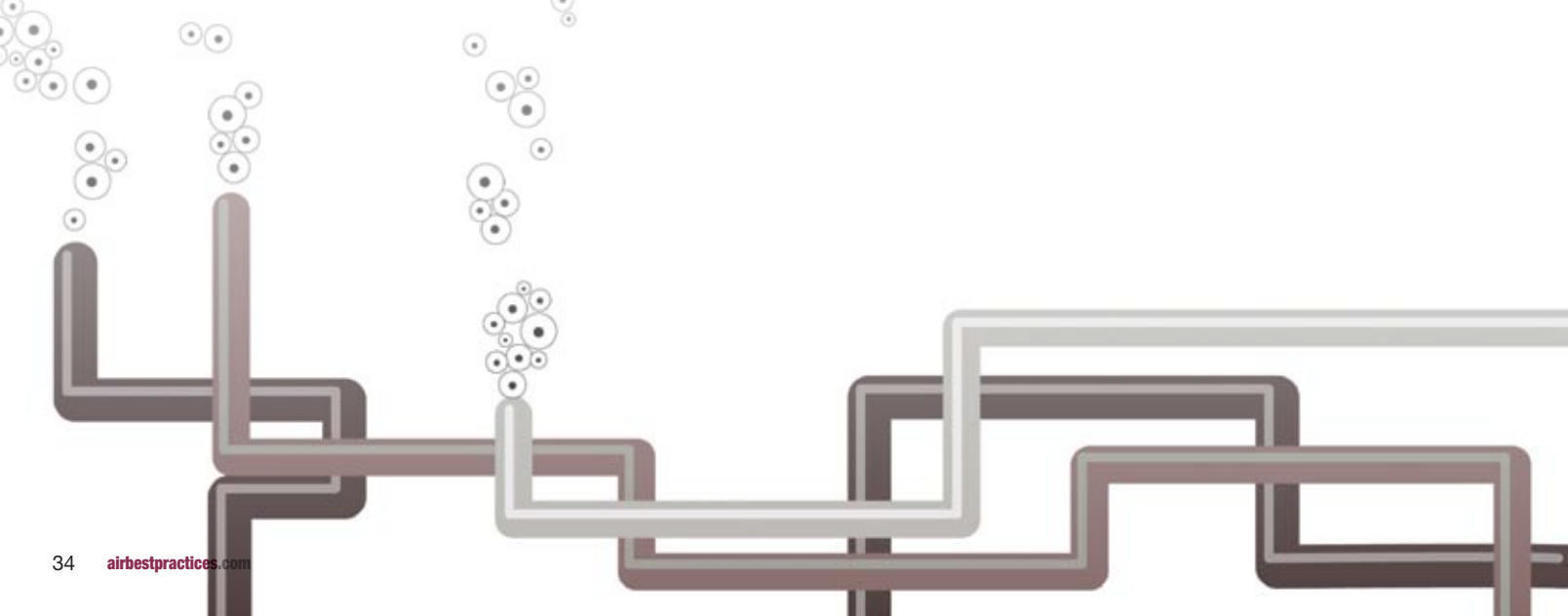
The total fitting count on the case packer machines was:

- 75 x push-to-connect fittings: 1/4" x 1/4" size
- 4 x push-to-connect fittings: 3/8" x 3/8" size

Solutions

Compressed air inlet pressure and flow data (to the inserter and case packer machines) was collected on each line running during normal production hours. This data was averaged and recorded. Complete leak repairs were made on all fourteen (14) machines and were tested with both ultrasound leak detectors.

In order to eliminate leaks, caused by the fittings, we replaced the standard push-to-connect fittings with the two-piece ferrule wedge



> "The total electrical energy savings for the seven production lines, associated with the reduction in compressed air leaks, was estimated at $44,637 per year."
>
> — Don van Ormer, Air Power USA

design. The project cost, for materials, was $2,270.00. As a reference, we calculated the cost to be $2,151.00 if we had used the less durable push-to-connect fittings.

When a production unit was deemed to have zero compressed air leaks it was run again and a "Best Practice" pressure and air flow was measured and recorded with the same flow meter and gauge. The total electrical energy savings for the seven production lines, associated with the reduction in compressed air leaks, was estimated at $44,637 per year. This was calculated assuming a cost for compressed air of $122.63 per scfm per year. It also assumed that only fifty percent (50%) of this value would actually be recovered.

Savings Calculation:
104 scfm x $122.63 scfm/year x .50 (%) x 7 lines = $44,637 per year

Conclusion

At this plant, the seven production lines of inserter and case packer machinery required the introduction of wedge-type fittings to eliminate compressed air leaks. The tubing was not the primary cause of the leaks. Sometimes this is not true partially in areas with "wash down" cycles.

When movement in the line is required, flexible tube or hose will be appropriate. Proper selection of the material is critical. If no movement in the line is required during operation, then wedge-type fittings with properly selected hard metal tubing will further minimize or eliminate operating leaks.

Finally, if production equipment is using standard push-to-connect fittings and there are no compressed air leaks — there is no reason to change. We strongly suggest, however, keeping careful records of compressed air repairs, flow and pressure to maintain operational efficiency. BP

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

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

From Pharma to Coffee: Pneumatic Conveying Design Basics

By Doan Pendleton, VAC-U-MAX

It's one thing to move materials during the production process, but when it's a finished product on the packaging line, choosing the right material handling system is essential. Getting it wrong results in squandered production time when product loss occurs, and wasted raw materials.

Pneumatic conveying systems have quickly become the method of choice to move product from the manufacturing line to the packaging line but often the choices in systems can seem overwhelming. There has been many technical papers written about dense phase and dilute phase conveying and whether the system should be a negative or positive

type of system; however, there often seems to be lack of definitive information that plant engineers can use to clearly define their own system. It's similar to getting lost when a local gives directions because instead of giving a straightforward route, the unfamiliar are led through a maze of back roads.

Just as there are various factors given consideration when planning a route to a destination, such as time, distance, conditions, purpose and safety, there are many factors to take into account when designing a pneumatic conveying system to deliver a finished product to a packaging line.

In packaging operations, the most common pneumatic conveyor systems are vacuum conveying systems, but before heading into that topic, a basic understanding of the components that make up a pneumatic conveyor system is essential.

The Five Components of a Conveying System

A standard conveying system consists of five basic pieces of equipment that come together to work as one — a pick up point, convey tubing, a vacuum receiver, a vacuum producer and a control module.

The selection of a pick-up point depends on the type of container that is used to store materials or products. If the product is in drums or box, then a pick up wand, inserted into the container, may be used to pull material from the container into the convey tube. When material is stored in bags, ergonomic bag dump stations that reduce spillage are often utilized. This allows the emptied material to flow by gravity into the vacuum conveying line. For supersacks, bulk bag dischargers are frequently the choice as a pick up point.

From the pick-up point, material flows through convey tubes to the vacuum receiver. There are a number of different types and sizes of vacuum tubes that are utilized and chosen, depending upon application.

Vacuum receivers transfer material from above packaging machinery through discharge valves on the bottom. Material is conveyed from the pick-up point to the vacuum receiver until it reaches a pre-determined load, or is "made", then the discharge valve opens and the material drops into the packaging machine.

Vacuum producers are the core of pneumatic conveying systems and work with the control panel to manage the flow of material through the convey tubes to the vacuum receivers. Vacuum producers come in many shapes and sizes. Two of the most common vacuum producers are venturi-powered units that run on compressed air, and positive displacement pumps that run on electricity; and, each has its advantages and disadvantages.

The advantage of units that run on compressed air is that there are no moving parts and therefore require no maintenance. Because they operate with air and there are no moving parts, these units are ideal in hazardous areas. The disadvantage of using compressed air, is that over time it can be expensive. Units that run on compressed air also offer lower upfront costs than positive displacement pumps. Although positive displacement pumps have higher upfront costs and moving parts that require oil changes twice a year, they are very reliable pieces of equipment that have long equipment lives and lower overall cost.

The most basic vacuum conveying system is a timed system, consisting of two basic cycles — a convey cycle and a discharge cycle. The control

Vacuum conveying systems are adapted according to the level of automation a manufacturer desires and the amount of equipment involved.

FROM PHARMA TO COFFEE: PNEUMATIC CONVEYING DESIGN BASICS

An understanding of material characteristics is essential when designing a vacuum transfer system — experts, like VAC-U-MAX, often already possess data about a particular substance's behavior and will test within a proposed configuration to ensure it will work properly.

panel, which often works in concert with some type of level control, dictates the amount of time that the system conveys product to the receiver and then how long the discharge valves are open to drop the material into the packaging machine.

Designing a Pneumatic Conveying System

Because each packaging operation has unique requirements, individual components are selected from each of the five basic pieces of equipment to design a conveying system that achieves the packager's desired outcome.

Many users of vacuum conveying systems often assume they need an expensive custom, one-of-a-kind solution. However, pneumatic conveying companies with extensive industry experience in the packaging arena, like Belleville, NJ based, Vac-U-Max, have pre-engineered systems that address common conveying problems in the packaging line and customizes them by providing option capabilities that address product specific needs.

A pioneer in vacuum solutions since 1946, Vac-U-Max is one of the few suppliers who routinely designs and builds custom and semi-custom pneumatic systems and support equipment for conveying, batching, and weighing dry materials.

Vacuum conveying systems are adapted according to how much automation a manufacturer desires and the amount of packaging equipment involved.

In a packaging line, whether moving caps and closures, glue chips, or dry materials such as powders, conveying experts compile a great deal of information about the application to design an efficient vacuum conveying system.

Perhaps the most common issues packagers face when implementing a pneumatic conveying system is product quality control; because, when moving powders and dry materials change in size, density, and texture can occur and potentially affect product performance. The following three applications for pneumatically conveying finished products to packaging machinery will demonstrate how customizing basic conveyor equipment fit individual applications.

Three Pneumatic Conveying Applications

The first application is a fairly simple system used to package 1,750 pounds of coffee an hour from floor-mounted silos to packaging machines. The pick-up point for the coffee is the floor-mounted silo. Convey tubes connect silos to vacuum receivers mounted on packaging feed hoppers. The vacuum producer in this system generates negative pressure, sucking the material from the silo through 10 meters of vertical convey tubes to vacuum receivers. In this case, level switches control the operation of the four vacuum receivers by signaling for more coffee when the level drops below an established setting. When the coffee in the hopper reaches the high set point, the level control

stops the vacuum receivers. The coffee then flows down to the vertical form-fill-seal packaging machines. Because the product in the vacuum line does not come in contact with air, it does not affect the quality of the coffee.

The next conveying solution, seemingly more complicated than the coffee solution, uses high speed conveying and dispensing for a blended self-lathering facial product. Volumetric auger fillers dispense the powder into two layers of non-woven material that is ultrasonically sealed as the powder is dispensed.

The powder's self-lathering properties presented the potential of being critically affected in any type of conveying method. If the powder particles became too small, the facial product self-lathered too fast; and, if the particles became too large, the self-lathering process took too long. In addition, a change in the density, component blend, and texture would produce inconsistent fill rates or volumes — both unacceptable for quality control. Testing in Vac-U-Max's large-scale testing facilities confirmed material flowability and proper convey rate for the product.

The pick-up point best suited for this application includes two low-profile drum dump stations for easy loading, powered by a positive displacement vacuum producer that pulls the powder through convey line piping to the receivers. For this system vacuum receivers deliver product into three volumetric auger fillers, supplied by an outside company. A level control automatically delivers powder to the auger fillers at pre-determined volumes.

Since labor is one of the highest costs in a plant or facility, reducing man-hours becomes a prime target of any executive interested in reducing operating cost. A prime benefit of a pneumatic conveying system should be the reduction of man-hours. Where numerous staff were previously required to manipulate material, there might now be the need for only one to add material at the front end of the process.

FROM PHARMA TO COFFEE: PNEUMATIC CONVEYING DESIGN BASICS

> "Standard conveyor components, coupled with industry expertise and customized options, make pneumatic conveying possible for just about any packaging operation."
>
> — Doan Pendleton, VAC-U-MAX

Since powder can change density in the auger filler head leading to improper fills, keeping the head full is critical. For proper powder density in the auger filler heads, and more accurate fills, the conveying expert mounted customized multi-filters to the powder receivers and designed the vacuum conveying system to convey material faster than the packaging machine was dispensing product.

Vac-U-Max also applied a high polish finish to the systems interior and exterior to reduce powder sticking inside the system and make the exterior easier to clean.

On installation, the conveying expert worked with the facial product manufacturer to adapt the system to their needs. To better accommodate a vertical receiver adjustment mechanism that the facial product manufacturer designed, convey piping was mounted on machinery rather than hanging it from the ceiling or supporting it from the floor. The result was a modular system easy to install or relocate, which took significantly less production floor space than typical material convey systems.

Often packagers must focus equally on plant efficiency, product quality and safety, as was the case in this last conveying solution where a marshmallow producer desired to reduce downtime, and minimize product loss caused by bucket elevators as well as provide a higher level of safety for nearby workers from loose starch in the air.

This particular application required extensive testing to ensure mandatory product quality, feed rates, and other variables. After this testing VAC-U-MAX designed two pneumatic conveyor systems that deliver finished marshmallows from processing to six packaging machines.

Again, systems were built using five standard components, however, the use of additional components customized the systems to meet the manufacturer's needs, such as FDA, USDA-approved hoses, filter separators that capture and reclaim excess starch from the system, explosion vents, and intuitive controls that enhance flexibility.

The inherent nature of the pneumatic system prevents loose starch from becoming airborne which eliminated the need for workers to wear dust masks or respirators, and made for a cleaner and safer environment all around.

It is clear from the examples above, that standard conveyor components, coupled with industry expertise and customized options make pneumatic conveying possible for just about any packaging operation.

VAC-U-MAX offers a wide range of standard pneumatic conveyor systems, weighing systems and accessories, plus semi-custom systems, as well as totally custom-engineered systems. They offer factory testing of trial materials, as well as installation assistance and full maintenance documentation. They are the provider of choice of many well-known companies in the food, drug, and industrial manufacturing sectors. BP

For more information contact Doan Pendleton, Vice President Sales, VAC-U-MAX.

Founded in 1954, VAC-U-MAX has been at the forefront of leading edge conveying systems and components across a wide range of industries including food, pharmaceutical, chemical and industrial markets. To learn more about how VAC-U-MAX pneumatic conveying systems can improve efficiency, ergonomics, preserve product integrity, or reduce costs, write to them at 69 William Street, Belleville, NJ 07109; call 1-800-822-8629; e-mail info@vac-u-max.com; or visit www.vac-u-max.com

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Atlas Copco Introduces Proprietary Drive Technology

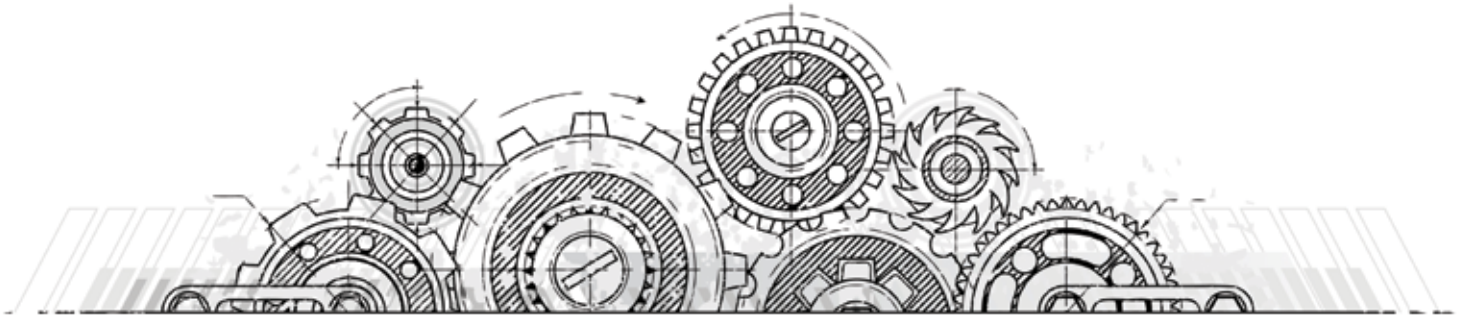
Atlas Copco Compressors has introduced proprietary drive technology for oil-injected screw compressors with variable speed drive in the 50-125 hp range. Robust, efficient and reliable, the Neos drive is specifically designed to meet the demands of heavy duty air compressor applications.

"The Neos drive is the result of collaboration between Atlas Copco and our long-time electronics providers, combining years of experience and knowledge of energy-efficient compressor technology," said Robert Eshelman, vice president, Industrial Air Division, Atlas Copco Compressors. "Since we introduced the first variable speed drive compressor in 1994, we have continued our legacy of innovation with the development of this proprietary drive technology."

In comparison to traditional drives that are typically designed for light duty applications with quadratic torque curves, the new drive technology was designed specifically for applications that have a constant torque curve, allowing the compressor to meet the demands of heavy duty applications. The Neos drive features an IP5x rated enclosure, which greatly reduces the risk of drive failure by blocking the introduction of outside contaminants into the electronic drive. In addition, the Neos drive features simplified controls and options that cater to the specific needs of an air compressor application.

The combination of simple controls, robust protection against contaminants and increased efficiency makes the Neos drive the

preferred drive for all oil-injected screw compressor applications in the 50-125 hp range. The Neos drive is currently available in all new compressors in this range; older Atlas Copco compressors can also be retrofitted with the new drive.



TECHNOLOGY PICKS

***Atlas Copco** is an industrial group with world-leading positions in compressors, expanders and air treatment systems, construction and mining equipment, power tools and assembly systems. With innovative products and services, Atlas Copco delivers solutions for sustainable productivity. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 170 countries. In 2012, Atlas Copco had 39,800 employees and revenues of BSEK 90.5 (BEUR 10.5). Learn more at www.atlascopco.com.*

***Industrial Air** is a division within Atlas Copco's Compressor Technique business area. It develops, manufactures and markets oil-injected and oil-free air compressors, vacuum pumps, gas generators, air treatment solutions and compressor controls and monitoring under several brands. In addition to serving a wide variety of industries, dedicated solutions are also available for marine, railway and oil and gas customers. The division's focus and main drive is to further improve its customers' productivity. The divisional headquarters and main production center are located in Antwerp, Belgium.*

Teseo Introduces New Piping Mounting Brackets

TESEO srl, specializing in the design, production and sale of aluminum piping and fittings for the construction of distribution plants for compressed air, vacuum, nitrogen and other fluids under pressure, is introducing new ceiling- and wall-mounting brackets for easy, fast and safe installation of AP and HBS aluminium piping.

Responding to market demand, requiring installers to cut installation times and costs with easier, quicker and cost-effective solutions, TESEO has developed **a new range of mounting brackets.** Designed to fasten profiles **to walls** or structures, or suspending piping **from a ceiling** using wires or studding.

The new mounting brackets are made of electrolytic galvanized sheet steel. **The "U" shape** provides for an easy positioning of the profile, while two clamping "wings" lock the profile in place. For improved safety, side holes are provided to insert screws that prevent the profile from slipping off the bracket. Safety screw and bolt are included in the new bracket kit.

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The dynamic shape of the new accessory allows the pipe to slide smoothly inside the bracket. As a result, **assembling, maintenance and modification operations are simplified and accelerated.** The new bracket concept also compensates for heat expansion due to room temperature variations (day/night, summer/winter), as the pipe is free to move axially.

New brackets are available for 50, 63, 80 and 110 HBS profiles and for all large diameters (45, 54 and 68) of the new AP range.

"Our R&D team is constantly committed to the development of innovative solutions to enhance and optimize our distribution systems for compressed air and other fluids under pressure — said Gianfranco Guzzoni, founder and managing director of TESEO. As a result, we can offer leading-edge high-tech products, designed to simplify the work of installers, increasing their loyalty and encouraging them to select our systems for the transport of non-hazardous technical fluids".

About TESEO srl

Teseo srl was founded in 1988 and immediately emerged as a pioneering, innovative and creative company. In the early '90s, Teseo was the first company worldwide to develop a modular system of aluminum profiles for the distribution of compressed air. Today, these systems have set a reference at international level for fluid power distribution such as compressed air and vacuum, both in small handicraft workshops and the big industry. Teseo is a dynamic and constantly developing company, both in terms of market presence and for its capacity to offer innovative, leading-edge solutions, as a result of the constant commitment and work by the internal R&D laboratory. With this approach, the modular piping by Teseo, the first and the original in its category, has been constantly developed, enhanced and modernized for two decades.

The modular piping systems by Teseo are installed in the most different fields, with prestigious references in the automotive, textile, mechanical and automation industries. Besides the Italian headquarters in Desenzano del Garda, Teseo srl has five subsidiaries: Teseo Iberica, Teseo Nederland, Teseo UK, Teseo Deutschland and the new North American branch office Teseo Canada.

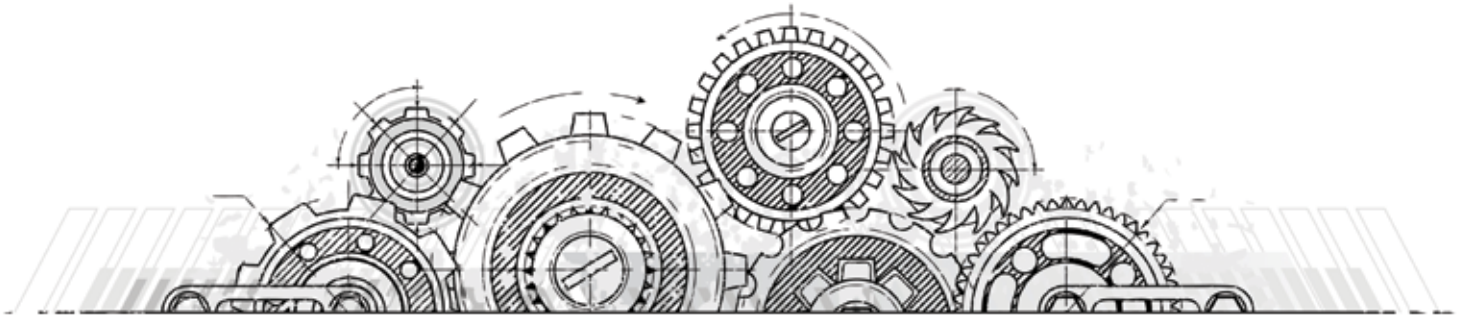
Teseo's distribution systems are manufactured in compliance with the safety requirements of the applicable standards and have obtained several product certifications. Besides manufacturing and selling its products, Teseo supports partners and customers for plant design and dimensioning, the study of tailored solutions for machinery and production lines, consulting on standards, training of installers and engineers, supervision during installation and tests.

For more information visit www.teseoair.com or email: sales@teseoair.com

Baldor Expands Offering of Super-E® Motors with Internal AEGIS® Bearing Protection Ring

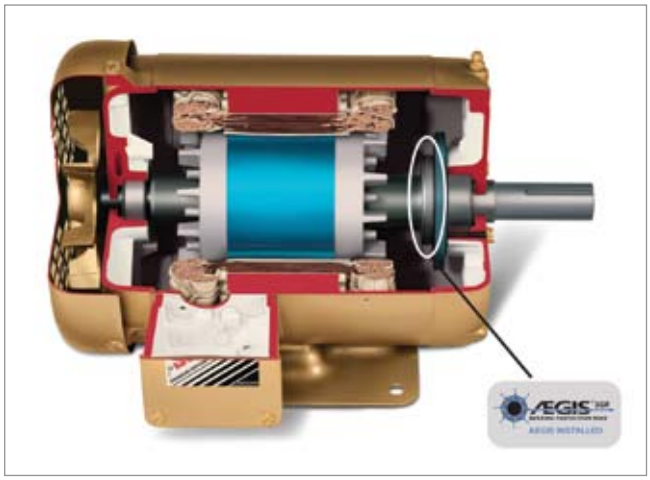
Baldor Electric Company is pleased to announce the addition of 28 new ratings to its portfolio of Baldor•Reliance® Super-E motors with internal AEGIS Bearing Protection Ring. These new ratings consist of 1 to 40 HP, Open Drip Proof motors, 200 volt and 575 volt, as well as 5 to 15 HP Totally Enclosed Fan Cooled designs for 200 volt.

With these latest additions, Baldor now offers 152 ratings from stock, meeting the continuing demand for inverter driven motors



TECHNOLOGY PICKS

with a shaft grounding device factory installed. This internally mounted design minimizes the effects of shaft currents that can be present in adjustable speed motor applications. Providing the shaft ground mounted internally on the motor in industrial HVAC and pumping applications greatly minimizes the potential for damage to the grounding device.



This complete line of motors is constructed with heavy-duty frames, cast endplates, is suitable for mounting in any position and features a Class H Inverter Ready insulation system. Baldor offers NEMA Premium® efficiencies on all models, including designs for close-coupled pumps, which is crucial for total system efficiency.

Baldor Electric Company *(www.baldor.com) is a leading marketer, designer and manufacturer of industrial electric motors, drives and mechanical power transmission products. Baldor, a member of the ABB group, is headquartered in Fort Smith, Arkansas.*

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"Compressed air is the #1 kW user across our 35 factories."
– Doug Barndt, Manager Demand-Side Energy & Sustainability, Ball Corporation

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"Do your homework, demand excellence, and don't be afraid to say no to the audit. If you want to audit my plant, you should be able to provide some savings incentive beforehand."

– Rodney Dayson, Sustainability & Energy Manager, Archer Daniels Midland BioProducts. Article published in the Jan/Feb 2013 Edition of Compressed Air Best Practices® detailing a compressed air energy-savings audit saving $422,000 annually at ADM.

"Demand Side" and "Supply Side" information on compressed air technologies and system assessments is delivered to readers to help them save energy. For this reason, we feature Best Practice articles on when/how to correctly apply **air compressor, air treatment, measurement and control, pneumatic, blower and vacuum technology.**

Industrial energy managers, utility incentive program managers, and technology/system assessment providers are the three stakeholders in creating energy efficiency projects. Representatives of these readership groups guide our editorial content. The Compressed Air Best Practices® Editorial Advisory Board guides our mission to help create more energy saving projects.

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Spectroline® UV LED Leak Detection Flashlight

The Spectroline® OPTI-LUX™ 365 is a powerful yet compact leak detection flashlight that provides UV light for optimal fluorescent dye response. It's ideal for all industrial fluid system applications.

The OPTI-LUX 365 works with all oil- and water-based fluorescent dyes: OIL-GLO® 22 (yellow), OIL-GLO® 30 (white), OIL-GLO® 33 (green), OIL-GLO® 40 (bright blue), OIL-GLO® 44 (yellow/green), OIL-GLO® 45 (blue) and OIL-GLO® 50 (red), as well as WATER-GLO® 801 and WATER-GLO® 802 water dyes. It produces a brilliant glow that makes all leaks easier to find, while slashing valuable diagnostic time! The flashlight even works with difficult-to-fluoresce dirty fluids.

The OPTI-LUX 365 is compact, lightweight and more than **twice as powerful** as most corded, high-intensity UV lamps. "Instant-on" operation enables the flashlight to reach full power immediately, and it provides up to four hours of continuous run-time. The rugged, anodized aluminum lamp body reduces corrosion and stands up to years of heavy use.

The flashlight comes complete with a lanyard, belt holster, two rechargeable batteries, smart charging cradle with AC power cord and UV-absorbing spectacles, all conveniently packaged in a padded carrying case.

For more information about the Spectroline® OPTI-LUX™ 365 (part no. OLX-365) LED leak detection flashlight, call toll-free 1-800-274-8888. Outside the United States and Canada, call 516-333-4840.

Website at www.spectroline.com

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- Minimum of 2 years experience, working on rotary screw and reciprocating air compressors.
- Possess strong mechanical and electrical abilities (including the ability to read wiring diagrams).
- Experience with refrigeration systems is a plus.
- Must have a valid drivers license and excellent driving record.
- Ability to work efficiently with minimal supervision.
- Demonstrated organizational skills and attention to detail.
- Strong problem solving skills.

Outside Sales

- Must have experience in selling air compressors and/or related equipment.
- Possess strong understanding of compressed air system design and layout.
- Must have a valid drivers license and excellent driving record.
- Ability to work efficiently with minimal supervision.
- Demonstrated organizational skills and attention to detail.
- Must be proficient in the use of Microsoft Office, email, and the internet.

We offer an excellent compensation and benefits package. Capital Compressor, Inc. is an equal opportunity employer.
Email resumes to: jlee@capitalcompressor.com or fax to: 703-365-0007

BEKO Technologies is hiring

please send cover letter and resume to: tilofruth@bekousa.com

Technical Service Personnel:

- 5-7 yrs. practical experience
- Able to understand and analyze product warranty
- Able to use ERP systems as well as MS Office
- Excellent written and verbal communication
- General knowledge and experience with customer orders
- Service technician background
- Electrical troubleshooting
- Understanding of elementary motor control
- Resolves issues in a timely manner

Product Manager/ Application Engineer:

- 3-5 yrs. experience
- Able to understand technical products and application
- Able to understand manufacturing process and customer application
- Organized
- Bilingual (Spanish/English)
- Strong technical/engineering background
- Compressed air background

Regional Sales Manager (Outside Sales, Central Territory):

- 3 yrs. experience
- Compressed air background
- Energetic, well organized
- Excellent communication skills
- Expert knowledge of MS Office
- Preferred candidate will be located in: Houston, Dallas or Austin
- 50-60% travel

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BEKO

JOBS

REGIONAL SALES MANAGER

Powerex manufactures industry leading oil-less and lubricated compressor and vacuum systems for medical, laboratory and industrial applications. The Regional Sales Manager is responsible for working with an established distributor network to expand the company's market share.

Responsibilities

- Reports to the Director of Sales
- Creates a territory business plan
- Supports the distributor's sales and marketing efforts
- Develops strong relationships with major end users
- Territory: Texas, Oklahoma and Louisiana
- A BS/BA undergraduate degree is preferred
- 5+ years of Capital Equipment sales experience required; Experience selling compressed air or vacuum systems preferred

Contact Chris Trusock at email: ctrusock@powerexinc.com with resume for employment consideration.

ASSOCIATION OF INDEPENDENT COMPRESSOR DISTRIBUTORS

"The AICD is open to all independent compressor distributors and is committed to serving the compressed air industry through education, energy conservation, and best business practices."

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- Annual meeting includes a business focused, practical, high value speaker program.
- Ford Motor Company Customer Association Incentive program offering fleet discount pricing on new vehicles.

Contact Cheryl Kiker at aicd@aicd.org or visit www.aicd.org

Job & Product Marketplace Advertising Information

Reach 13,000+ readers of Compressed Air Best Practices® Magazine with Marketplace Ads every month!

Prices are $300.00 per Job Marketplace Ad and $350.00 per Product Marketplace Ad ($300 if 6 or more ads are placed).

Contact Rod Smith at rod@airbestpractices.com to schedule your Marketplace Ads.

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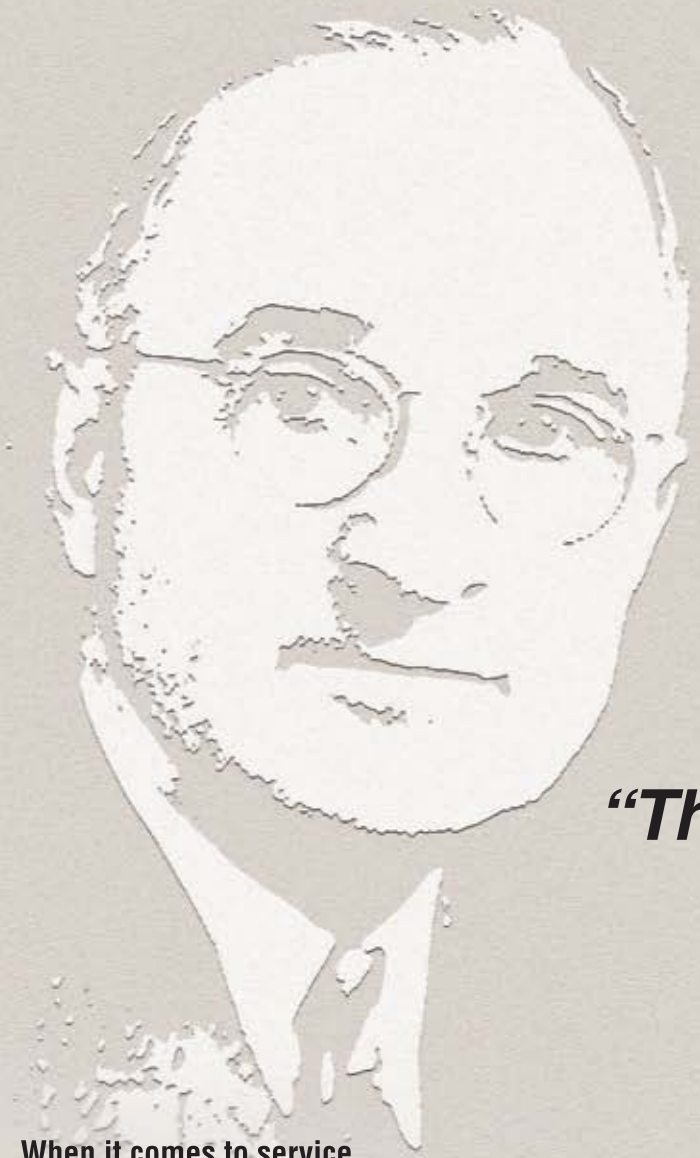

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