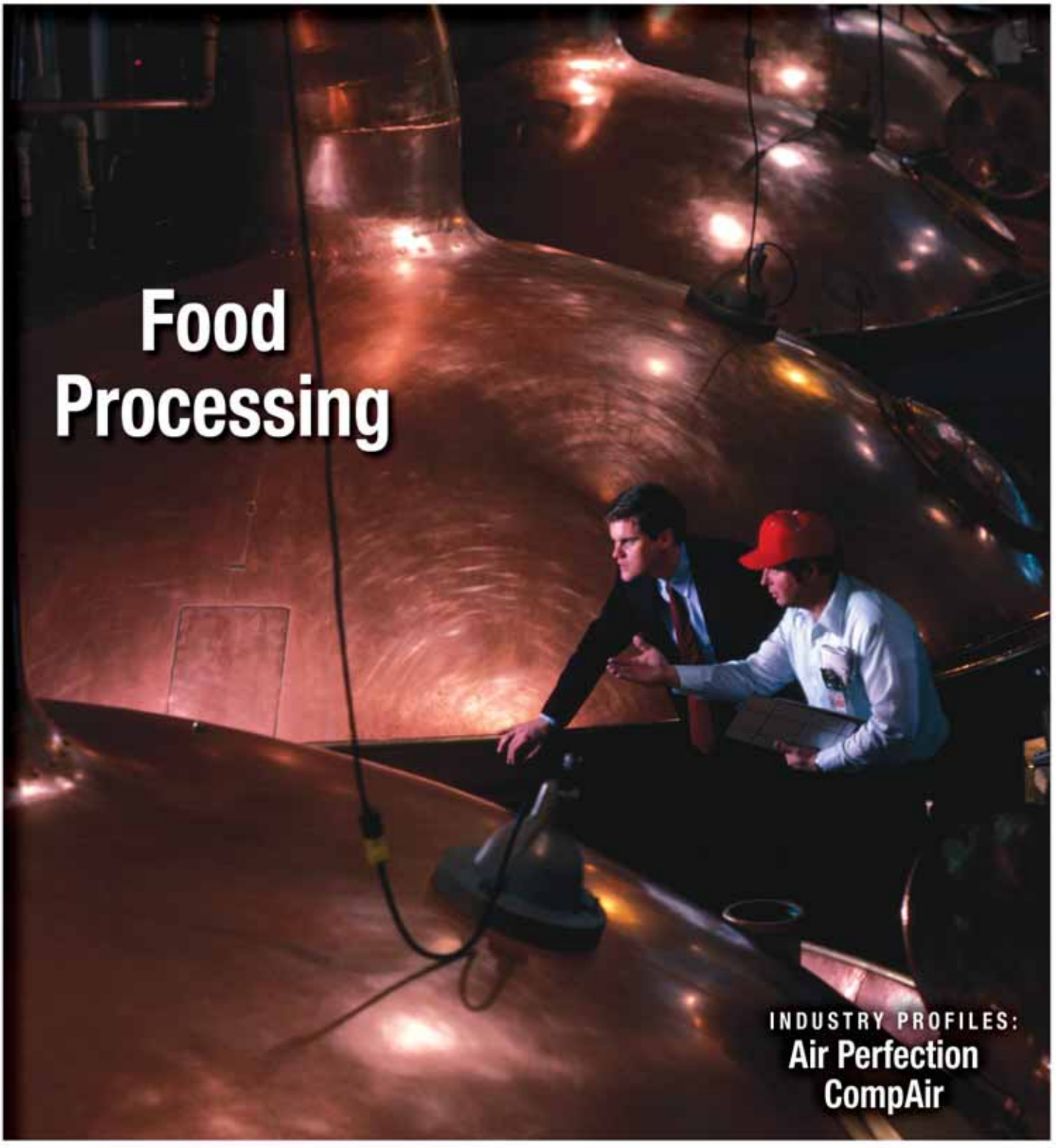
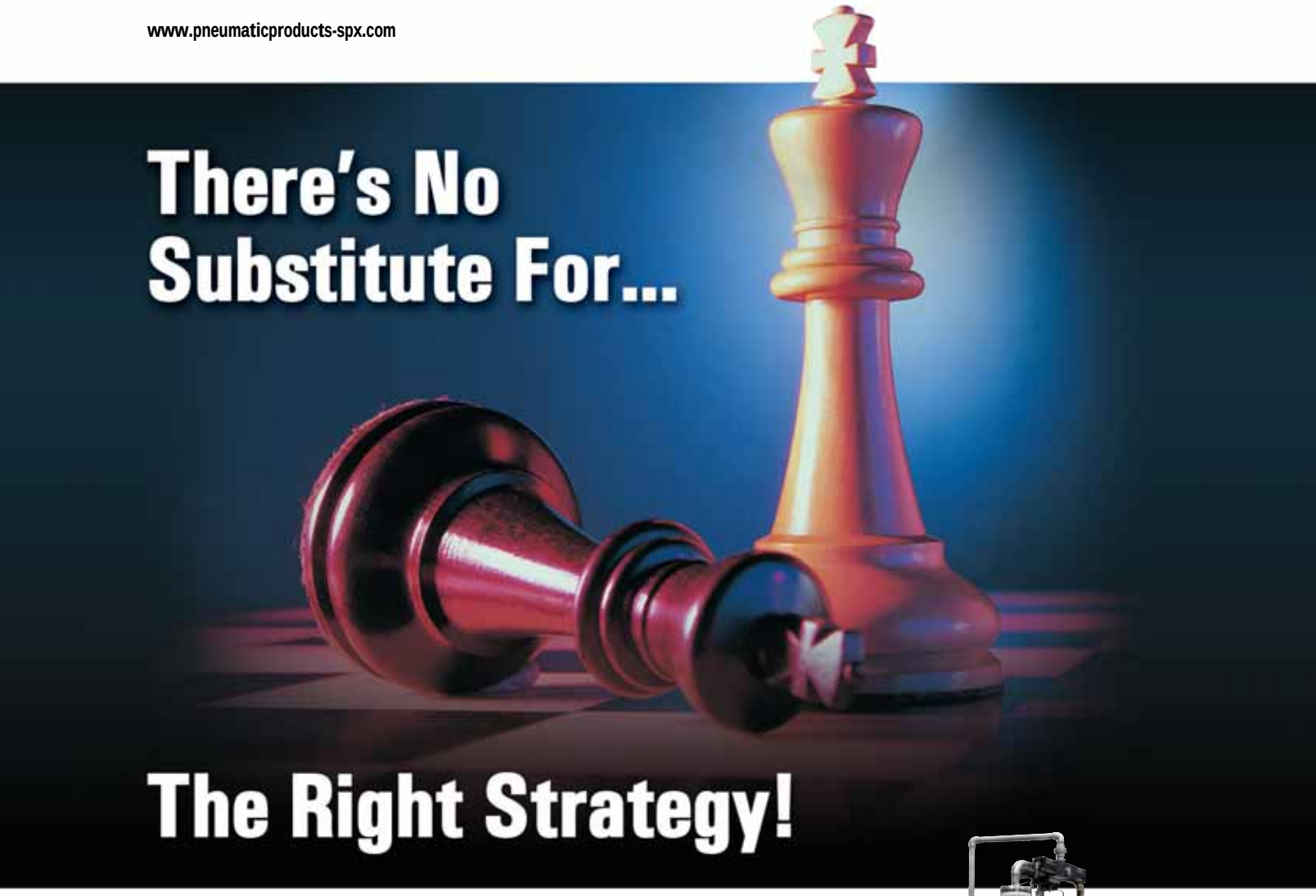
Oil-Free Air | Fruit & Vegetable Processing | Pneumatics

OCTOBER 2006

COMPRESSED AIR BEST PRACTICES™





Pneumatic Products Doesn't Play Games with the Quality of Your Compressed Air or Gas!

Engineers inherit air systems where reliability, integrity and countless devices determine the fate of productivity. The wrong moves can result in product rejects or costly downtime. The right moves keep production, profit and your career advancing. Since 1946, generations of engineers have avoided checkmate by insisting upon legendary Pneumatic Products brand air and gas treatment systems for their toughest applications in the nastiest of environments — because, **there's no substitute for the right strategy.**

- Flows to 20,000 scfm
- Pressures to 5,000 psig
- Dew Points to -100°F
- Specialty Metals
- Standard Designs or Built to Specifications

PNEUMATIC PRODUCTS
pneumaticproducts-spx.com

Phone: 352-873-5793 • Email: pneumatic.products.sales@dehydration.spx.com • www.pneumaticproducts-spx.com

FOCUS INDUSTRY FEATURES

24

PRODUCT & SERVICE FEATURES

52

Compressed Air Best Practices

JOB MARKET ADVERTISING RATES

MAGAZINE ADS

For smaller classified-type ads use the following rates per column inch:

1x per year: per column inch	$94.00*
3x per year: (i.e., this is a 10 col. inch, reversed ad)	$90.00*
12x per year:	$84.00*

*reversed ads = 1.5x normal price

Add $50.00 to post the job opening on www.airbestpractices.com when you purchase an ad in the magazine

Contact Patricia Smith for 4 color full page, 1/2 page and 1/3 page ad rates

ONLINE ONLY ADS

Each job posting is up on the site for 60 days. Postings can be purchased in bulk quantities per the rates below. The customer has twelve months to put the postings on the site. After twelve months, any unused postings will be charged at the minimum quantity.

Small Qty.	Price Per Posting	Bulk Qty.	Price Per Posting
1	$250	5-9	$185
2	230	10-24	170
3	210	25-49	150
4	195	50+	135

patricia@airbestpractices.com, tel: 251-510-2598

COMPRESSED AIR INDUSTRY ARTICLES

SUBSCRIBE NOW!

COMPRESSED AIR BEST PRACTICES

COMING EDITIONS!

Concrete, Manufacturing Productivity

IDEAL FOR:

INDUSTRY:
Plant Engineers, Plant Managers & Maintenance Managers

MANUFACTURERS:
Management, Sales, Marketing & Engineering

COMPRESSOR DISTRIBUTORS:
Every Branch Location

Rates: 12-month Subscription

Number of Subscriptions	1-10	11-19	20-49	50+
U.S.	$55.00	$50.00	$45.00	$40.00
Canada	$65.00	$60.00	$55.00	$50.00
International	$95.00	$90.00	$85.00	$80.00

3 WAYS TO SUBSCRIBE*:

1.) Call Patricia Smith at 251-510-2598 and use your VISA/Mastercard.

2.) Email us at patricia@airbestpractices.com and mail your check.

3.) Mail your information and check to:
Compressed Air Best Practices
161 Clubhouse Circle
Fairhope, AL 36532

Checks should be made out to "Smith Onandia Communications, LLC". Questions, call Patricia Smith: 251-510-2598.

*Information required:

First Name:

Last Name:

Company Name:

Street:

City:

State (Province): Zip Code:

Country: email:

Phone:

Fax:

COMPRESSED AIR BEST PRACTICES MAGAZINE

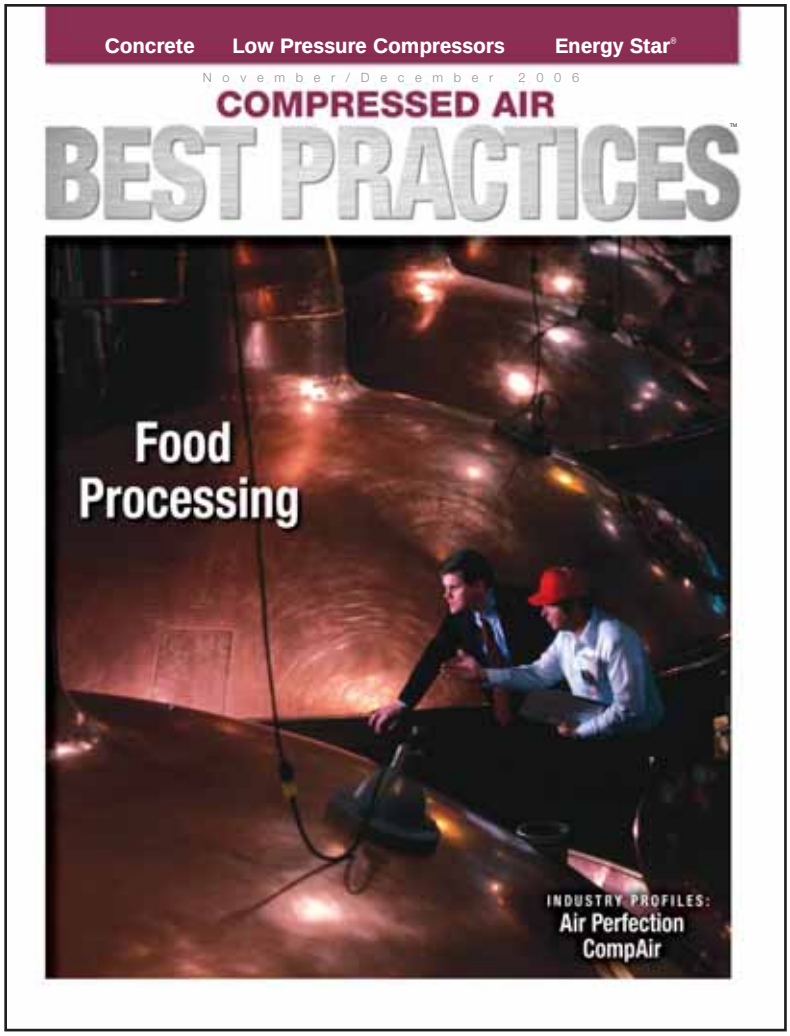
www.airbestpractices.com

Advertising & Editorial: Rod Smith
rod@airbestpractices.com
Tel: 251-680-9154

Subscriptions & Administration: Patricia Smith
patricia@airbestpractices.com
Tel: 251-510-2598

A Publication of: Smith Onandia Communications L.L.C.
161 Clubhouse Circle
Fairhope, AL 36532

COMING NEXT MONTH!



WWW.AIRBESTPRACTICES.COM

Compressed Air Best Practices is published monthly by Smith Onandia Communications LLC., 161 Clubhouse Circle, Fairhope, AL, 36532. Phone (251) 510-2598. Publisher can not be held liable for non delivery due to circumstances beyond its control. No refunds. SUBSCRIPTIONS & REPRINTS: Annual rates for one subscription: U.S. $55; Canada $65; International $95. Reprints are available on a custom basis. Contact Patricia Smith for multiple-subscription discounts, reprint quotations and customer service at (251) 510-2598 or email: patricia@airbestpractices.com. When available, extra copies of current issues are $20. Standard postage paid at 233 Jefferson Street, Greenfield Ohio 45123. Canadian and international distribution: IMEX International Mail Espress, 1842 Brummel Drive, Elk Grove Village IL 60007. POSTMASTER: Send address changes to Compressed Air Best Practices, 161 Clubhouse Circle, Fairhope, AL 36532. Printed in U.S.A.

FROM THE EDITOR

The "American Dream" Is Alive And Well

Innovation, hard work, investment, leadership, creativity, entrepeneurship, risks and rewards: these words represent the "American dream" to me and it is alive and well. I saw it first-hand, in September, at the **World Energy Engineering Conference** in Washington D.C. The conference was a gathering of energy management leaders in corporate America (most of whom are members of the Association of Energy Engineers) — along with government organizations such as the DOE and EPA. The topics focused on energy policy, future energy sources, and technologies available today to better manage energy in industry.

Energy policy is a hot topic in D.C. and that's good news for alternative fuels. Senator Martinez (R-FL) and Senator Dorgan (D-ND) made impressive speeches about the urgent need for energy independence in U.S. energy policy. They painted the sober scenario of how the U.S. consumes 25% of the world's oil production, with 60% of our supply coming from abroad. We would be in real trouble if oil supply was blocked. Living in the Gulf Coast, the past couple of years, has made me realize that supposedly impossible, worst-case, scenarios are possible. Unprecedented government funding is now supporting research and production of alternative fuels and renewable energies such as ethanol, wind, and solar power.

Industry consumes 37% of the nation's energy and corporate energy management teams have taken the lead to reduce energy costs. I spoke with energy "czars" from General Motors, California Portland Cement, Mercury Marine, Cargill, and NAVFAC (Naval Facilities Engineering Command), to name a few. These Energy Managers & Directors scoured the Conference for innovations and spoke of having assumed greater responsibilities for capital equipment purchasing in the factories of their organizations. The reason being that the greatest cost, of these purchases, is the energy cost incurred during the lifecycle of the product.

The show itself was full of energy-saving innovations that industry can use — true examples of the "American dream". Solar panels for manufacturing facilities, wireless sensors to monitor performance, and pre-engineered remote control systems were just a few of the innovations. Management of compressed air energy costs was a hot topic and Compressed Air Best Practices Magazine was made to feel most welcome in our booth.

Our own "American dream" at Compressed Air Best Practices Magazine continues to build a solid foundation and I'd like to thank our growing number of advertisers, subscribers, and editorial contributors for their support.

ROD SMITH

For feedback contact Rod at rod@airbestpractices.com

ASK the EXPERTS

This area is designed for readers of Compressed Air Best Practices Magazine who have questions regarding their compressed air systems. The editors of this magazine invite readers to email us questions and issues they may have. We will forward the questions to experts in compressed air systems with whom we work and provide answers to 100% of the questions. We will choose a few questions, each month, and print them in the magazine so that others may learn from the process.

Please note that answers provided are done so with limited information. Answers should be considered guidelines to consider. In no way, do the writers or this magazine assume responsibility for any actions taken as a result of these answers. Questions may be sent to rod@airbestpractices.com

Question #1 Massillon, OH

We manufacture various small containers of specialty food items for restaurants. We use quite a few vacuum generators and ejectors in our packaging and palletizing. One of my foremen attended a compressed air energy seminar and was told these are a great waste of air and shouldn't be used. Is this true?

> "...a centralized vacuum system may be the best selection..."

The facts are, that when properly applied and controlled, the venturi-driven vacuum generator can be the more energy-efficient method to operate. If there is enough vacuum flow being constantly removed and the total system gets up to a 20–25 hp positive displacement with a vacuum pump system, the central system will look very good. With this type of vacuum system, after you reach 14" of vacuum and continue to pull down the actual energy to hold the lower vacuum, the required electrical energy falls at the pump. However there are other things to consider. For example, "cycle time" is an important consideration for packaging lines and case erectors.

The Venturi generator can be located right at — or even on the cup — creating a very short reaction time allowing high cycle rates. A centralized system may or may not be able to match this. We have found in our plant evaluations that, if there is 250 cfm or more to be evacuated in a given area, a centralized system may be the best selection from an energy standpoint. This, however, should be verified for each application taking into consideration such things as cycle time, evacuation air per cycle, maximum vacuum required, and reliability.

In order to create a vacuum, some kind of air pump or vacuum pump is required to evacuate the volume. There are two basic approaches to accomplish this task: mechanical pumps and vacuum generators (or ejector pumps). Mechanical pumps usually have an electric motor as a power source for industrial applications. The "design" resembles compressors — both in lubricated and non-lubricated types. There are two basic types of mechanical pumps.

1. Blowers (e.g., regenerative and centrifugal) — suitable for larger volumes and low maximum vacuum requirements. These units are slower to start up and run down.

2. Positive displacement (e.g., vane, piston and screw) — suitable for high vacuum and flow requirements.

Generally, mechanical pumps are used on centralized vacuum systems, which usually require "higher volume" capabilities. Use of positive displacement pumps is most effective where the user requires a continuing large volume flow at a sustained high maximum vacuum. For requirements beyond an average of 14 inches of mercury vacuum pressure, the input kW to the pump will be reduced as the vacuum increases due to the lower mass flow of air being handled.

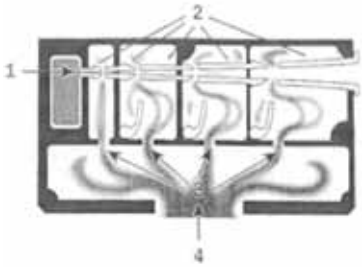
Vacuum generators (or ejector pumps) are often selected for more localized or "point of use" vacuum applications, due to the smaller volumes they handle and their faster local response times. Manufacturers of production machinery often supply them as standard equipment. There are two basic types of ejector pumps: single-stage vacuum generators and multi-stage vacuum generators.

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

- The Venturi pump should only be "on" when vacuum is actually needed for production.
- Cycles and software should be designed to perform with a minimum amount of "on time". When using vacuum generators, for example, on a palletizer with a "slip-sheet", if the cycle is one slip-sheet every four minutes, don't have the software hold the slip-sheet with vacuum for three minutes and fifty seconds. Pick up the slip-sheet ten seconds before it is needed.
- Run all vacuum generators at the lowest acceptable pressure which correlates to the lowest effective flow.
- Be careful how you turn the vacuum generator "off". Many times we see the vacuum "shut off" by closing the vacuum line. This does shut off the vacuum but compressed air flow is still on! To stop the vacuum shut off the compressed air line.
- Selecting the proper and most efficient generator for your applications is critical. These come in single stage, multi-stage and coaxial flow. Generally speaking, multi-stage units have a better ratio of compressed air consumption to vacuum flow from single stage. Each should be compared at your specific conditions.

ASK THE EXPERTS

Venturi Vacuum Generators



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

Question #2 Macedon, NY

We are a company that produces, freezes, and packages frozen meals. We have had a great deal of trouble on our belts, where moisture freezes to the surface, allowing the containers to slide all over and even fall off the moving belt. We have tried various belt materials and they all have the same problem. Recently, we added twenty-one ¼" tubes blowing compressed air onto the belts. This works very well because the air is hot enough to keep the moisture from freezing.

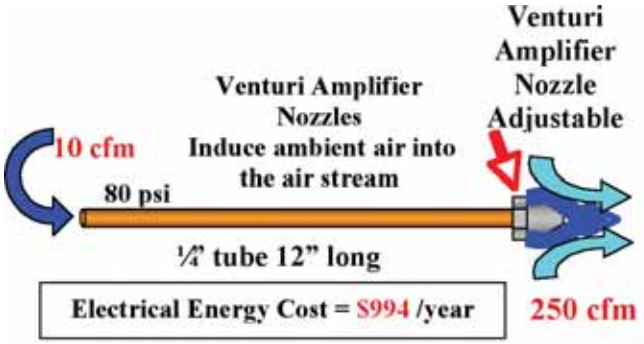
My boss came down and said that this was much too expensive a way to do this because of the cost of compressed air. I don't know the cost of our air or how much air I am using. I also don't know of another way to do it! What can you tell me?

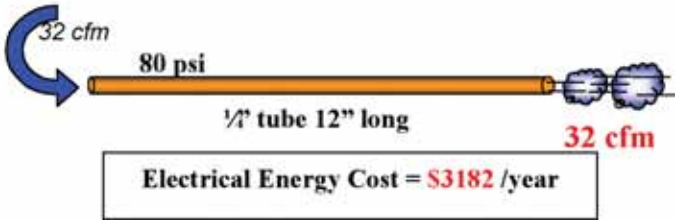
We have seen this same problem in many operations similar to yours. Many people have no idea what their compressed air processes cost. Twenty-one ¼" tubes will use quite a lot of compressed air. At a power rate of $0.06 per kWh, 8,000 hours a year, and an average single-stage rotary screw compressor supplying the air (4,0 cfm/input hp), your air will cost about $100 cfm/year. Twenty-one ¼" open blows, even at 40 psig inlet pressure to the tube, will probably use about 20 cfm each for a total of 420 cfm or 105 input hp (78.33 input kW). Running 8,000 hours/year at $0.06 /kWh = 78.33 x 8,000 x .06 = $37,598 per year or $89.52 cfm/year. This, of course, is using a compressed air supply at full load efficiency, which most multiple-unit air systems do not realize. If the efficiency fell off by just 10% for part load operation, the cost would go to $99.47 cfm/year. For this purpose, let's say it is costing you at least $40,000/year in electrical energy plus any associated maintenance, repair, capitalization costs, etc. to perform this function.

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

- Use high pressure compressed air only as a last resort
- All blow off air should be regulated
- All blow off air should be regulated to the lowest effective pressure—higher pressure means higher flow, which may not be needed
- Use Venturi air amplifier nozzles whenever and wherever possible. This will usually reduce blow-off air by at least 50%, freeing up more air-flow for other applications. These should also be regulated.
- All blow-off air should be shut off (automatically) when not needed for production
- Always consider low-pressure compressors or blower-supplied air.

One savings approach is to use an **air amplifier**, which requires less compressed air. Air amplifiers use "Venturi" action to pull in significant amounts of ambient air and mix it directly into the air stream, which amplifies the amount of air available at the point of use. Air amplifiers have amplification ratios up to 25:1. Using 10 cfm of compressed air can supply up to 250 cfm of blow-off air to the process and generate a savings of 15 cfm of compressed air per ¼" blow off.





Another savings approach, to be investigated, is the use of "blower generated" low-pressure air. This air is much less costly to produce on a $/scfm basis. It is the volume of air (scfm) that creates the mass or weight of the air that performs the blow-off. The pressure influences the "thrust" out to the end of the nozzles where it quickly dissipates. Often a "higher volume," or weight of air, at a lower thrust (pressure) improves productivity and quality of the blow-off over the higher-pressure version.

Let's see what each of these moves does to your project. You are currently using 420 cfm of high-pressure air to blow on the belts, at approximately a $40,000 per year, direct energy cost.

If we were to put 25:1 air amplifiers on this, we will reduce each blow to 10 cfm of high-pressure compressed air and deliver 250 cfm of total air to the project at room temperature, which may be (and probably is colder than the compressed air). However, we now have 5,250 cfm of cooler air flowing over the belt. For estimating purposes, let's assume we can accomplish the goal with just 16 blow offs (4,000 cfm). We would be using 160 cfm at 100 psig or 40 input hp/29.84 kW. Annual energy costs equal $29.84 x .06 x 8,000 hrs by the cost or $14,323 year or a savings of $25,626 per year. The cost of these nozzles installed with regulation, as needed, will be about $6,500 to $7,500.

What about a blower? We could go back to a 500 cfm-class blower at 15 to 18 psig, which can easily be set up to deliver warmer air than you are now using — about 48% input hp or 35.8 kW x .06 x 8,000 = $17,187 /year in electrical energy operating cost. This 50-hp class blower will be significantly more expensive than the blow-off nozzles.

After this exercise, you must determine if the projected savings is worth a look. The amplifier nozzles look to be a "no brainer" kW initial cost and plenty of room for error. The blower, on the other hand, may require some more review. Can it be smaller? Can it be lower pressure? What are the maintenance costs? This is a commitment to a larger capital expenditure. Can you set up a blower system and pull other processes in to increase the savings impact? Do you already have a blower system nearby? These questions don't generate simple yes or no answers, but following this trail can lead to "lotsa Gold"!

Answers provided by Hank Van Ormer. Mr. Van Ormer is a leading compressed air systems consultant who has implemented over 1200 air improvement projects. He can be contacted at (740) 862-4112, email: hankvanormer@aol.com, and www.airpowerusainc.com

PROMOTING ENERGY EFFICIENCY IN FRUIT AND VEGETABLE PROCESSING: THE ENERGY STAR®

BY ERIC MASANET AND ERNST WORRELL, LAWRENCE BERKELEY NATIONAL LABORATORY

The ENERGY STAR for Industry Program

ENERGY STAR is a voluntary government program that offers businesses and consumers a broad range of resources on the best in energy efficiency to help save money and protect the environment. The ENERGY STAR for Industry Program works directly with U.S. manufacturers to help them improve competitiveness through improved energy management, increased energy efficiency, and reduced environmental impact.

To date, the ENERGY STAR for Industry program has established eight different Industrial Focuses in partnership with specific energy-intensive industries in the United States. Current and past Industrial Focuses include motor vehicle manufacturing, corn refining, cement manufacturing, breweries, petroleum refining, glass manufacturing, pharmaceutical manufacturing, and food processing. Many of the companies participating in these Industrial Focuses have reported significant cost and energy savings and have gone on to receive recognition as leaders in energy efficiency and environmental performance.

As part of each Industrial Focus, participating companies have access to energy professionals who offer assistance to plant energy managers and share proven,

Box 1: The Energy Guide for Fruit and Vegetable Processing Plants

The forthcoming Energy Guide, which is titled Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry: An ENERGY STAR® Guide for Energy and Plant Managers, will be publicly released by the U.S. EPA in early 2007. The Energy Guide is designed to reduce information barriers by providing plant and energy managers with a concise source of state-of-the art information on energy efficiency measures applicable to their plants. The Energy Guide contains detailed information on over 150 energy efficient technologies and energy management practices applicable to the typical fruit and vegetable processing plant in the following categories:

Given the importance of water as a resource in fruit and vegetable processing, the Energy Guide also contains a chapter on proven measures for plant-level water efficiency.

FOR INDUSTRY PROGRAM

non-proprietary approaches for improving corporate energy management. An annual Industrial Focus forum is also held, where companies can openly discuss non-confidential issues confronting their energy management programs.

ENERGY STAR also offers each Industrial Focus two key management tools for improving plant-level energy performance: (1) the plant Energy Performance Indicator (EPI), which is a software tool that allows individual plants to benchmark their energy performance against industry peers using data from the U.S. Census Bureau, and (2) the Energy Guide, which discusses a wide variety of energy efficiency opportunities applicable to plants within the focus industry, including information on best practices for compressed air system efficiency.

The Energy Guides are researched and authored by Lawrence Berkeley National Laboratory (LBNL) in partnership with ENERGY STAR and participating focus companies. The Energy Guides are used by energy managers to identify areas for energy efficiency improvements, to evaluate potential energy improvement options, to develop action plans and checklists for plant-level energy management, and to educate company employees on the importance of and actions for improved energy efficiency.

LBNL recently developed an Energy Guide for fruit and vegetable processing plants as part of the ENERGY STAR Industrial Focus on food processing, which is due for public release in early 2007.[1] This Energy Guide contains an overview of industry trends and energy use as well as detailed information on over 150 energy efficient technologies and energy management practices applicable to the typical fruit and vegetable processing plant (see Box 1). This article provides a brief summary and advance preview of information contained in the forthcoming Energy Guide.

THE ENERGY STAR® FOR INDUSTRY PROGRAM

The U.S. Fruit and Vegetable Processing Industry

The U.S. fruit and vegetable processing industry is comprised of manufacturing plants primarily engaged in the canning, freezing, and dehydrating of fruits and vegetables. Many of the industry's products are staples in the typical American home, including frozen concentrated orange juice, canned tomato sauces, ketchup, frozen French fried potatoes, canned soups and stews, pickles, frozen fruits and vegetables, dehydrated potatoes, and fruit jams and jellies. In 2003, the U.S. fruit and vegetable processing industry processed nearly 33 billion pounds of fresh fruits and nearly 55 billion pounds of fresh vegetables into canned, frozen, and dehydrated end use products.[2]

Some key industry statistics are summarized in Table 1. In 2004, the U.S. fruit and vegetable processing industry generated nearly $38 billion in product shipments, or about 7.5% of the value of shipments of the entire U.S. food industry.[3,4] Nearly one-half of the industry's total value of product shipments is generated by fruit and vegetable canneries.

The U.S. fruit and vegetable industry currently employs around 112,000 people at over 1,300 plants.[5] Together, the three states of California, Oregon, and Washington account for roughly 40% of all employment and one-third of all plants, which demonstrates the importance of the entire Pacific Coast agricultural region to the industry.

Most plants in the U.S. fruit and vegetable processing industry are fairly small enterprises: Roughly two-thirds of the industry's facilities employ fewer than 50 people, and nearly 80% of the industry's facilities employ fewer than 100 people. Large processing facilities with 500 or more employees are somewhat of a rarity in the industry, accounting for only 3% of all plants.[6]

TABLE 1. U.S. FRUIT AND VEGETABLE PROCESSING INDUSTRY OVERVIEW

Industry value of product shipments, total (2004)	$38 billion
Fruit and vegetable canning	$18 billion
Frozen fruits, juice, and vegetables	$9 billion
Specialty canning (e.g., soups and stews)	$7 billion
Dried and dehydrated fruits and vegetables	$4 billion
Industry employment (2004)	112,000
Industry establishments (2004)	1,325
Total pounds of fresh vegetables processed per year (2003)	55 billion
Total pounds of fresh fruits processed per year (2003)	33 billion
Value of industry exports (2003)	$3 billion
Major fruit and vegetable processing states	California, Washington, Oregon, Florida, Wisconsin, New York

Oranges, tomatoes, and potatoes are the highest volume crops processed in the United States by a significant margin. Oranges represent nearly one-half the mass of all fruits processed in the United States each year, primarily for fresh, canned, and concentrated orange juice products. Together, tomatoes for canning (e.g., for canned pizza and spaghetti sauces, ketchup, salsa, and tomato paste) and potatoes for freezing (e.g., for frozen French fried potatoes, potato patties, and puffs) comprise nearly two-thirds of the total mass of vegetables processed each year.

Energy Use

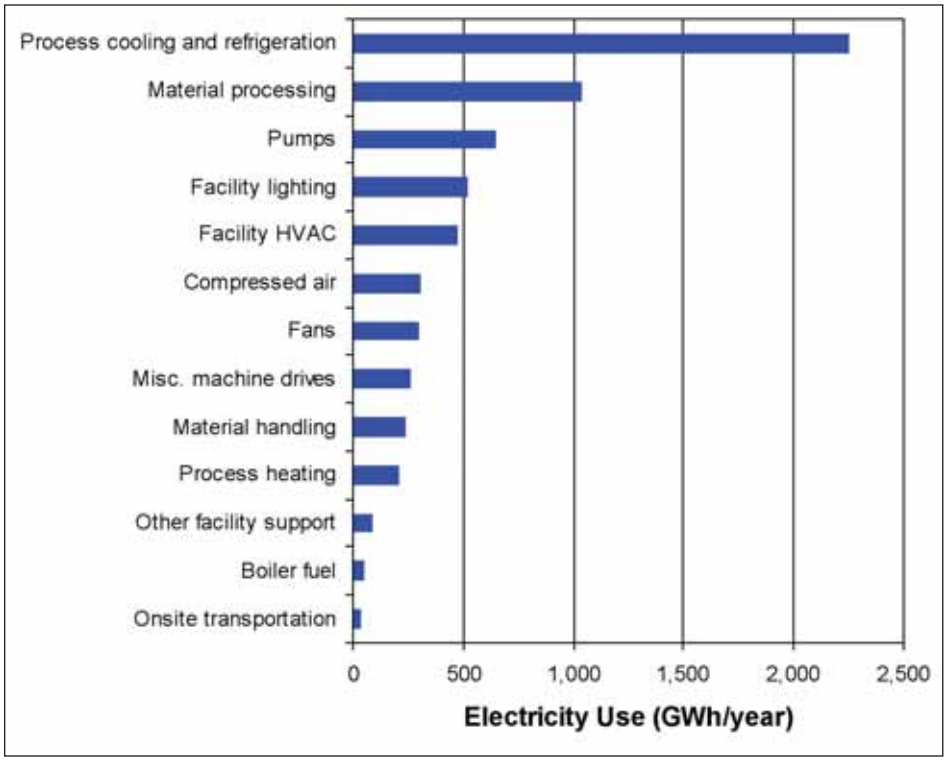
Energy represents a significant operating cost to the U.S. fruit and vegetable processing industry. In 2002, the industry spent nearly $810 million on purchased fuels and electricity, or roughly 4.5% of the industry's total cost of materials.[8] Of this, $370 million was spent on purchased electricity and $440 million was spent on purchased fuels (primarily natural gas).

Boiler systems represent the most significant end use of purchased fuels in the U.S. fruit and vegetable processing industry, accounting for roughly 80% of all purchased fuel use.[9,10] Boiler systems are used extensively for the generation of steam in common food process heating applications such as blanching, evaporating, sterilizing, and pasteurizing as well as for facility water heating and cleaning applications. The remaining 20% of purchased fuels is used for direct process heating applications (e.g., natural gas-fired dehydrators), for facility heating, and for on-site generation of electricity.

The major end uses of electricity in the industry are summarized in Figure 1.[11] Electricity is used throughout the typical fruit and vegetable processing plant to power motors, conveyors, compressed air systems, and pumps, as well as building lighting and heating, ventilation, and air conditioning (HVAC) systems. As can be seen in Figure 1, the most significant end use of electricity in the industry is refrigeration, which is used for process cooling, cold storage, and freezing applications. For all end uses, the U.S. fruit and vegetable processing industry consumed a total of 6.7 terawatt-hours (TWh) of electricity in 2002, or nearly 10% of the electricity consumed by the entire U.S. food industry.[12]

In many fruit and vegetable processing plants, compressed air systems are used for air cleaning of containers prior to product filling, automated product sorting, and product packaging systems. While compressed air systems do not represent the most significant use of electricity in fruit and vegetable processing plants, the total electricity consumption of compressed air systems across the industry is nonetheless significant. In 2002, the U.S. fruit and vegetable processing industry's compressed air systems consumed an estimated 310 gigawatt-hours (GWh) of electricity, enough electricity to power nearly 30,000 American households for an entire year.[13] The implementation of best practices for compressed air system energy efficiency therefore represents an important strategy for reducing plant-level energy use and utility costs.

Figure 1. Estimated Breakdown of Electricity Use in the U.S. Fruit and Vegetable Processing Industry, 2002



THE ENERGY STAR® FOR INDUSTRY PROGRAM

"The U.S. fruit and vegetable industry currently employs around 112,000 people at over 1,300 plants"

Best Practices for Compressed Air Systems

Many opportunities to reduce energy consumption in compressed air systems are not prohibitively expensive; in fact, payback periods for some options (such as improved system maintenance) can be extremely short. Energy savings from compressed air system efficiency improvements can typically range from 20% to 50% of total system electricity consumption.[14] The Energy Guide for fruit and vegetable processing plants provides detailed information on a number of proven, cost-effective measures for improving the energy efficiency of compressed air systems. A summary of the efficiency measures discussed in the Energy Guide is provided in Table 2.

TABLE 2. SUMMARY OF COMPRESSED AIR SYSTEM ENERGY EFFICIENCY MEASURES DISCUSSED IN THE ENERGY GUIDE FOR FRUIT AND VEGETABLE PROCESSING PLANTS

System upgrades and improvements	Improved load management
Improved maintenance	Pressure drop minimization
System monitoring	Inlet air temperature reduction
Leak reduction	System controls
Turning off unnecessary compressed air	Properly sized pipe diameters
Modification of system in lieu of increased pressure	Heat recovery
Replacement of compressed air by other sources	Natural gas engine-driven compressors

Information on best practices for compressed air system energy efficiency was compiled by LBNL from a wide variety of sources, including U.S. Department of Energy's (DOE) Industrial Technologies Program Best Practices publications, the International Energy Agency's Centre for Analysis and Dissemination of Demonstrated Energy Technologies (CADDET) database, the U.S. DOE's Industrial Assessment Centers database, journal articles, and industry publications.

Often, plant and energy managers do not have the time, budget, or resources to obtain such detailed information on efficient technologies or improved efficiency practices. This lack of information can be a major barrier to industrial energy efficiency improvement at many U.S. plants. The aim of the Energy Guide

Box 2: Compressed Air System Efficiency Case Studies

Case studies that illustrate the successful application of energy efficiency measures in actual industrial plants are one of the key components of the Energy Guides. Case studies allow plant and energy managers to assess potential cost and energy savings in real-world applications, and arm them with powerful peer examples for making the case for energy efficiency investments within their own organizations. An example case study contained in the Energy Guide for fruit and vegetable processing plants is provided at right.

Improvements to system controls and load management

Yasama Corporation U.S.A., a manufacturer of soy sauce, installed new compressor system controls at its Salem, Oregon facility in 2004. Previously, the company ran its three compressors using inefficient individual load/unload controls. Additionally, the company added two 2,200 gallon air storage receivers to help handle the facility's short-term peak loads. Under the new control strategy, the three compressors were sequenced to run most efficiently, leading to annual energy savings of 100,000 kWh and annual electricity savings of $5,100. Additionally, the new control system allowed the company to better manage the total operating hours of each compressor as well as the number of starts per unit per hour, helping to reduce compressor wear and tear.[15]

is therefore to reduce this information barrier by providing plant and energy managers with a concise source of state-of-the art information on energy efficiency measures applicable to their plants, while also arming them with enough basic information to understand the potential energy and cost savings associated with each measure.

In the discussion of each energy efficiency measure, the Energy Guide typically provides:

- A brief description of the efficiency measure, including any limitations on applicability
- An estimate of typical energy savings associated with the measure
- An estimate of typical cost savings associated with the measure, including the simple payback period associated with any investments
- An industrial case study to illustrate successful application of the measure, when available (see Box 2)
- References to publicly-available sources of additional information

Plant and energy managers are encouraged to consult the references and tools recommended in the Energy Guide to facilitate a more in-depth assessment of the applicability of any given energy efficiency measure to their specific plant.

Additional Information

For additional information on the ENERGY STAR for Industry Program, please visit: www.energystar.gov/industry. For information on the forthcoming Energy Guide for fruit and vegetable processing, please contact: Eric Masanet, Lawrence Berkeley National Laboratory, Phone: (510) 486-6794, Email: ermasanet@lbl.gov.

End Notes

[1]*Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry: An ENERGY STAR® Guide for Energy and Plant Managers. By Eric Masanet, Ernst Worrell, Wina Graus, and Christina Galitsky. Lawrence Berkeley National Laboratory, Berkeley, California. LBNL-59289. Forthcoming.*

[2]*United States Department of Agriculture (2005). Food Consumption (Per Capita) Data System. United States Department of Agriculture, Economic Research Service, Washington, D.C.*

[3]*United States Census Bureau (2005). Annual Survey of Manufactures, Value of Product Shipments: 2004. United States Department of Commerce, Washington, D.C.*

[4]*United States Census Bureau (2005). Annual Survey of Manufactures, Statistics for Industry Groups and Industries: 2004. United States Department of Commerce, Washington, D.C. Report M04(AS)-1*

[5]*United States Census Bureau (2005). County Business Patterns Database. United States Department of Commerce, Washington, D.C.*

[6]*Ibid.*

[7]*United States Department of Agriculture (2005). Food Consumption (Per Capita) Data System. United States Department of Agriculture, Economic Research Service, Washington, D.C.*

[8]*United States Census Bureau (2004). 2002 Economic Census, Manufacturing, Industry Series. United States Department of Commerce, Washington, D.C.*

[9]*United States Department of Energy (DOE) (2005). Manufacturing Consumption of Energy 2002 Data Tables. Energy Information Administration, Washington, D.C.*

[10]*United States Department of Energy (DOE) (1997). Manufacturing Consumption of Energy 1994. Energy Information Administration, Washington, D.C.*

[11]*Estimated using energy consumption data from the U.S. DOE Manufacturing Consumption of Energy, 2002 and 1994 data tables, and electricity end use breakdown data for motors from U.S. DOE (1998), United States Industrial Motor Systems Market Opportunities Assessment, Office of Industrial Technologies, Washington, D.C.*

[12]*United States Census Bureau (2005). Annual Survey of Manufactures, Statistics for Industry Groups and Industries: 2003. United States Department of Commerce, Washington, D.C.*

[13]*According to the U.S. DOE's 2001 Residential Energy Consumption Survey, the average American household consumes 10,656 kWh/year.*

[14]*Efficiency Partnership (2004). Industrial Product Guide — Manufacturing and Processing Equipment: Motors. Flex Your Power, San Francisco, California.*

[15]*Food Processing Industry Resource Efficiency (FIRE) Project (2005). Achieving More Production and Better Quality Using Less Energy. Case Study of Yasama Corporation U.S.A. Northwest Food Processors Association, Portland, Oregon.*

Compressed Air Auditing at an Organic Food Processor

BY JIM MORGAN

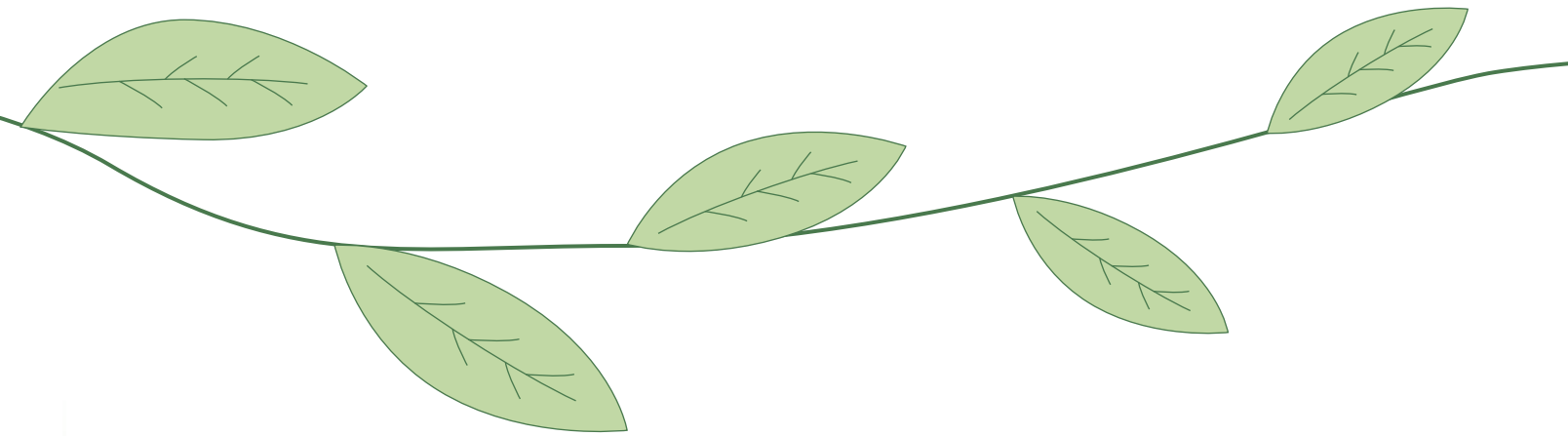
A processor & packager of organic foods, located in California, was having trouble with their packaging equipment. Every four-to-five hours, the packaging machines would shut down — causing very expensive work stoppages. It was determined that the cause was that the plant air pressure was occasionally dipping below the minimum pressure requirement, of the packaging machines, of 95 psig air pressure. The facility was unable to determine why this was happening and called Air Perfection Inc. to conduct a compressed air system audit.

Jim Morgan, the Director of the Energy Management Group at Air Perfection Inc., visited the facility and began the audit methodology, his firm uses, to analyze a system. This article will walk the reader through the methodology, which led to a successful result for this packaging company.

Step 1: Determine the actual capability and condition of the individual supply equipment including the compressors, dryers, filters, and cooling systems, etc.

The system had three fixed-speed rotary screw air compressors. The air compressors were loading and unloading frequently, in response to changes in plant air pressure. A rental air compressor was on-site to supply extra air when the line-stoppages occurred.

The compressed air was then treated by three heatless desiccant air dryers. They provided a -40˚ F pressure dew point. The heatless desiccant air dryers had pre- and after-filters to remove solid contaminants from the system. The compressed air was then sent to the plant where roughly 40% of the air was introduced into a nitrogen generator to produce nitrogen for the packaging of the product in the bags. Nitrogen maintains the freshness of the produce in the package during it's shelf life. During the initial visit, everything was functioning well — aside from the costly load/unload situation for the air compressors. Plant air pressure was being maintained above the minimum of 95 psig and the air quality was fine. The plant personnel, however, told us that this was typical. Everything runs perfectly for four-to-five hours, and then boom — the line shuts down due to insufficient pressure.



Step 2: Measure the storage capabilities of the system and its relationship to the changes in air demand that occur in the system. Determining the demand event sizes and comparing them to the relationship of supply power and storage is key to stabilizing the system pressure and often provides major opportunities for efficiency improvement.

Amperage meters were hooked up to the air compressors and tied into data loggers and left to run. After a few days, the data was reviewed and it became clear that a significant energy-savings opportunity existed. Under normal production loads, two air compressors were shouldering the work. They were loading and unlading frequently which was raising the kW consumption. This signaled for an opportunity to save energy using variable speed air compressors. The compressors were also producing air at 130 psig to compensate for pressure losses in the air system. Knowing that the required air pressure was 95 psig, the path towards achieving savings was apparent.

Table 1: Existing System Under Normal Production Load

ROTARY-SCREW AIR COMPRESSORS	BHP	KW	SCFM	% LOAD	SCFM /BHP
Fixed-Speed Unit #1	116	94.1	308	35%	2.66
Fixed-Speed Unit #2	188	152.4	687	78%	3.65
Fixed-Speed Unit #3	0	0	0	0%	0
Totals	304	247	995		3.27

130 psig discharge pressure

Table 2: Existing System Under Peak Production Load

ROTARY-SCREW AIR COMPRESSORS	BHP	KW	SCFM	% LOAD	SCFM /BHP
Fixed-Speed Unit #1	119	96.5	308	35%	2.59
Fixed-Speed Unit #2	194	157.5	745	85%	3.84
Fixed-Speed Unit #3	198	160.2	744	85%	3.77
Totals	511	414	1,797		3.52

130 psig discharge pressure

Table 3: Existing System Energy Costs

EXISTING SYSTEM	BHP	KW	HOURS	KWH	COST
Normal Production Load	304	247	4,250	1,047,643	$136,194
Peak Production Load	511	401	4,250	1,704,540	$221,590
Totals			8,500	2,752,184	$357,784

Average electrical rate of 13 cents/kWh

Step 3: Evaluate the air users in the system including waste, leaks, artificial demand, and inefficient applications.

The system was carefully reviewed to determine what was causing the large drops in pressure. A representative from the local utility company was invited to the facility to review the findings and begin the process to qualify the proposed project for a rebate from the utility company. The following areas were identified.

- The heatless desiccant air dryers were EACH purging up to 14% of the air to ambient. Heatless desiccant dryers use a percentage of the compressed air to regenerate the tower that is off-line. The dryers were also piped to the air compressors in a manner which allowed all three air dryers to be under pressure even when only one air compressor was working. The "off-line" dryers, under normal production, were still cycling and purging air! The dryers were set for five minute cycles, to facilitate a -40˚ F dew point. Often the dryers would purge simultaneously and create a sudden loss of up to 42% of the compressed air capacity! This was the main cause of the sudden air pressure losses in the system.

  The recommendation was made to reduce the dew point specification to 0˚ F. This permitted the three heatless dryers to be replaced by one heated desiccant dryer which only purges 7% of the air — a tremendous savings. There are many installations with dew point specifications of -40˚ F which are unnecessary and costly.

COMPRESSED AIR AUDITING AT AN ORGANIC FOOD PROCESSOR

"Made with Organic Ingredients must contain 70% organic ingredients by weight."

- The facility used many timed solenoid valves as condensate drains. These drains have timers which open the valves to use compressed air to blow out the condensate for the set number of seconds. Invariably, the valves are open longer than necessary and simply waste compressed air. There were multiple solenoid valves all over the facility wasting air.

  The recommendation was made to replace the timed solenoid valves with electronic demand drains. These drains utilize internal sensors, which open and close depending upon the amount of condensate they hold. They do not use any compressed air and are also known as "zero air-loss" condensate drains.

Table 3: Existing System Demand Graphs

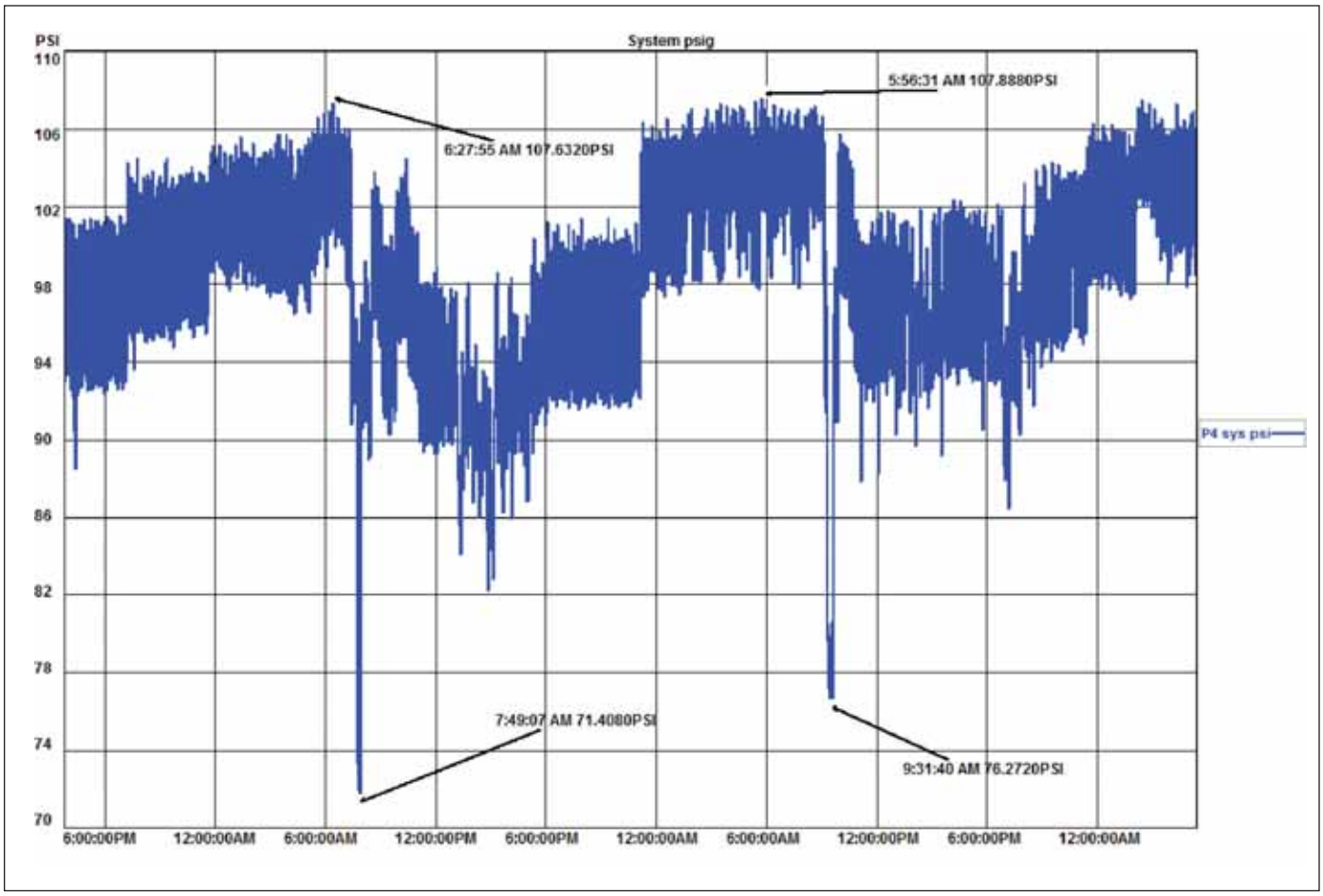
NORMAL LOAD	LOW	MEAN	HIGH	RANGE	
system psig	71.5	98.6	107.6	36.1	PSI

WHAT IS ORGANIC FARMING?

"Certified organic" refers to produce grown on farms that have been inspected by an independent, third-party certifier. The certifier ensures that a certified organic farm complies with strict National Organic standards set by the United States Department of Agriculture. To earn certification, organic farms must:

- Have long-term soil management plans.
- Establish buffers between their fields and nearby conventional farms.
- Meet specific requirements for labeling and record keeping.
- Use no chemical herbicides, fumigants, or synthetic fertilizers and no unapproved pesticides on soil or produce.
- Keep detailed records of all the materials used in their growing operations.
- Observe a 3-year transition period for fields that have been farmed conventionally. During this time, the field must be farmed organically. Produce grown on this land may not be labeled "organic" until the 3-year transition period is completed."

Annual certification inspections enforce these strict guidelines, so consumers have the security of knowing exactly what goes into their food.



Labeling Rules

For single-ingredient foods, such as produce:

Look for a smaller sticker with the USDA Organic seal or on the sign above the organic produce display. These foods are 100 percent organic.

For foods with more than one ingredient, there are four labeling categories:

1. 100% Organic must be just that—100% organic ingredients.
2. Organic with the USDA Seal must contain 95% organic ingredients by weight.
3. Made with Organic Ingredients must contain 70% organic ingredients by weight.
4. Products with less than 70% organic ingredients may list specific organically produced ingredients on the side panel of the package, but may not make any organic claims on the front of the package.

Environmental Best Practices:

Organic farming is known as a sustainable method of producing safe and nutritious food for many generations to come. Here is a listing of some of the benefits, published by a 22,000 acre organic farmer:

- Avoids the use of 267,000 pounds of toxic and persistent pesticides
- Avoids the use of more than 8,400,000 pounds of synthetic fertilizers
- Conserves nearly 1,381,000 gallons of petroleum by avoiding the use of petroleum-based pesticides and fertilizers
- Combats global warming because carbon dioxide, a greenhouse gas, is absorbed by organic fields at the rate of 3,670 pounds per acre, that's the equivalent of taking more than 6,000 cars off the road each year!

COMPRESSED AIR AUDITING AT AN ORGANIC FOOD PROCESSOR

"Knowing that the required air pressure was 95 psig, the path towards achieving savings was apparent."

Step 4: Analyze and provide solutions to fix applications that are not performing adequately.

The packaging machines, when analyzed, offered two areas of opportunity. One issue would eliminate the pressure problem causing work stoppages and the other would provide an opportunity to save energy.

One key packaging machine was shutting down every time the pressure went below 95 psig. Compressed air powers the pneumatic valves, actuators, and cylinders which allow the machine to function. The solution was to place a 80 gallon receiver tank, with a check valve, in front of the packaging machine, to act as a buffer between system pressure and the 95 psig required by this machine. In this manner, this storage tank will ensure that this machine always has enough air pressure to operate.

The energy-saving opportunity lay with supplying the nitrogen generator with air dried by a refrigerated air dryer — rather than air dried by the heatless desiccant air dryers. The packaging machines insert nitrogen into the plastic bags along with the produce. Nitrogen, an inert gas, maintains the freshness of the product during its shelf life. A nitrogen generator supplies the nitrogen. Compressed air is introduced into the nitrogen generator where oxygen is separated from the nitrogen. The nitrogen generator created 500 scfm of air demand — between 30–50% of the total air system air demand. Refrigerated air dryers do not purge any air and the +35 dew point they provide is dry enough for the generation of nitrogen. The solution was to pipe a separate air line from the air compressors to a refrigerated air dryer to accomplish this.

Step 5: Create a process flow diagram that depicts the general arrangement of your compressed air system, as well as the supply power and demand volume in all operating conditions.

A complete process flow diagram was supplied of both the existing and proposed installations. Variable-speed, water-cooled, rotary-screw air compressors were recommended along with the heated desiccant air dryer. A refrigerated air dryer was also proposed for the new, dedicated air-line going to the nitrogen generator. In order to allow the air compressors to operate at 95 psig, instead of 130 psig, a air storage receiver tank was recommended. A flow-controller, after the receiver tank, was also recommended. The proposed power and demand volumes are depicted in the tables below.

Table 4: Proposed System Under Normal Production Load

ROTARY-SCREW AIR COMPRESSORS	BHP	KW	SCFM	% LOAD	SCFM /BHP
New Variable-Speed Unit #1	239	193.8	995	66%	4.16
New Variable-Speed Unit #2	Auto-start				
Fixed-Speed Unit #3	Auto-start				
Totals 95 psig discharge pressure	239	194	995		4.16

Table 5: Proposed System Under Peak Production Load

ROTARY-SCREW AIR COMPRESSORS	BHP	KW	SCFM	% LOAD	SCFM /BHP
New Variable-Speed Unit #1	364	295.2	1508	96%	4.14
New Variable-Speed Unit #2	Auto-start				
Fixed-Speed Unit #3	Auto-start				
Totals	364	295	1,508		4.14
95 psig discharge pressure					

Table 6: Proposed System Energy Costs

EXISTING SYSTEM	BHP	KW	HOURS	KWH	COST
Normal Production Load	239	194	4,250	823,641	$107,073
Peak Production Load	364	280	4,250	1,189,755	$154,668
Totals			8,500	2,013,395	$261,741
Average electrical rate of 13 cents/kWh					
Projected Savings				738,788	$96,043

Step 6: Determine the total operating costs of the system including energy, maintenance, labor, cooling water, etc.

After working with the utility company representative, the project was approved for a rebate. The energy costs for the compressed air system showed a savings of $96,042 per year with a total new operating cost of $181,042 per year.

Table 7: Compressed Air System Financials Summary

CONSTITUENT	EXISTING	PROPOSED	VARIANCE
Electricity	$357,784	$261,741	$96,042
Rental Compressor	$85,000	$0	$85,000
PG&E Rebate		$59,103	$59,103
Totals	$442,784	$261,741	$181,042
Estimated Retrofit Costs		$287,154	
Simple Payback		19 months	

Step 7: Developing a prioritized action plan with capital costs and estimated installation costs for the proposed modifications to your system.

A detailed action plan outlining all the equipment required and the timing of the project was supplied. This is where project management skills are essential. Coordinating vendors, the utility company paperwork, and the contractors doing installation modifications in a timely manner is the key to delivering timely results. The payback on the project must be accomplished as projected.

Taking the time to fully understand the compressed air system paid off for this food processing company. Costly downtime was eliminated in the packaging area while a lower over-all electrical cost-base was accomplished for the compressed air system.

For more information please contact: Jim Morgan or Steve Strah, Air Perfection Inc., tel: 707-678-0573, email: jmorgan@airperfectioninc.com, sstrah@airperfectioninc.com or visit our web site at www.airperfectioninc.com

MODIFIED ATMOSPHERE PACKAGING USING ON-SITE NITROGEN GENERATION

BY ROD SMITH

"The replacement of oxygen by nitrogen, in MAP processes, is commonly done through gas-separation techniques."

The increase in consumption of raw fruits and vegetables, in the U.S., has placed tremendous demand on the food processing and packaging industry. One of the most important advancements in these industries has been the continued progress of Modified Atmosphere Packaging (MAP). MAP is a technique used for prolonging the shelf-life period of fresh or minimally processed foods. The composition of air is altered to provide optimum conditions to extend the storage and shelf-life of food/produce. Modified ambients are combined with temperature control and special packaging materials of the food products to implement MAP. Different perishable products like meat, fish, fruits, and vegetables require different MAP approaches to the three variables of temperature control, modified ambients, and packaging materials. On-site nitrogen generation, using gas separation techniques, has become an established and very efficient technique to modify the atmosphere.

Table 1: Per capita (kg) consumption of raw fruits and vegetables in the U.S.

YEAR	FRUITS	VEGETABLES
1982	38.7	52.9
1992	44.5	64.2
1997	46.7	74.4

Source: Fruit and Tree Nut Situation and Outlook Report, USDA, 1999

Modified Atmosphere Packaging (MAP)

MAP works with three gases — oxygen (O_2), nitrogen (N_2), and carbon dioxide (CO_2). The objective is to alter the composition of air (78% nitrogen, 21% oxygen, 0.03% carbon dioxide and traces of noble gases) to provide the best atmosphere, for that particular product, to reduce the rate of respiration (or decay) of the product. Replacing oxygen, which causes oxidation and assists with the ripening and maturation of fruits and vegetables, with nitrogen is the primary "gas flushing" process which takes place.

Oxygen (O_2) and Product Respiration

Normally, the concentration of O_2 in a pack is kept very low (1–5%) to reduce the respiration rate of fruits and vegetables. Reducing the rate of respiration by limiting O_2 prolongs the shelf life of fruits and vegetables by delaying the oxidative breakdown of the complex substrates which make up the product. The rate of respiration of a fruit or vegetable is inversely proportional to the shelf life of the product; a higher rate decreases shelf life. In general, those products with increased wounding, as in the case of fresh-cut produce, will have a high degree of perishability due to increased respiration rates. Therefore, a goal of MAP is to decrease the produce respiration rate, which can be successfully achieved with decreased O_2 levels

MAXIGAS
Nitrogen Gas Generators

MAXIGAS
Nitrogen Gas Generators

■Convenient, secure supply
With MAXIGAS, the gas you need is always available on demand , 24 hours a day, eliminating the risk of lost production time due to running out of gas

■The right purity
MAXIGAS systems deliver the nitrogen purity your application needs from 97% to 99.999%

■Space saver
The compact design of MAXIGAS means that our installations take up less floor space than other systems, allowing you to use it for what it's meant for - producing products and making money

■No growing pains
Unique modular design means you can simply add extra banks of MAXIGAS as your business grows and gas requirements change

■The safest supply
No worries about safety hazards of storing, handling and changing of heavy, high pressure cylinders

■Cost savings
Producing nitrogen from compressed air with MAXIGAS can cut your operating costs significantly. Typical cost as low as $0.05 per 100 cubic feet

domnick hunter

tel: (800) 345-8462
www.domnickhunter.com
Email: indgassystems@domnickhunter.com

Visit us at Process Expo,
McCormick Place, Chicago, IL
October 29 - November 2, 2006
Booth # E-6860

MODIFIED ATMOSPHERE PACKAGING USING ON-SITE NITROGEN GENERATION

(1–5%) and with refrigeration. Also, O_2 concentrations below 8% reduce the production of ethylene, a key component of the ripening and maturation process. However, at extremely low O_2 levels (that is, <1%), anaerobic respiration can occur, resulting in tissue destruction and the production of substances that contribute to off-flavors and off-odors.

MAP is used with various types of products, where the mixture of gases in the package depends on the type of product, packaging materials and storage temperature. Meat and fish need very low gas permeability films. so for non-respiring products (meat, fish, cheese etc.) high barrier films are used. The initial flushed gas-mixture will be maintained inside the MA package. But fruits and vegetables are respiring products where the interaction of the packaging material with the product is important. If the permeability (for O_2 and CO_2) of the packaging film is adapted to the products respiration, an equilibrium-modified atmosphere will establish in the package and the shelf-life of the product will increase.

"MAP is a technique used for prolonging the shelf-life period of fresh or minimally processed foods."

Nitrogen (N_2)

Nitrogen is an inert gas. It is colorless, odorless, tasteless, and nontoxic. It will not, therefore, provoke discoloration or spoilage in food products. Nitrogen has three uses in modified atmosphere packaging (MAP):

1. Displacement of O_2 to delay oxidation in food
2. Retardation of the growth of aerobic spoilage organisms
3. Perform as a filler to maintain package conformity

Strict safety guidelines for storage and handling of nitrogen are required wherever nitrogen is used to displace oxygen, in that it could act as a simple asphyxiate.

Carbon Dioxide (CO_2)

Of the three major gases used in modified atmosphere packaging, CO_2 is the only one that has significant and direct antimicrobial activity. A "greenhouse gas", carbon dioxide is a major component of the carbon cycle. The never-ending battle against microbial contamination and spoilage, in food packaging, begins with the balance between storage temperature, CO_2 content and O_2 content. These variables change, for ideal MAP, for each product. Table 2 below illustrates some examples:

Table 2: Optimum Storage Conditions of Whole Fruits & Vegetables for MAP

COMMODITY	OPTIMUM CO_2 (%)	OPTIMUM O_2 (%)	REC'D STORAGE TEMPERATURE °C	APPROXIMATE STORAGE LIFE
Whole Fruits				
Apple	1–3	1–2	0–3° C	2–11 months
Avocado	3–10	2–5	5–13° C	8–10 days
Banana	2–5	2–5	12–15° C	15 days
Vegetables				
Artichoke	2–3	2–3	0–5° C	29 days
Beans	5–10	2–3	5–10° C	7–10 days
Broccoli	5–10	1–2	0–5° C	2–3 months
Carrot	3–4	5	0–5° C	4–5 months
Cucumber	0	3–5	8–12° C	14–21 days
Lettuce (leaf)	0	1–3	0–5° C	3–4 weeks
Tomatoes				
(mature)	0	3–5	12–20° C	2 weeks
Onion	0	1–2	0–5° C	8 months

Source: Analysis and Evaluation of Preventive Control Measures for the Control and Reduction/Elimination of Microbial Hazards on Fresh and Fresh-Cut Produce, Chapter VI, Table VI-4, US FDA, Center for Food Safety and Applied Nutrition, September 30, 2001

On-Site Nitrogen Generation from the Compressed Air System

The replacement of oxygen by nitrogen, in MAP processes, is commonly done through gas-separation techniques. The two most common gas-separation techniques are pressure-swing adsorption (PSA) and hollow fiber membrane (HFM) systems. Supplied with air from the compressed air system, specific installation considerations are required to maximize productivity. Both PSA and HFM techniques offer advantages over packaged nitrogen delivered in cylinders.

Pressure-Swing Adsorption (PSA)

In a pressure-swing adsorption (PSA) system, compressed air is flown through a chamber of activated carbon such as carbon molecular sieve (CMS). Oxygen, and other noble gases, are adsorbed by the narrow-range pore openings of CMS. While the smaller oxygen molecules are adsorbed, the larger nitrogen molecules by-pass the CMS and emerge as the product gas. The PSA system regenerates the first CMS chamber by venting/flushing the adsorbed oxygen through the depressurization of the chamber. While this first chamber is being regenerated, the compressed air stream has been re-directed to a second on-line chamber which can continue the nitrogen generation process.

PSA systems effectively offer extremely high nitrogen purity to MAP applications. They are most effective for nitrogen specifications of 99.999% to 97%. These nitrogen purities ranges are what most MAP applications specify for O2 displacement.

In order to achieve these high nitrogen purity levels, PSA systems normally specify inlet air pressure dew points of -40˚ F before the air enters the chambers with oxygen-adsorbing activated carbon materials. Energy savings can be attained, by managing the purge air associated with -40˚ F pressure dew points. Some facilities unnecessarily supply the entire facility with a -40˚ F dew point air — due to the inlet air specification for the nitrogen generator. A dedicated compressed air line can be run to the packaging area.

Hollow-Fiber Membranes (HFM)

Hollow-fiber membrane (HFM) systems generate nitrogen with higher oxygen concentrations than other techniques. HFM systems are most effective for nitrogen purity specifications in the range of 90% to 99.7%. Some applications, traditionally set at 99.999%, are studying the implications and benefits of reducing their nitrogen purity specifications. Some applications include snack-food packaging and juice blanketing.

HFM membranes use the principle of selective permeation of gases to separate oxygen and noble gas molecules from nitrogen molecules. Compressed air enters the housing, where the membrane fibers are, and the undesirable gases are channeled through the interior walls of the hollow membrane fibers to a waste gas vent port. Nitrogen molecules remain on the outside of the membrane fibers are flow to the nitrogen outlet port as enriched nitrogen.

Purge air is also a factor to be considered with HFM systems and must be managed to reduce energy costs. Air flow, inlet temperature, and inlet dew point can all have significant impacts on purge ranges. Effective monitoring of these conditions can significantly reduce purge flows.

Advantages Over Cylinders

Both PSA and HFM techniques, using the existing compressed air system, can offer advantages over high-pressure cylinders and insulated liquid Dewars. Some of the advantages include:

- Operating costs can be lower than the monthly charges for pick-up and delivery of cylinders
- Safety issues may arise potential injuries associated with moving the 330 cubic foot cylinders which can weigh 165 lbs. Cylinders are also at a pressure of 2,640 psi and a sheared-off valve, from a dropped cylinder, will become a projectile

As the consumption per capita of fruits and vegetables continues to grow, so will the importance of modified atmosphere packaging (MAP). On-site nitrogen generation, using PSA and HFM systems, are expected to play a larger role in the future.

For more information please contact Rod Smith, Compressed Air Best Practices Magazine, email: rod@airbestpractices.com, tel: 251-680-9154

*Reference materials: Analysis and Evaluation of Preventive Control Measures for the Control and Reduction/Elimination of Microbial Hazards on Fresh and Fresh-Cut Produce, US FDA, Center for Food Safety and Applied Nutrition, September 30, 2001

MILKING the Benefits of Pneumatics

BY KJELL LYNGSTAD, MARKET SEGMENT MANAGER — FOOD & PACKAGING, BOSCH REXROTH CORPORATION — PNEUMATICS

Manufacturers around the world rely on machinery to rapidly produce quality products on a daily basis. Investing in the right technology and proper equipment is critical to the overall success of the business by increasing the bottom line. Companies that continually process food and frequently washdown their machines are turning to pneumatics to decrease downtime, lower maintenance costs and, ultimately, increase production.

The Clean Line Valve (CL03) from Rexroth is the only IP69K rated (capable of withstanding 1450 psi wash down) pneumatic valve in the industry.

Evergreen Packaging, a beverage and juice equipment manufacturer based in Cedar Rapids, Iowa, has used pneumatics technology for over 30 years. Most of the equipment produced at Evergreen is gable-top equipment so the machines form, fill and seal gable-top cartons in the dairy and juice industries. Pneumatics is an ideal solution for this type of environment. Because the equipment in a dairy or juice plant needs to be very clean to avoid contamination, it has to be washed down constantly. The machines are not just subjected to water, but are also exposed to chemical cleaners and sodium potassium hydroxide.

Advantages of Pneumatics

With minimal contamination risks, pneumatics is a very clean technology and the first choice for food and packaging companies such as Evergreen. This circumstance makes it desirable for sanitary food applications compared to other technologies such as hydraulics, which sometimes has oil leaks. According to Tim Hughes, development project manager for Evergreen Packaging, choosing the wrong technology can have negative effects on production: "In a wet environment, having leaked oil on a polished tile floor becomes a real safety hazard."

The CL03 Clean Line valve from Rexroth was designed for the most demanding food industry applications with input from several of the leading food processors and OEMs.

Using pneumatics, particularly for washdown and sanitary food applications, is an advantage because of the low maintenance costs and downtime associated with it. "In the dairy and juice industry, you can't afford to have downtime on a production line," said Hughes. "Even if a machine stops working, milk is continuously coming in, and customers expect milk to be at the grocery store. Since stores get their milk shipments in every day, avoiding downtime is absolutely critical." Hughes continues, "Regarding maintenance costs, dairies survive on very low margins. If they have high maintenance costs for keeping a piece of equipment going, that

comes out of the profit from the facility. So, maintenance cost is critical. That's the beauty of pneumatics; it's easy to troubleshoot and to detect the problem without downtime being an issue."

Pneumatic products are a great choice for the food industry because they withstand even the toughest environments, with a longer life expectancy due to their simple design and the limited number of internal components. The major valves and cylinders come standard, so spare parts are available from a number of distributors and they are flexible in use and functionality. In addition, the systems are easy to design and the components are easy to configure.

There are several other advantages to using pneumatics in food applications, including its affordability and durability. "A pneumatics system can be anywhere between 35–50 percent cheaper than a full mechanical system," Hughes said. "Most importantly, it is so user friendly. The sheer muscle of pneumatics—an air cylinder is basically a mechanical muscle—allows you to do so much with it and makes it so easy to use and control. It has become very reliable."

"There are several other advantages to using pneumatics in food applications, including its affordability and durability."

Selecting Pneumatics Equipment

Because it is cost effective and easy to maintain, pneumatics is ideal for food processing applications where washdown is a consideration. When using pneumatics in food applications, it is important to remember to:

Select the right product for each application—various products suit different needs.

- Mount the valves close to the cylinders.
- Mount the cylinders so they can be easily cleaned.
- Decentralize valve-manifolds on larger production lines.
- Dimension pneumatic systems for optimal performance.
- Ensure the air-pressure is constant to maintain optimal actuator cushioning by placing the regulators close to the actuators.
- Filter the compressed air according to the applications for which it is being used. If possible, place filters by each valve-manifold.
- Use food grade lubrication. Lubrication is generally not needed but, if it is used, it must be food grade (type NSF H1).
- Involve your technology supplier from the beginning of the project to get the correct solutions for each application.

Bosch Rexroth offers pneumatics solutions designed for food applications, such as valves, actuators and cylinders, and helps customers select the right solution for each application. The industry gives a rating, such as IP65, to pneumatics

The new Rexroth ICS all stainless steel cylinders available in both 316 and 304 grades, combined with a hygienic design are ideal for harsh washdown applications.

MILKING THE BENEFITS OF PNEUMATICS

components based on particle tight design and watertight design—the first number is the dry particle rating and the second number is the wet test rating. Bosch Rexroth is the only company offering IP69K rated pneumatic valves, such as the Clean Line Valve (CL03), that withstand pressurized water and steam damage. In order to meet the IP69K rating, the valves had to withstand pressure of 1450 psi/100 bars at a distance of 4–6 inches/10–15 cm, with water (at a temperature of 80˚C) flowing at 14 to 16 inches/min while the object was rotated between 0, 30, 60 and 90 degree angles.

Pneumatic actuators are also used in sensitive washdown applications and with parts that are in direct contact with food. If applied wrong, pneumatic actuators can act as bacterial pumps, so it is important to ensure they are fitted properly. For harsh washdown applications, cylinders such as the ICS-ISO Clean Stainless Steel Cylinder Series contain rounded corners for easy drainage, positive sealing, "male" cushion-screw, clean cylinder-noses and food grade lubrication (type NSF H1).

According to Tim Hughes, for companies such as Evergreen, which heavily depend on pneumatics equipment, Bosch Rexroth offers the ideal solution: "Our environment is a washdown environment. We have to assume everything

Potential Cost Savings Using the Clean Line Valve (CL03)

With rising energy costs and the ever-increasing expense of stainless steel cabinet installations, Bosch Rexroth knew it was time to design a pneumatic valve that could eliminate stainless steel cabinets and minimizing air-tube and wiring installation and reduce cycle time, which could reduce expenses by over 50 percent. The IP69K rated Clean Line Valve from Bosch Rexroth is the only washdown pneumatic valve in the industry.

The CL03 was designed in cooperation with the leading food and packaging End-Users and OEMs in both Europe and the USA. When designing the CL03, Bosch Rexroth took the needs of the industry (such as hygiene) into consideration and produced a product that contains the following:

we use is going to get a bath everyday whether it likes it or not. There are a lot of valve companies in the industry that claim to have IP65 products, which means the valve can handle hose-directed water. Our experience has been that the IP65 components really don't work as well as the manufacturers believe they do. With the Clean Line products from Bosch Rexroth, the design is actually IP69K, which is extremely watertight. All the surfaces are either plastic or stainless steel, so you don't get any corrosion from cleaning chemicals, versus other valves that use aluminum or some lesser metals that would corrode."

For washdown and sanitary food applications, pneumatics applications provide effective prevention against contamination while maximizing operational costs, guaranteeing food quality and improving production capacity. No matter what equipment is chosen, the key points to remember are it must be easy to clean and maintain. And, Hughes points out the importance of getting products from a company that has a good reputation in the industry: "Someone can come in the door with a great valve but if it's a company you've never heard of before, that's a risky thing to do."

> "In the dairy and juice industry, you can't afford to have downtime on a production line."

Company Information:

Bosch Rexroth Corp. — Pneumatics
Lexington, KY
www.boschrexroth-us.com
1-800-REXROTH (1-800-739-7684)
info@boschrexroth-us.com

For more information, please contact Eric Deist, Tel: (630) 654-0170, ext. 115, email: edeist@market-sense.com

- Smooth corners and drainable surfaces
- Strong fiberglass reinforced polyamide 12
- Stainless steel A2
- Only positive joints
- Separate covers to resist temperature differences
- Manual override that is protected by a cover
- Light, "clean" color and minimum labeling
- HNBR seals between the valve cover, sub-base and sub-plates
- Minimized valve manifold design time through via on-line configurator
- And no aluminum materials in exposed surfaces

The CL03 maximizes operational costs by ensuring corrosion resistance; secures food quality through optimized hygienic design; and improves production capacity by mounting the CL03 valves closer to the actuators. By placing the valves closer to the actuators, the machine moves at a faster rate and end users are able to reduce the cycle time, which increases productivity and reduces cost.

The unmatched hygienic design and carefully selected corrosive resistant materials allow the Rexroth CL03 valves to be located closer to the actuators, improving productivity and eliminating the cost of expensive cabinet installations.

USING ENERGY EFFICIENCY CLUSTER TRAINING TO IMPROVE REGIONAL ECONOMIC PERFORMANCE

How a Group of Food Processing Companies in the Northwest are Increasing Energy Productivity and Experiencing Non-Energy Benefits

BY ED BIRCH, DIRECTOR OF FOOD PROCESSING FOR THE INDUSTRIAL EFFICIENCY ALLIANCE AND BY JOHN MOLITOR, INDUSTRIAL ACCOUNTS/ ENERGY SERVICES FOR GRANT COUNTY PUBLIC UTILITY DISTRICT

The Grant County Public Utility District (GCPUD) provides energy to its industrial customers at one of the most affordable rates in the country. For that reason, it may be surprising to learn that in Grant County, Washington, food processing companies are using progressive methods to sustain energy savings, including tying training to measurable, sustainable results.

However, that is exactly what this story is all about — one utility's quest to provide expertise in keeping a local industry profitable by focusing on energy efficiency to drive productivity gains. GCPUD's strategy for energy efficiency is helping industrial customers improve market share, increase employment and improve the bottom line. In addition, this tale explains how a variety of resources and people came together to create a model for compressed air energy efficiency among a cluster of food processing plants in the Northwest.

The Benefits of Cluster Training

Located in central Washington, Grant County counts among its blessings beautiful scenery and lakes formed atop prehistoric lava flow valleys and mountains. It is home to a wide variety of agricultural endeavors, including wheat, potato, hay, corn, asparagus, spearmint and peppermint farming. The county is also home to a number of food processing plants, including: Basic American Foods, which makes de-hydrated potatoes; Quincy Foods, a division of Norpac Foods, which processes vegetables; National Frozen Foods, which produces frozen vegetables; and J.R. Simplot, which produces potatoes.

In early 2006, the Northwest Food Processors Association (NWFPA) rolled out its strategy to improve regional economic performance by addressing an important regional need: to strengthen economic viability among food processing clusters in a four-state area. The Northwest Food Processors Association Economic Cluster Initiative stimulates innovation and greater productivity among food processing plants with the idea that networking among clusters of related businesses helps improve competitiveness and ultimately, financial success for participating businesses on a region-wide basis.

With this in mind, Grant County PUD approached NWFPA and one of its regional partners, the Industrial Efficiency Alliance (IEA), with a request to provide a new approach to training, which would ensure a positive economic impact for participating food processing companies. In preparation, GCPUD had strategically provided plant walk-through assessments in 2005. Working in partnership with

GCPUD and NWFPA, IEA took this opportunity to develop a compressed air training program which would allow the participants to return from training with an energy efficient solution in hand. This innovative approach capitalizes on the DOE's Compressed Air Challenge Level 1 class on the first day of training, and uses a field trip on the second day of training to give participants an opportunity to observe training principles in action. In addition, participants are assigned a technical mentor to coach them as they return to their plants to address projects.

Today, participating companies are experiencing a number of benefits including:

- Notable energy savings by reducing line pressure from 120psi to 90psi
- Non-energy benefits such as improved productivity due to reduction of compressed air leaks
- A reduction in O&M costs by eliminating moisture in compressed air
- Greater environmental impact savings
- Enhanced collaboration and resource sharing as a regional industry
- Improved relationships with local utility and account representatives

Engaging IEA in Training and Project Design

The cluster training idea fit IEA's mission to a tee. IEA manages an innovative industrial energy efficiency program designed to help food processing companies and pulp and paper mills understand the benefits of Continuous Energy Improvement. Also, it employs energy efficiency specialists who are available to help companies create customized approaches to improving system operations. Similar to other continuous improvement initiatives, Continuous Energy Improvement is based on the concept of incremental change, recognizing that small changes add up to big savings. The approach is comprehensive, focusing on both the demand and supply side of systems. Improving a system's effectiveness requires technical expertise supported with high quality training to ensure sustainable results.

"In the end, the Industrial Efficiency Alliance provides companies with a way to get their hands around their energy problem," noted Ed Birch, director of food processing for IEA.

IEA's Continuous Energy Improvement process uses five steps to accomplish sustained energy efficiency among food processing companies:

1. Top management support and commitment requirements that drive accountability to the system champion
2. Assessing both energy management practices and technical capabilities
3. Developing key performance indicators, to ensure systems are operating at optimal efficiency
4. Training and educating staff to take a "comprehensive systems" approach to energy efficiency
5. Working with vendors that promote energy efficient products and services, and take a "whole systems approach" to energy efficiency

The IEA deployed a compressed air energy efficiency expert to conduct an initial walk-through among a select group of plants — including Basic American Foods, Quincy Foods, National Frozen Foods, Genie Industries and J.R. Simplot — to determine viability for Continuous Energy Improvement, starting with cluster training.

The lifeblood of each plant's operations is its compressed air systems, but the participating companies did not have a defined, clear process regarding how to conduct root cause analysis on their compressed air systems. Plant managers were enthusiastic about the idea of assigning technical mentors to support their energy champion in resolving a plant energy problem, which would improve operations.

USING ENERGY EFFICIENCY CLUSTER TRAINING TO IMPROVE REGIONAL ECONOMIC PERFORMANCE

Genie Industries

Headquartered in Redmond, Wash., with branch offices worldwide, Genie Industries manufactures material lifts, aerial work platforms, trailer-mounted booms and light towers, scissor lifts, self-propelled telescopic and articulating booms and telehandlers.
For more information, please visit www.genieindustries.com.

Genie Industries, Inc. is a subsidiary of TEREX Corporation (NYSE: TEX), a diversified global manufacturer based in Westport, Conn. For more information on TEREX, please visit www.terex.com.

Best Practice Tip No. 1 — Cross-pollinate Ideas Among Industries

The two-day training started with CAC (Compressed Air Challenge Level 1 & 2) courses, hosted by IEA, Grant County PUD and the Bonneville Power Administration (BPA). Coursework was followed by a tour of a best-in-class plant, Genie Industries, which manufactures power lift platforms. Genie has a lean manufacturing environment and a commitment to high performance infrastructure and technologies. Best practices are often achieved through cross-pollination among industries, and Genie provided the perfect environment for a plant tour.

Participants were asked to use the knowledge and skills gained from the first day's training class to review Genie's compressed air system with a critical eye geared toward offering recommendations for improvements. At the same time, they were tasked with thinking about their own compressed air systems and their approach to making continuous improvements upon return to their own plants.

Best Practice Tip No. 2 — Create a Project with Measurable Results

Immediately following the plant tour, each company team worked with their technical mentors to further identify their compressed air problem and build an action plan to resolve their issues. The mentor and the energy team would continue to work together for the next 90 days to complete the project. Each project plan is designed to be measured on a combination of energy savings and non-energy benefits, which can contribute significantly to improved production performance, oftentimes significantly outweighing the benefits of energy savings.

In the end, the companies are working to create a knowledgeable plant staff who will agree to measure compressed air efficiencies on a consistent basis in 2007 and beyond. The cluster training class does not end officially until each project is measured and evaluated.

Best Practice Tip No. 3 — Use Tools to Measure Key Performance Indicators (KPIs)

Understanding process design, operational data and performance metrics are the most important parts of a project plan. Participants were asked to develop compressed air supply and demand line diagrams to enable them to identify design issues that transpired with the growth of the company. Spending time monitoring and measuring pressure drops and identifying leaks, allowed the team to further identify opportunities for improvement. Making the appropriate repairs and modifications while establishing key performance indicators, or KPIs, allowed them to improve operations while reducing line pressure. To assist them in gathering data, IEA agreed to loan each company an ultrasonic leak detector. Participants were encouraged to use the detector and develop a maintenance procedure that would include regular ultrasonic leak detection and repair. In return, IEA determined that the companies could keep the detectors for later use at no cost. All of the companies excluding one, which already had a leak detection device, used the tool effectively and are now proud owners.

Best Practice Tip No. 4 — Engage Management and Mentors

Managers and mentors have a tremendous influence over the success of Continuous Energy Improvement Programs. Supportive managers can empower trained personnel to make good decisions about their compressed air systems, and they can extend the value of training and other activities throughout the plant, leading to systemic change in behaviors regarding compressed air system energy use.

In addition, mentors can help trained personnel transition classroom activities into a real world environment. Cluster training participants in Grant County were each assigned a mentor who has made himself available for questions, plan reviews and progress reports. Measuring success is different for each plant and mentors help keep projects fresh while ensuring consistency in approach.

> "The approach is comprehensive, focusing on both the demand and supply side of systems."

Conclusion

Overall response from each of the participating companies has exceeded everyone's expectations. Grant County PUD, NWFPA, BPA and IEA were all cautiously optimistic that projects would succeed based on personal responses from the training. However, as projects have moved forward, each company has met its own challenges with a combination of commitment and heart.

"I have been a compressed air trainer for the past 20 years, and I've never been involved with a training that was as successful as this one has turned out to be. That's because we tracked the commitments made at the training, and we know behavior change is underway," said one of the cluster trainers.

Participants were recently recognized at a September 2006 awards dinner hosted by Grant County PUD and attended by corporate executive sponsors. The exciting 4-hour event included presentations from each plant, the GCPUD, IEA and Dave Zepponi, the NWFPA Executive Director. Projects at each plant are set to continue through the end of this year.

Although, this story remains a Best Practice case study in the making, there is still much that can be learned from it. Each team leaves this training session with comprehensive knowledge of compressed air system operations, a set of priorities for future projects, and in-place preventative maintenance practices designed to improve the bottom line.

For more information please contact: Ed Birch, Director-Food Processing, Industrial Efficiency Alliance, email: ebirch@industrialefficiencyalliance.org, Tel: 208-762-9687

COMPANY PROFILE

CompAir Rotary Screw Factory in Simmern, Germany

CompAir USA

ENGINEERED TO SAVE

Compressed Air Best Practices interviewed Bill Steele (Vice President Sales & Marketing) of CompAir USA

Good morning! What does "Engineered to Save" mean?

Thank you for asking. CompAir technologies are designed to either save energy or help efforts to save the environment. Whether it is reducing the electric bill, eliminating oil, reducing noise-levels or helping recycle/recover gases — CompAir designs products with these goals in mind.

How is the big launch of the new DH Series Oil-Less Compressor progressing?

Fantastic! The industries demanding environmental responsibility and energy savings are responding strongly to our new water-injected, oil-less, rotary screw compressors. These industries include food processing and food packaging, computer-chip manufacturing, pharmaceuticals, medical and health care facilities, electronics and finally chemical facilities. The new DH Series offers users the peace of mind of NO OIL ever being introduced into the compressed air stream by the air compressor.

The DH Series also offers energy savings by offering VFD (Variable Frequency Drive) drives as standard on all models. This allows users to have their kW costs, related to running the air compressor, mirror the percent of load on the air compressor.

> "Another important feature is the ability to switch between two pressure set points."

The New CompAir Rotary Screw Oil-Less DH Series

CompAir USA

Company Profile

So what is this big truck doing cruising around the country?

We introduced this product with the CompAir Road Show! We outfitted a truck with a DH Series air compressor and have been driving around the country demonstrating the product to plant engineers, plant managers, and maintenance managers. We have toured, so far, Wisconsin, Iowa, Illinois, Indiana, Ohio, Michigan, and New York. Now we're headed out west — starting with our national distributor meeting, being held in October in Palm Springs. End users are enjoying the chance to see the air compressor run and view the following features:

- A full range of models from 20–100 horsepower with pressures to 150 psig
- Isothermal compression, tip sealing, and standard VFD Drives for energy savings
- Low-sound enclosures and no oil — great for the environment
- Extended equipment life due to low rotational speeds of airends
- Very low maintenance costs due to fewer components and the absence of oil

The CompAir Road Show

CompAir Road Show Compressor Demonstration

"We are introducing to the market, for example, a unique methane air compressor."

What is your operational structure to support the DH Series and other product lines?

The DH Series is manufactured at our global manufacturing center, for rotary screw air compressors, located in Simmern, Germany. This facility occupies 35 acres of which 258,000 square feet comprise manufacturing buildings and offices. This campus produces all CompAir lubricated, variable frequency drive, and oil-less rotary screw air compressors. This includes L Series (lubricated) models offering flows from 24 to 2,000 scfm and LSR Series (speed-regulated VFD) offering flows from 40 to 543 scfm.

Our unique LSR Series speed-regulated air compressors are at the center of our strategy to save energy for our customers with VFD compressors. These models use SR drive technology which allows end users to save energy as air demand falls. Another important feature is the ability to switch between two pressure set points. This enables end users to set lower working pressures for weekends and maintenance periods — and therefore save energy.

CompAir USA

Company Profile

Where are your Hydrovane air compressors being built?

CompAir's Hydrovane line of rotary sliding-vane air compressors continues to be a solid performer globally. The product line continues to be manufactured in the center of England, in Redditch. We first introduced this rugged and reliable design in 1952. The Redditch facility continues to improve designs and manufacture rotary sliding-vane air and gas compressors from 1 to 75 horsepower. The facility occupies 8½ acres and has 90,000 square feet of factory space along with 20,000 square feet of offices.

Our Hydrovane product line is compact and ideal for OEM applications. It is also popular with light industrial applications. Energy efficiency is again a focus as Hydrovane models, using an inverter, are available with VFD.

CompAir Hydrovane Factory in Redditch, England

Don't you have air compressors for 6000 psig pressure?

Yes. CompAir has been a pioneer in high-pressure piston air compressors. Reavell compressors was founded in 1898, and joined CompAir in 1968. They have been well established in marine and gas high-pressure applications throughout their history. This unit continues to manufacture in Ipswich, England.

These products have unique capabilities to assist those looking to protect the environment while running a profitable business. We are introducing to the market, for example, a unique methane air compressor. We have successfully completed our trial installations of these systems and are ready to roll it out nationwide. The installations are being used in businesses which recover methane. They take methane, created by farm animal refuse placed in farm ponds, and compress it in one of our methane compressors. They then store it in tanks and ship it off to be sold.

Please describe your other operations in North America.

CompAir Canada has facilities in Oakville (Ontario) and in Montreal. CompAir USA is headquartered in Sidney, Ohio. This business has a long history, starting in 1913, as the home of LeROI compressors. LeROI was founded in Milwaukee and moved to Sidney in 1960. CompAir acquired the business in 1995 and the 250,000 square foot facility sits on 17.3 acres. We have the capabilities to customize air compressors to the special needs of our customers out of our North American facilities. We also carry significant inventories of finished goods to supply this market with fast deliveries.

Thank you CompAir.

For more information contact Bill Steele, VP Sales & Marketing, CompAir USA, Tel: 937-498-2500, email: bill.steele@compair.com, or visit www.compairusa.com

CompAir Reavell Factory in Ipswich, England

AIR PERFECTION INC.

PARTNERING WITH EMPLOYEES AND CUSTOMERS

Compressed Air Best Practices interviewed Jim Morgan (Director, Energy Management Group) and Steve Strah (Senior Project Manager) of Air Perfection Inc.

Offering energy management services to our customers is part of our core strategy. We believe, however, that creating a partnership with our employees enables us to then create partnerships with our customers — often around the topic of energy conservation. Partnerships, in our opinion, take working for Air Perfection to a deeper, more meaningful level.

Air Perfection began business in 1989. We focused on providing technical service, invested in technicians, service trucks and a small garage where we could repair equipment. We didn't hire an outside sales person until 1995. Then, in 1997, everything changed for us.

Pride in Excellent Technical Service

As co-owners, was that when you began "partnering"?

Yes. In 1997, we worked hard, focusing on our employees and we began the long road learning to audit compressed air systems. In those days, distributors, "like us" didn't know what an air system audit was and we have learned even some of the larger companies truly don't understand partnering with their employees.

There is nothing more valuable to our company than a committed and professional employee. We go to any length to make sure they enjoy working for Air Perfection. They have rewarded us with loyalty, high performance, and friendships. We have four areas we focus on:

1. **Pride:** Excellence installs pride in the employee and in Air Perfection. We could give many examples across our company. One is when our service technicians go out to jobs, they always take pressure-washers and touch-up paint to leave the air compressor looking like new, if allowed. We always take the appropriate colors with us in the service trucks. Our customers are always pleasantly surprised by this extra service and they treat our service technician as some one special. This is good for our company as we receive most new customers through word-of-mouth referrals from our current customers. This is good for our technicians as they are recognized for what they do and feel pride.

2. **Compensation:** Northern California is known for being high-priced and competitive. Our business sector is no different. There are high-turnover rates as employees move from job-to-job seeking higher compensation. We decided, in 1997, to offer top wages as well as a top work environment. We have worked hard at our compensation programs and arrived at innovative packages, which allow both the employee and the company to prosper in a "win-win" situation. This has been a critical factor in allowing us to recruit and retain the best employees in the region.

3. **Competence & Professionalism:** Sound business processes, supported by appropriate tools, create a professional atmosphere. Steve Strah focuses his energy on creating and supporting this professional environment. Our processes, from procurement to inventory management to project management, we feel are the best in our area. Our employees take professional pride in always taking these processes to the next level. This ties back into the importance of creating a sense of pride and competence.

4. **Fun:** If you don't enjoy yourself where you work, you won't stay for too long. We feel that the "fun factor" is a essential complement to the above factors. Fun allows Air Perfection to be more than an employer. We strive to be a second family. It makes a "work colleague" a friend. It makes us more than "the bosses". We feel that activities designed outside of the workplace, to build relationships, are essential. During a busy work-day, it simply isn't possible to build more meaningful relationships. To this end we organize:

    A. Occasional Friday pot-lucks and company lunches and BBQ's

    B. Camping trips (rafting, camping, canoeing, fishing,)

    C. Girls-Night Out: From San Francisco to the Wine Country

> "Offering energy management services to our customers is part of our core strategy."

AIR PERFECTION INC.

Company Profile

Air Perfection Headquarters in Dixon, California

How did you begin auditing compressed air systems?

We met one of the top compressed air auditors in 1997, named Dean Smith, and spent seven years learning how to audit air systems. In the beginning we found our competitors were just selling air compressors — while we were turning air compressors off! We were learning to sell system components, which reduced energy costs, stabilized working pressures, and put us in a great position to build relationships with end users. A big investment was made in learning to walk the factory floor and take measurements. We learned to take the time to understand specific pieces of equipment, using compressed air, and to determine whether they were receiving air at the appropriate air pressure.

What were the market conditions in the late 1990's in Northern California?

Energy prices in Northern California went from 6–8 cents per kW/hour, in the late 90's, to 10–15 cents per kW/hour in 2000. The average is 12 cents per kW/hour. These high energy costs, combined with the recession of 2000–2002, forced a lot of firms in the compressed air business to fold. Under our auditing strategy, we sold system components, which reduced energy costs, and actually grew during the recession. Energy prices have remained high. The "demand-rate" goes from 13–27 cents per kW/hour. If you exceed your allocation, your facility will operate at the "demand rate" for the rest of the month. Alameda and local ports like San Francico, have demand rates of up to 27 cents per kw/hour. Under demand rates, a 25 hp compressor would cost $65,000 per year to operate. Energy conservation is the only option for a viable business.

How did you educate the market on compressed air energy costs?

During the recession we focused on the education of end users with countless workshops. These workshops went through all the fundamentals with regards to energy-saving "best practices" in compressed air systems. For most end users then (and still today) there were many areas of low-hanging fruit to be picked. We also invited people from the regional utility companies and/or co-sponsored workshops with them. During these years we built our strong working relationships with PG&E, Sacramento Municipal District (SMUD), Modesto Irrigation District (MID), Turlock Irrigation District (TID), and with the Public Utility Commission (PUC). We also became an Allied Partner of the Department of Energy and have had our auditors featured on their web page (see the story on the San Jose Mercury Newspaper).

What role does project management play in air auditing?

Executing and implementing a compressed air audit REQUIRES excellent project management abilities. These projects involve countless steps to deliver the energy-savings we have calculated for their investment. Air Perfection, under Steve Strah's management, organizes the schedule with the factory for audits to take place, works with vendors to ensure deliveries, and with contractors to ensure timely installation and implementation. Utility firms must be involved in specific stages of the project in order to qualify the project for rebates. Specific documentation must also be provided to the end user and to the utility company. Efficient project management, of major audits, is a core expertise we have worked hard at to develop over the years. Once completed, it's very rewarding when the audit and implementation go as planned.

> "A big investment was made in learning to walk the factory floor and take measurements."

So how is the compressed air market today?

When capital became more readily available in 2002, Air Perfection Inc. was already established as a serious compressed air auditing firm. We had built a reputation as a firm able to generate energy-savings for our customers, attract rebate dollars from utility companies, and execute projects on schedule. Throughout the next couple of years our company grew in size and market share due to these capabilities.

The market has changed in that today there are many firms claiming to offer auditing services via "boxes". "White boxes" and "black boxes" can measure certain things and provide end users with a first-glance at their system — but they are fundamentally a sales tool. We believe, however, that a full audit, on the factory floor, continues to be the best way to truly understand the needs for compressed air, in a facility, and to then construct the most efficient manner in supplying that demand.

AIR PERFECTION INC.

Company Profile

Jim Morgan and Steve Strah of Air Perfection Inc.

Are there any new "green initiatives" coming out of California?

The EPA is very strict in the Silicon Valley. Condensate management is becoming a major issue. A manufacturing firm, in Stockton, was recently shut-down temporarily, by the EPA, because they were not separating oil from the condensate created in the compressed air system. The company lost three days of operation and the maintenance manager was fired. We were asked to rush out and install an oil-water separator. Today, you simply cannot have condensate going anywhere except for into an oil-water separator. The EPA will fine offending companies and write-up a "fix-it" ticket which gives them 30 days to comply. Fines can be $1,000 per day until an oil-water separator is installed. EPA enforcement does vary county-to-county out here. At this time, Air Perfection feels it is our obligation to provide every end user with a written notification, of our recommendation to install an oil-water separator to properly dispose of the oil.

What kind of oil-water separators do you recommend?

Gravity-type separators, using charcoal bags, are not always accepted in the Silicon Valley. The charcoal bags are normally difficult to dispose of without dripping oil on the floor. Many are also incapable of handling certain common types of oil which create emulsions with the condensate. We recommend oil-water separators which vaporize the water leaving very little oil for removal. This reduces the difficulty and cost of proper disposal. These systems can handle all types of oil and emulsion situations.

What is the scope of Air Perfection today?

We have grown to 46 employees with 22 service technicians and seven sales people with an in house engineer. Our 30,000 square foot headquarters is in Dixon, California and we have branches in Reno, Sacramento, Castro Valley, San Jose, and Tracy, California. The Dixon Corporate office houses our service parts inventory, new machine stock, and a complete service shop where we can over-haul and rebuild air compressors. We also have a large rental fleet of 85 pieces of equipment. The equipment in the fleet ranges from 5–350 horsepower air compressors, CDA air compressors with -40˚ F dew point desiccant dryers, vacuum pumps, and stand-alone dryers and filtration packages.

Air Perfection today continues to create partnerships with customers who have a focus on energy management. Our employees make these partnerships beneficial to all parties involved.

Thank you Air Perfection for your insights.

For more information please contact: Jim Morgan or Steve Strah, Air Perfection Inc., tel: 707-678-0573, email: jmorgan@airperfectioninc.com, sstrah@airperfectioninc.com or visit our web site at www.airperfectioninc.com

INDUSTRY NEWS

Press Releases

ENERGY SAVINGS AND LOW DEW POINTS!

Superior drying performance with minimal purge losses

Kaeser Compressors announces the latest addition to its comprehensive line of energy saving desiccant dryers. The new Kaeser Blower Purge Desiccant dryers and Kaeser Exhaust Purge Desiccant dryers use a heated regeneration method to produce high quality air and dew points as low as –40˚ F with minimal purge air losses.

All of our desiccant dryers feature a dual tower design and durable, activated alumina. The desiccant beds are specially designed to optimize contact time between the purge air and the desiccant and to maximize desiccant life. Kaeser dryers also feature leak-free switching and check valves to reduce pressure drop, and solid state controllers to monitor all essential operations.

Standard sizes in our desiccant line range from 5 to 5400 cfm with larger models available. Kaeser also offers heatless desiccant dryers and a complete line of filters, drain traps and condensate management products. We have the right solution for your clean air treatment needs.

For more information, please call 800-777-7873 or visit us at www.kaeser.com.

INDUSTRY NEWS

Press Releases

SENSICAST SHIPS THIRD-GEN WIRELESS MESH SENSOR NETWORK SOLUTION: SENSINET® 3.0

Needham, MA — September 21, 2006 — Today, Sensicast Systems (www.sensicast.com), worldwide provider of wireless sensor networks for industrial automation and monitoring enhancement, announced it is shipping SensiNet 3.0® — the industry's first, end-to-end, wireless mesh sensor network solution that can be tailored to specific applications using a self-configuring building block approach.

Sensicast's third-generation mesh networking offering, SensiNet 3.0 is based on a building block deployment approach — for fast installation and scalability (from small networks to very large/multi-facility networks of hundreds of sensors). SensiNet's patented wireless mesh network technology enables end-user customers such as plant and building managers to quickly install and operate comprehensive, yet tailor-made systems to wirelessly track conditions and processes in their facilities.

Modular building-block elements of SensiNet 3.0 include:

- SensiNet Smart Sensors--Battery-operated, long-MTBF, ruggedized components that interface directly with thousands of industry-standard sensor probes to monitor a range of physical data types (e.g. temperature, current, pressure)
- SensiNet Mesh Routers that are used in large-scale networks to extend the range of Smart Sensors, as well as create a redundant network backbone infrastructure. Mesh Routers can be placed in convenient locations and are automatically self-configuring for optimum performance.
- The NEW SensiNet Services Gateway: a hardware appliance with embedded connectivity and data reporting functionality that manages the SensiNet network and integrates it with legacy systems (e.g. ICONICS, Intellution, Wonderware, RSView and others); basic built-in data visualization applications, and standard Web 2.0 interfaces (SOAP, OPC, ODBC, XML). The Gateway functions as the "hub" of the network through a browser-based control panel that lets network administrators configure and monitor network properties and topology, as well as Smart Sensor battery levels and data reporting intervals.

The new SensiNet Services Gateway is designed as a plug-and-play smart component delivering powerful interface services and integrated applications including:

- An ODBC interface for databases
- SOAP Connection for Web 2.0 applications
- OPC connectivity for popular automation software
- ModBus TCP/IP support for industrial control systems software
- Remote M2M interface for connection to Software-as-Services (SaaS) platforms

Sensicast's Wireless Sensor Network systems are currently deployed in hundreds of facilities worldwide yielding quick and significant benefits for operators, including:

- FDA-compliant temperature monitoring for pharmaceutical manufacturers, food and beverage distributors
- Reduced energy consumption, by measuring power consumption concurrently with systems performance — from factories to urban apartment buildings
- Wirelessly-enhanced field service operations through remote monitoring of humidity and moisture
- Enhanced process-control in metals and plastics manufacturing
- Web-based alarms and reporting — for rapid response and compliance documentation

For More Information Contact:
Patrick Rafter, Sensicast Systems, Inc., prafter@sensicast.com, www.sensicast.com

DOMNICK HUNTER PRESS RELEASE

Chilling: Creating the right environment with Hyperchill process chillers

Process cooling is regularly used in food applications such as beverage, confectionary, chocolate, processing and storage.

domnick hunter's *Hyperchill* process chiller technology is characterized by a high refrigeration yield for low electrical consumption. Combined with a small footprint this leads to a compact space-saving and energy efficient solution.

Chillers are available for internal and external installation and are equipped with microprocessor intelligence providing precise control and automatic function.

Hyperchill process chillers offers:

- Standard and custom designed options provide unrivalled choice
- Wide range of cooling capacities
- Minimal space-saving footprint and
- Low energy consumption.

For more information, contact domnick hunter at (800) 345-8462.

INDUSTRY NEWS

Press Releases

AGGREKO PLC AGREES TO ACQUIRE GE ENERGY RENTALS FOR US$212 MILLION

(Houston, Texas — 26 September 2006) — Aggreko plc, a global provider of temporary power, temperature control and oil-free compressed air solutions, announces today that it has entered into a definitive agreement with General Electric Company ("GE") to acquire substantially all the activities, other than those relating to large gas turbines, of GE Energy Rentals ("GE-ER"). The maximum consideration, payable in cash, is US$212 million (£111 million).

Highlights

- Supports Aggreko's strategy of growing its core business in power and temperature control by fleet investment, geographic expansion and acquisitions.
- Strengthens Aggreko's position in key geographies, notably in Central and South America, as well as adding scale in the United States, Europe, the Middle East, Asia and Australia.
- Increases Aggreko's core rental fleet capacity by c.30%.
- Improves Aggreko's capability in entertainment, emergency response and gas-fuelled power generation.
- Approximately US$35m of operating profit expected to be delivered by the acquired assets within 3-4 years.
- EPS neutral in 2007, materially accretive thereafter. Return on Invested Capital above Cost of Capital by 2008.

Commenting on the transaction, Rupert Soames, Chief Executive of Aggreko, said: "This is an important acquisition for Aggreko and a milestone in the implementation of our strategy of driving the growth of our core business through capital investment in new fleet, geographic expansion and acquisitions. The acquisition of GE-ER substantially increases our rental fleet, improves our access to key regions, and brings experienced people who can support our growth. We will achieve valuable synergies in the enlarged group by removing duplicate infrastructure and overheads. For the many GE-ER employees who will transfer to Aggreko as a consequence of the acquisition, it provides the opportunity to work for a company which is completely focused on energy rentals, and which is a truly global player. We greatly look forward to welcoming them into the Aggreko team."

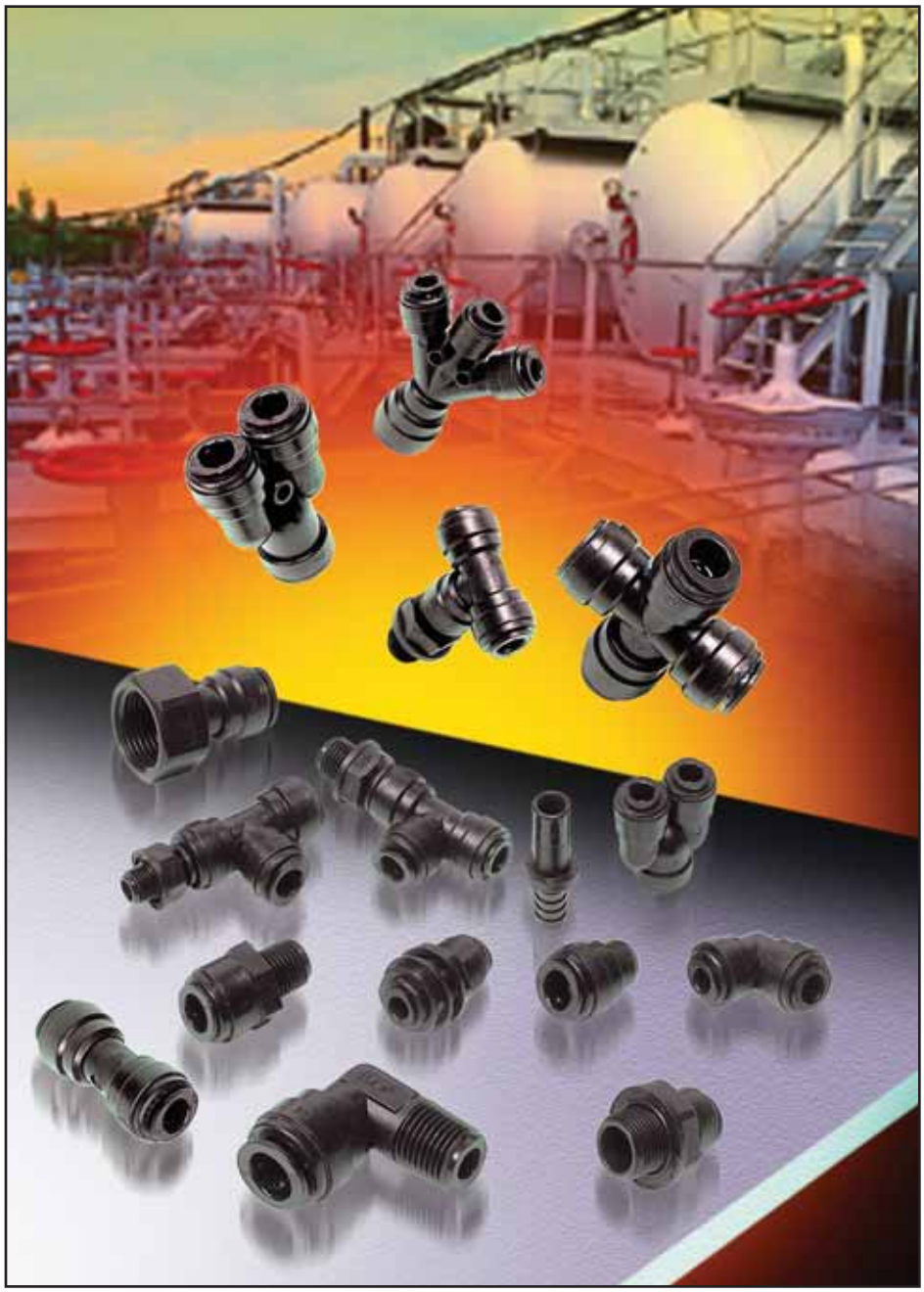
Enquiries
Aggreko plc +44 141 225 5900
Rupert Soames, Chief Executive
Angus Cockburn, Finance Director

Investor Contacts:
Maitland +44 20 7379 5151
Neil Bennett
Charlotte Barker

U.S. Media Contacts:
Aggreko, LLC 281.985.8200
Rod Jay, Marketing Manager
Amy Stine, Communications Specialist

NORGREN INTRODUCES ITS NEW RANGE OF PNEUFIT D FOOD GRADE PNEUMATIC FITTINGS

Littleton, Colorado, USA — April 2005. Norgren, the motion and fluid control specialist, has extended its range of world-class push in fittings with the introduction of the all-new Pneufit D series. Providing a perfect complement to its existing Pneufit range the new composite fittings feature quick and easy connection without the need for tools thus saving on valuable installation times. Pneufit D is suitable for a wide range of compressed air applications and is approved by FDA, WRAS (UK), SK Zert (Ger) and NSF-51 (USA) for use in food processing.



The integral stainless steel grab rings offers fast secure assembly for Nylon PU and PE tubing and the new range consists of over 45 different shapes equating to over 600 part numbers. Tube sizes are available from 4mm to 12mm in metric and 5/32" to 1/2" in inch. Pneufit D can also be specified with NPTF, BSP and UN type threads.

Focused on providing a wide range of solutions Norgren now offers customers Pneufit C for general industrial, Pneufit D for specialist food, water and beverage and metal Pneufit for higher specification requirements.

More information on the complete Pneufit series can be found at www.norgren.com.

COMPRESSED AIR SYSTEMS FOR ISO

BY TIM MCDONALD AND PAUL ROWLANDS

For many sectors of the process and energy industries such as those involved in food and drink, pharmaceutical, electronic, textile manufacturing, as well as nuclear and offshore engineering, there is a need for pure process air without the additional costs, limitations and risks related to in-line filtration systems.

The question of air quality and its relevance to these industries and other applications is one that has been debated by suppliers and users of compressed air equipment for many years. In times past, the choice was simple; if air quality was important, an oil-free compressor was used; if air quality was unimportant, an oil-flooded compressor was used.

In both instances it would be rare to see a filter in place other than on the inlet of the compressor. In recent years it has become increasingly common to see oil-lubricated machines fitted with a bank of filters and operating in processing environments that would formerly have required oil-free machines and oil-free air.

Atlas Copco Oil-free Air Compressor

8573-1, CLASS-ZERO, OIL-FREE AIR

Change of View

What has brought about this significant change of view? Is it due to a sudden increase in efficiency and reliability of filtration equipment, or perhaps an increase in the efficiency and effectiveness of filtration salesmen?

Could the reason be that in times of economic hardship, short-term, lower-cost solutions become more attractive under the ever-increasing influence of company accountants, despite the convincing counter-arguments of quality control and engineering departments?

Maybe it is simply that, despite being environmentally aware, some production people just have not yet come around to thinking about the compressed air part of the process? The arguments for the different types of systems are many and complex and need to be reviewed painstakingly, application by application. But, the decision starting point must always be "What quality of air do I need?" to be quickly followed by "What is the impact of not achieving that quality?"

The Risk

Using a modern lubricated compressor without any filters will result in the presence of oil at 3ppm in the air supply when everything is working according to design. If the compressed air is being used in a plant to drive wrenches and nutrunners, this level of air quality may suffice. The risk of excess oil coming down the line only means that the tools would need more cleaning and possibly more maintenance.

On the other hand, in a textiles application where the air is driving threads across looms, any oil carryover could have an obvious and serious effect on the quality of the product.

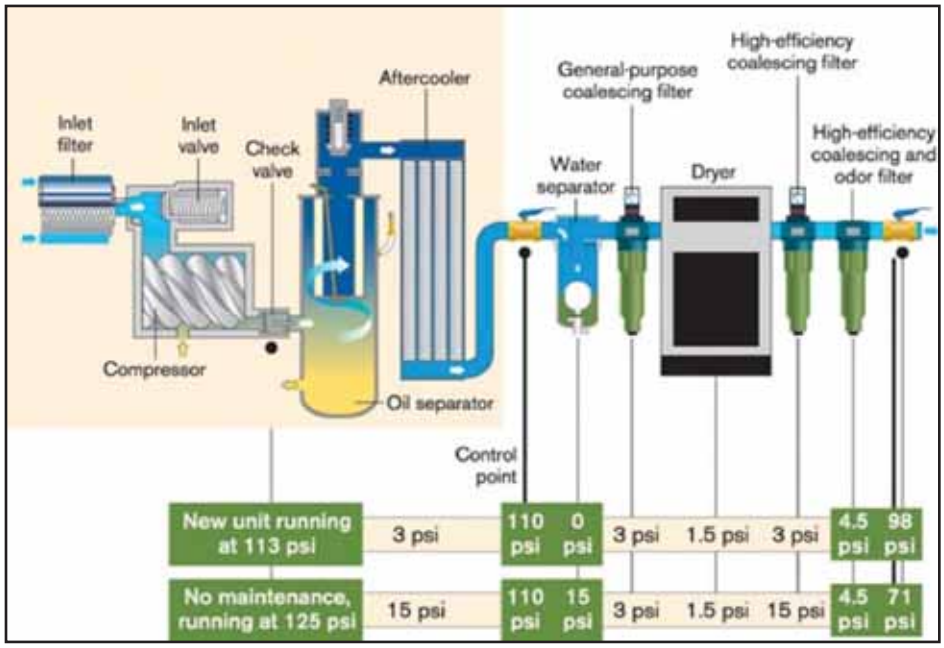
The risk of oil going through the system and contaminating production equipment is totally unacceptable. Any system that relies on an oil-lubricated air compressor will have oil introduced into the system.

The absence of maintenance or the addition of filters may vary the amount. But, how much is acceptable must be evaluated along with operating costs (Fig. 1).

It is fair to say that most applications are a combination of these extremes; the majority of users would prefer oil-free air by whatever method it can be achieved. Quantifying the element of risk is something that can only be done accurately by the manager operating the plant. Consider the outcome when things do not go according to plan. For example, if ambient conditions do not match the design criteria then the obvious question that has to be asked is "how good are the filters?"

The answer is that at specified and fixed inlet conditions of temperature and pressure, and if regularly maintained, the best products can achieve levels of filtration (using two filters) about as efficient as 0.01 ppm at 70˚ F. However, even this small amount of oil carryover builds up in time to a significant volume. The real world also has a habit of varying considerably from design conditions. A small increase in the ambient air temperature can cause the filtration system to pass more oil.

If maintenance is not done properly or frequently enough, more oil may be passed. Of greater concern, if filters are not maintained properly, they are liable to collapse and pass almost all of the oil out of the compressor straight into the product process.

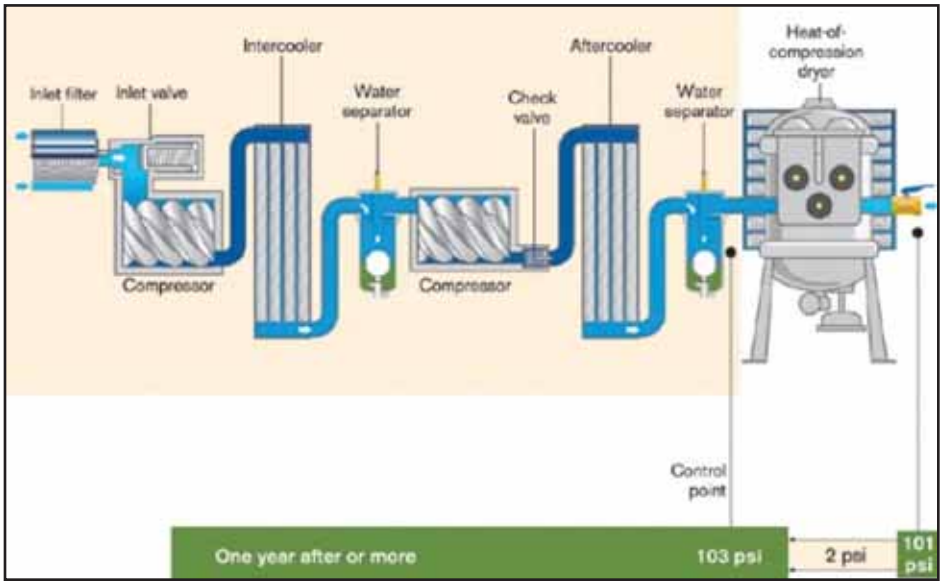


COMPRESSED AIR SYSTEMS FOR ISO 8573-1, CLASS-ZERO, OIL-FREE AIR

The Cost

Although there are filters that claim to remove oil vapor, their effectiveness is very reliant on inlet conditions and thorough, frequent maintenance. Considering this, it may not seem unreasonable to question why anyone buys compressors that need filtration. The major factor most usually cited is capital cost. While it is fair to say that in almost all cases an oil-free compressor will cost more than its oil-lubricated equivalent plus a bank of filters, it has been shown that the initial capital cost of a new compressor plant represent only 7% of the total running costs of a compressor over a 10-year period.

A filter bank user is tied into a program of buying and replacing filter elements throughout the life of the compressor in an attempt to maintain the desired level of air quality. Although the level of capital cost will always be important, should the investment cost factor be allowed to compromise end product quality?



Looking at applications where air quality is important, it can be seen that plant managers may in general use an oil-free compressor because the consequences of a failure in any one of the elements of the filtration system would be disastrous.

In such situations the possibility of the capital cost being slightly higher for oil-free compressor systems is irrelevant when compared with the costs involved in a system failure, maintenance, and energy. Consequently, the price for improvements in operations efficiency and reduced maintenance becomes almost incidental by comparison (Fig. 2).

Is Oil-free Air Needed?

On what basis does the decision need to be made? It's back to the starting point, "Do I need oil-free air?" If the answer is no, save some money and install an oil-lubricated compressor. If the answer is yes, then consider the consequences of a costly failure in the system and the effects of dumping oil into the process, contaminating pipe work and equipment on the way. A 100 cfm compressor working normally will put up to a gallon of oil into a system in a year of operation.

Once these figures for the system have been correctly quantified, an informed decision can be made about what kind of system may need to be installed. Present trends indicate that there will come a time in the relatively near future when process air consists of nothing but air; any oil required by the process or product can be added at the point of requirement as opposed to being present as a by-product of the compression process.

The environmental impact of filtering out any oil and its disposal methods is becoming an important issue with buyers. They will have to look into the process to ensure that they can guarantee the quality of the product and, as a result, the oil-free process will become attractive.

ISO 8573-1 Class Zero

Due to risks involved with filtration and industry expectations, ISO (the International Organization for Standardization) has further clarified, and added to the standards for air purity over time. The latest being Class Zero.

1991 ISO 8573-1: classes 1–5

The 1991 ISO 8573-1 edition of the air quality standard established five purity classes, 1 through 5. The best, Class 1, specified an oil concentration of 0.01 mg/m³ at 1 bar(a) and 20˚ C. Conformance to Class 1 was sometimes called "a technically oil-free solution". However, only oil aerosols and liquids were considered. Below 35˚ C, vapors could be ignored when, in fact, the quantity of vapors may be higher than aerosols. Some manufacturers still use this old edition to promote their machines

2001 revised version: CLASS 0 is born

In 2001, the standard was revised to address the needs of applications where air purity is essential. These include industries such as pharmaceuticals, food and beverages, electronics, automotive painting and textiles. In these cases, risk of contamination must be excluded to avoid severe consequences: spoiled or unsafe products, production downtime or damage to brand and reputation.

The 2001 revision established a more comprehensive outlook by specifying the measurement of total oil content, as opposed to the earlier edition which called for the measurement of aerosols and liquids alone and not the vapors, below 35˚ C. Moreover, to the existing purity classes 1 through 5, a new and more stringent class was added: ISO 8573-1 CLASS 0.

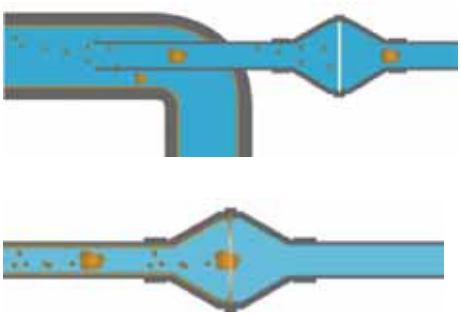
CLASS	Concentration total oil (aerosol, liquid, vapour) mg/m³
0	As specified by the equipment user or supplier and more stringent than class 1
1	≤0.01
2	≤0.1
3	≤1
4	≤5

2006: the first air compressor certified ISO 8573-1 Class 0 (2001)

Atlas Copco asked the TÜV (Technical Monitoring Services) to type-test the Z range of oil-free screw compressors. The test concluded that no traces of oil existed in the output air stream. Atlas Copco has thereby become the first compressor manufacturer to receive certification for a new industry standard of air purity: ISO 8573-1 CLASS 0.

Technical Monitoring Services is an independent, international organization specializing in evaluating the safety and quality of technology. The TÜV is recognized worldwide for its independence, neutrality, professional expertise and strict standards. They Z compressors were submitted to the most rigorous testing methodologies available. All possible oil forms were measured across a wide range of temperatures and pressures.

COMPRESSED AIR SYSTEMS FOR ISO 8573-1, CLASS-ZERO, OIL-FREE AIR



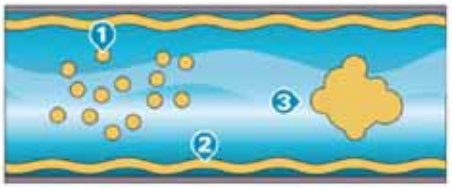
Test Requirements and Methods

The ISO 8573-1 (2001) tests are in two parts: Part 2 and Part 5. Part 2 measures aerosols and liquids. Testing can be done through partial flow (B2) or full flow (B1) methods (see below). Part 5 measures vapors only. Both parts are necessary to obtain ISO 8573-1 CLASS 0 (2001) certification. This means that all three sources of oil contamination — aerosol, vapor and liquid — have to be measured.

The B2 method targets only the center of the air flow. Oil aerosols are registered but oil that sticks to the pipe wall (wall flow) is not detected. Most air compressor manufacturers still prefer this less stringent method.

The B1 method examines the entire air flow to measure both aerosols and wall flow. This comprehensive test method was used on the Atlas Copco Z range of oil-free screw compressors. Even so, no traces of oil were found in the output air stream.

Types of oil content
Lubricated air compressors introduce three forms of oil contaminant into the compressed air stream: aerosol droplets, vapor and liquid wall flow. By contrast, oil-free compressors introduce no oil contaminants whatsoever.



1. **Aerosols** - Minute droplets of oil suspended in the air stream
2. **Wall flow** - Oil in liquid form, which creeps along the pipe wall
3. **Vapors or oil mist** - Vaporised oil in a cloud form

What about oil contamination in ambient air?

Ambient air has very small traces of oil coming from vehicles and industrial sources. However, in contaminated areas, oil content does not normally exceed 0.003 mg/m^3.

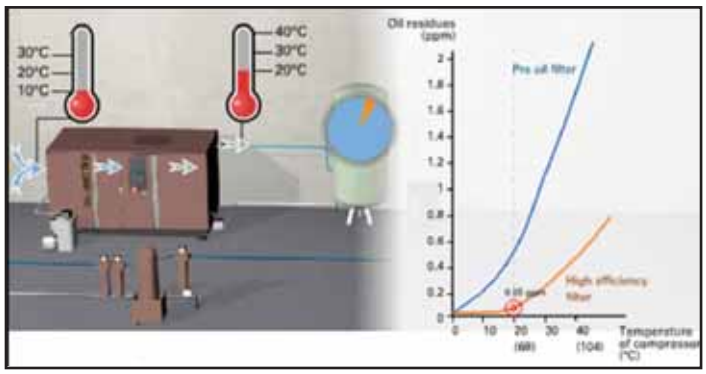
This is borne out by tests conducted by the TÜV near a factory with heavy machining activity (including turning, milling, grinding and drilling). Heavy vehicular traffic and a garbage incinerator were in the vicinity.

Aspirated by an oil-free screw compressor, this extremely low level of atmospheric oil is almost completely washed away by the condensate in the intercooler and aftercooler, resulting in pure oil-free air for your process.

Influence of Temperature On Oil Content

As alluded to earlier in this article, one aspect influencing the filter efficiency and purity of air is temperature. When using oil-injected compressors with filters, oil carryover through filter media increases exponentially according to the temperature at the filtration interface.

Filter performance is often specified at 20˚ C. If the ambient temperature in the compressor room increases to 30˚ C, the compressor outlet temperature could be 40˚ C with the oil carryover 20 times the specified value of 20˚ C. Such temperatures are not unusual even in colder countries, where the compressor room temperature is substantially higher than that outside.



Temperatures also cause an increase in the vapor content of the air, some of which can carry through to the end product. Moreover, high temperatures shorten the lifetime of activated carbon filters. An increase in temperature from 20˚ C to 40˚ C can cut filter lifetime by up to 90%. Even worse, the activated carbon filter does not warn the user when it is saturated. It will simply allow oil to pass on to processes. For Atlas Copco's oil-free screw compressors, air quality is independent of temperature.

The Arguments for Oil-free Compressors

Compared with oil-injected compressors, Atlas Copco oil-free screw compressors offer you benefits in terms of lower costs and environmental compliance. But above all, only oil-free compressors eliminate the risk to your business of oil contamination.

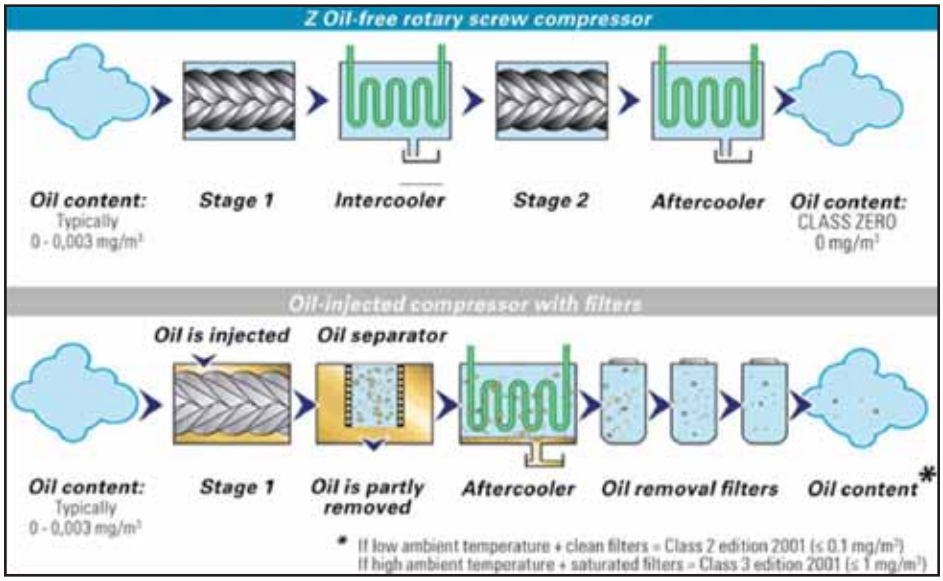
Lower cost of ownership

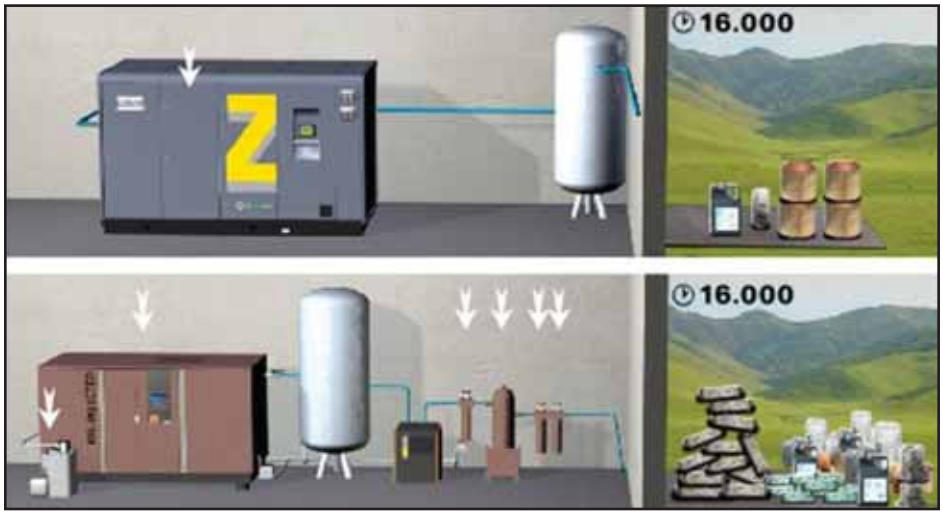
Atlas Copco oil-free technology reduces expenditures in four ways: by avoiding expensive filter replacements, cutting maintenance costs and costs of treating oily condensate, and avoiding the costs of extra energy needed to combat pressure drop in filters. These costs, although not apparent at the time of purchase, are very high and contribute substantially to the total cost of ownership. Moreover, as Atlas Copco's oil-free air compressors eliminate the risk of a contaminated end-product, production downtime and damaged reputation, CLASS 0 compressors are well worth the investment.

Eliminating risk

Oil-free screw compressors are designed specifically for applications demanding the highest levels of purity. Whether your activities are in pharmaceutical production, food processing, critical electronics or in a similarly exacting industry, zero oil means zero risk. Zero risk of contamination. Zero risk of damaged or unsafe products, or of losses due to operational downtime. Above all, zero oil means zero risk of ruining your hard-earned reputation.

COMPRESSED AIR SYSTEMS FOR ISO 8573-1, CLASS-ZERO, OIL-FREE AIR





The waste from consumables is significantly different over the lifespan of a compressor. Also, notice the points of regular maintenance (symbolized by the white arrows) between the two compressors.

Oil-injected compressors can only deliver "technically oi-free air"

The solution often referred to as "technically oil-free air" does not ensure complete air purity. Even under optimum conditions and with several stages of oil removal, the air quality with regard to oil is suspect. To achieve even barely acceptable air quality with oil-injected compressors, it is necessary to have air cooling devices and several stages of oil removal with multiple components. A failure of any of these components or inadequate maintenance can result in oil contamination of a process. With oil-injected compressors there will always be a risk of contamination and the possibility of severe consequences for the business.

Environmental compliance

With Atlas Copco's oil-free technology, leaks and energy waste are minimized. Also, the need for condensate management is eliminated. Lubricated air compressors require costly and time-consuming separation and disposal of the lubricants in the compressed air system. Lubricants will mix in with the condensate present in the compressed air. When separated by dryers and filters, this condensate must be disposed of properly. An oil-free air compressor means you can safeguard the environment and better comply with international regulations.

Meeting Expectations

With demands of manufacturing becoming more exacting and efficient with each passing year the move toward long term, ensured solutions have become the standard. By investing more on high-quality equipment that meets the strictest of standards, manufacturing plants across the country will see dividends paid down the road. In many cases that road can be quite short. But for those in the food and beverage, electronic, pharmaceutical, textile, and many other industries where the need for oil-free compressed air is absolute, the payoff is immediate. A Class Zero compressor eliminates the possibility of oil contamination in your process, therefore ensuring satisfaction and meeting expectations.

For more information please contact Tim McDonald, Atlas Copco, tel: 413-493-7213, email: tim.mcdonald@us.atlascopco.com, or visit www.atlascopco.com or for more information on ISO 8573-1 Class 0 please visit www.classzero

DIRECTAIR®

COMPRESSED AIR UTILITY SERVICE

BY KURT LANG

Compressed air has been called industry's 4th utility. Along with electricity, water, and natural gas, compressed air is a basic resource powering everything from hand-held pneumatic tools to plant-wide manufacturing systems. Most industrial concerns produce their own compressed air. Increasingly, however, manufacturers are beginning to treat compressed air as they would any other utility. They purchase compressed air, not compressed air equipment.

In simple terms, a third party supplier manufactures compressed air on a user's site, and the user agrees to purchase the quantity and quality of compressed air required. A pioneer and one of the largest suppliers in the U.S. is Direct*AIR*, a division of Air Technologies. Based in Columbus, Ohio, and with offices throughout Ohio, Pennsylvania, West Virginia, Kentucky and Michigan, Air Technologies is the largest distributor of Atlas Copco air compressors in the world.

Air Technologies Headquarters in Columbus, Ohio

DIRECT*AIR*® COMPRESSED AIR UTILITY SERVICE

Necessity Drives Invention

Providing compressed air as a utility service, pioneered in 1995, is possible because of expertise created out of necessity. Steve Schoeny, Corporate Utility Services Manager for Air Technologies, explains.

"In 1993, Air Technologies sold 20 compressors to a major gas utility company for filling their CNG vehicles, and we were responsible for maintaining the compressors. They had PLC's (programmable logic controllers) that sent an alarm to a technician's pager if a problem was brewing. When there was an alarm, a technician would drive to the site, which could be hours away, to address the issue. Too often he'd drive all the way just to hit a reset button."

Schoeny says what solved the problem was the ingenuity of technicians. "We had some in-house techs who were extremely intelligent, knew our machinery inside and out, and had background writing software code. They decided to design and produce a control system to run compressors unattended 24/7 and monitor them remotely. Just like that we had something special."

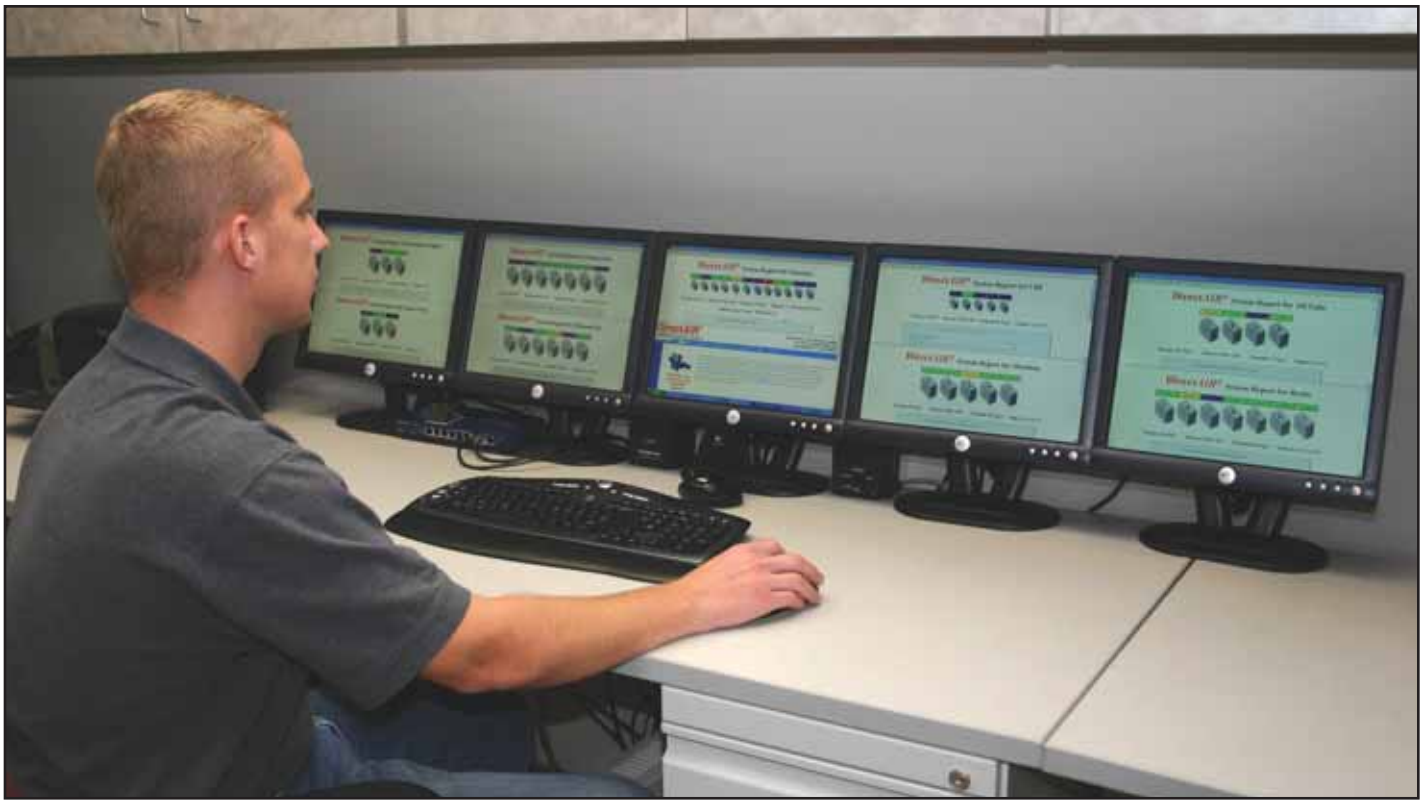
Air Technologies was already applying this remote capability for the utility company when they got a call from another business neighbor in Southwest, Ohio. "A steel mill was shutting down one of their on-site power houses," says Schoeny. "They asked if we could supply them with compressed air — not air compressors, just compressed air."

Schoeny talked it over with Phil Derrow, then president of the group and now the CEO of Ohio Transmission Corporation, the parent company of Air Technologies. The idea was interesting, the risk was manageable, and the potential was enormous. The necessary skills, the culture for risk taking, and the financial resources were at hand. With the equipment, expertise, technology and a responsive service organization at the ready, the venture looked promising.

Simply stated, it worked — to the benefit of all parties. Building on the success of the steel mill installation, Schoeny's team began to develop the concept into a separate business that evolved into Direct*AIR*. As of the date of this publication, Direct*AIR* operates 21 air as a utility service sites in the U.S., mainly in the Midwest and Northeast.

Combined, these sites have 81 Atlas Copco compressors, 16,475 installed HP, the ability to deliver over 70,000 cfm, and total installed Direct*AIR* assets of nearly $10 million. Significantly, because of Air Technologies' application and service expertise combined with the superior reliability of Atlas Copco compressors, machines at Direct*AIR* sites have reliably logged more than 1.5 million running hours and delivered more than 61 ***billion*** cubic feet of clean, dry compressed air. In more than 500,000 hours of combined site operations, Direct*AIR* customers have not experienced a single continuous hour of lost production because of low air pressure. That is equivalent to more than 50 *years* of combined operation without an hour lost.

Direct*AIR* Installation With Atlas Copco Compressors



Direct*AIR* sites are monitored 24/7 by a certified master service technician

DirectAIR Is About Reliability

A customer that requires compressed air provides the necessary land and utility hook ups. Direct*AIR* supplies, installs, operates, and maintains a new air compressor system. A monthly fee is charged based on the customer's compressed air consumption, with billing similar to what a manufacturer gets from their electrical power supplier.

"Direct*AIR* customers never have to buy another air compressor or dryer," Schoeny says. "They never issue another purchase order for repairs or maintenance of compressors, and all but eliminate the possibility of costly production down-time due to loss of air or poor quality air. It's a different value proposition because we are really selling ***reliability*** — guaranteed reliability with more than 50 years of combined operational hours to back it up."

Because Direct*AIR* is selling reliability, the company takes responsibility for engineering the most reliable system possible. The heart of the systems are Atlas Copco compressors, filters and dryers because Atlas Copco, the world's largest manufacturer of industrial air compressors, has an outstanding record of designing and producing efficient, reliable machines. Manag*AIR* — today's version of the software created by Air Technologies' technicians — enables unattended operation and remote monitoring with intuitive, point-and-click access to real-time data. Air Technologies supports the operation with predictive and preventive maintenance.

"All Direct*AIR* installations have full feature, top-of-the-line systems," Schoeny explains. "We won't cut corners because we know what it takes to make a system 100% reliable. Our compressors don't have major failures because we never let them get close to that condition. This keeps costs low over the long term, which enables Direct*AIR* to offer fee-for-service compressed air cost-effectively for our customers."

DIRECT*AIR*® COMPRESSED AIR UTILITY SERVICE

System Design

Every Direct*AIR* installation is built to meet a unique customer's needs and designed for maximum efficiency, performance and reliability. Our software manages the use of the equipment at the site assuring only the most efficient and reliable units are on line at any one time and notifies us electronically of any problems so they can be resolved before they can escalate.

The systems are modular so they can be decentralized, with multiple locations reducing operating costs and improving system-wide pressure balance. Modules are easily added or removed to address changes in the need for compressed air. This offers a degree of flexibility that's hard to duplicate with owned or leased compressors.

Direct*AIR* installations are as small as two 25-hp compressors that deliver 200 cfm and can be as large as a customer requires. For example, a new installation at an auto plant features twelve 350-hp compressors that deliver 18,000 cfm.

Financial Considerations

Corporate financial people are finding many reasons to like Direct*AIR*. There are no assets to purchase and no leases to capitalize, so Direct*AIR* is good for a company's balance sheet. It's a long-term solution but with the flexibility to cancel on short notice with minimal financial exposure. And, depending where a facility is located, a Direct*AIR* arrangement may lower property taxes.

Direct*AIR* improves planning by eliminating cost variables including service, repair, lubricants, disposal of oil, costs from inefficient machinery and controls, lost production and scrap due to poor air quality, and excessive in-plant maintenance due to poor air quality.

It's important to realize that Direct*AIR* is not a lease arrangement. It's a no-hassle, fee-for-service utility that includes:

- Design engineering, installation, and buildings
- All operation, maintenance, and service
- Guarantees with penalties
- Ability to cancel with a minimal charge

DirectAIR Advantages

- State-of-the-art technology
- Field proven reliability
- Total system responsibility
- Modular flexibility
- Fee-for-service simplicity
- Guaranteed performance

Focus On Core Competencies

"Selecting Direct*AIR* not only frees up capital for more profitable investment elsewhere in your business," Schoeny explains, "it enables your people to focus on your business instead of compressed air. It really comes down to core competencies. Our customers are in the business of manufacturing automobile parts or paper or fluid controls or chemicals or steel. Direct*AIR* is in the business of supplying superior quality compressed air with 100% reliability. Everything about Direct*AIR* focuses on being a compressed air supplier. It's hard to overstate the importance of this point. Since the beginning of the compressed air industry, customers have struggled to justify the investments in assets and people to design, purchase and maintain reliable compressed air systems, and frequently had to live with less than reliable results. With Direct*AIR*, customers don't have to live with anything but 100% reliability, guaranteed."

What started in 1995 with a single Direct*AIR* contract has grown continuously. Some in the industry view it as the new paradigm for compressed air —— a flexible, reliable, cost-effective solution for industry's 4th utility.

Direct*AIR* is *not* a lease arrangement. It's a no-hassle, fee-for-service utility. Every Direct*AIR* arrangement includes:

- Design engineering, installation, and buildings
- All operation, maintenance, and service
- Guarantees without penalties
- Ability to cancel with a minimal decommissioning charge

For more information please contact Steve Schoeny at Direct*AIR*, tel:1-800-536-8411 x632, email: sschoeny@aircompressors.com

INDUSTRIAL MARKETING

On-line Marketing for Industrial Companies

BY ROD SMITH

What Does Your Web Site Accomplish?

Is your companies' web site a necessary evil? Does your firm, because everyone else has one, have a web site with "About Us", "Products", and "Jobs" (with outdated jobs in it) buttons? Or, perhaps your firm invested in a very professional-looking web site, which presents your company in the best possible manner to the world. Finally, it could be that your web site is "making a difference" on the financial results of your company. All three results are present, in industrial marketing, with the first two being the most common.

What Are the Objectives of the Web Site?

All too often a web site is created with no clear expectation of what the results will be. Did your firm really establish objectives up-front? There are three suggested primary objectives of a web site designed to represent industrial companies; increase brand awareness, provide value to the visitor, and generate sales leads and orders. This column will discuss providing value to the visitor of your web site.

Providing Value to the Visitor

It is very easy to fall into the trap of writing too much web content covering your company history, the many fine factories, and the incredible technical developments your company has accomplished since the 1800's. For the plant engineer who now does the job that three plant engineers did ten years ago, information and knowledge-transfer is all he/she is interested in. If the plant engineer/specifier has time to read your company history, they probably won't keep their job too long.

Knowledge-Transfer is the #1 Objective

Help your customers do their job. If they are visiting your web site, it's probably because they have a job to do in your area of business. Transfer your knowledge to them efficiently. If they are looking for information on a product of yours they purchased (instruction manuals, spare parts lists, drawings, specs), make it EASY to find and FAST to retrieve. A positive experience may lead them to want to keep purchasing your products.

Some surveys indicate that a high percentage of capital equipment purchasers turn to the web to begin researching potential vendors. Placing tools for their use, such as product configurators or energy-efficiency calculators, can help customers do their own evaluations of benefits and features. Make it convenient for them to analyze your products off your web site. They will do it when it suits them-not just when a sales appointment is made. Provide them with the in-depth numbers and technical information companies used to keep secret. A good example of this is provided by Bosch Rexroth Corporation at www.boschrexroth-us.com/tools.

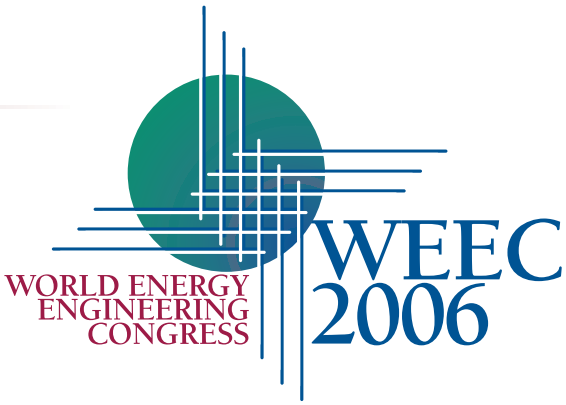
Maximize Your Budget by Delivering Value to Customers

Set realistic expectations considering the time, effort, and dollars your company will invest in the web site. Like any other initiative, there is a relationship between investment and results. A smart investment will prioritize spending money on what your customers want to receive off of the web. To be sure, don't assume your company already know what the customers want — ask them. After having your firms valued (vs non-valued) knowledge transferred to them, they will find a way to reward you for your investment.

This is the first of a series of articles on industrial internet marketing. Rod Smith is the former Vice President of Marketing for Hankison, PPC, & Deltech (divisions of SPX Corporation) and for Quincy Compressor (a division of EnPro Industries).

TRADE SHOW REVIEW

THE WORLD ENERGY ENGINEERING CONFERENCE



The World Energy Engineering Conference (WEEC) was held September 13–15 in Washington D.C. Presented by the Association of Energy Engineers (AEE), the show drew corporate energy managers from industrial firms around the country. The AEE, a non-profit society, has grown to 9,000 professionals in 75 countries with 70 chapters around the world, under the direction of the Executive Director, Mr. Albert Thumann, who founded the organization in 1977.

Compressed Air Best Practices Magazine had its' inaugural trade show booth at the WEEC! We have been mailing the magazine to the AEE's membership, as our core audience, due to the members' commitment to reduce energy consumption in industrial facilities. We were excited and honored to receive many favorable comments from AEE members, stopping by our booth, who had read the magazine.

Walking around the show, Compressed Air Best Practices Magazine was impressed by all the show participants. A few of note were:

- Sensicast Systems Inc. (www.sensicast.com) had a very interesting array of wireless sensors, which can assist with compressed air audits.
- Siemens (www.siemens.com) had a PS-2 flow control valve with zero air-loss, which can provide energy savings
- Connected Energy Corp (www.connectedenergy.com) displayed a pre-engineered virtual control center from which the energy costs of an entire facility can be managed.

The WEEC began with a morning of impressive presentations. Senator Mel Martinez (R-FL) spoke of his interest to increase America's energy independence. Senator Martinez is on the Senate Energy Committee. He supports alternative fuel initiatives, like the building of 34 new sugar-cane ethanol plants which could support E-85 fuel, while also supporting additional "safe" oil drilling in Anwar, Alaska and in the Gulf of Mexico.

The AEE then presented Senator Byron Dorgan (D-SD) its Energy Executive of the Year Award. Senator Dorgan has been leading promoter of ethanol, fuel cells, and wind energy. As the ranking member on the Appropriations Interior Subcommittee, Senator Dorgan has supported vital DOE and EPA programs for energy efficiency each year. Senator Dorgan has recently published a book titled "Take This Job and Ship It!" discussing concerns with the "offshoring" of U.S. industry. Senator Dorgan discussed the four objectives of the new Energy Bill:

1. Increase supply of oil: Senator Dorgan supports drilling in the Gulf of Mexico but not in Alaska
2. Conserve energy in the U.S. Senator Dorgan gave the example that of the 84 million barrels of oil extracted from the earth per day, 21 million are used in the U.S.
3. Invest $3.575 billion in renewable alternative energy sources such as wind, solar, and hydrogen fuel cells
4. Establish a renewable energy standard

After Senator Dorgan's award, seventeen U.S. manufacturing plants became first-time winners of EPA's Energy Star award in recognition of their energy-efficient operations that prevented some 3 billion pounds of greenhouse gas emissions. The manufacturers' efforts not only cut pollution but also lowered energy consumption and reduced costs." By committing to smart energy use, America's historic economic backbone is now supporting our nation's brightening environmental future," said U.S. EPA Administrator Stephen L. Johnson. "Working with our manufacturing partners, we are implementing President Bush's aggressive and practical strategy to reduce greenhouse gas emissions while growing the American economy." The plants represent six percent of cement production capacity; seven percent of wet corn milling capacity; and 23 percent of auto assembly capacity.

The first plants being recognized with the Energy Star award, listed by industry, include:

Auto Assembly

The Ford Motor Company assembly plant in Chicago, Ill.

The Ford Motor Company assembly plant in St. Paul, Minn.

The Ford Motor Company assembly plant in Claycomo, Mo.

The Ford Motor Company assembly plant in Norfolk, Va.

The Nissan North America, Inc. assembly plant in Canton, Miss.

The Nissan North America, Inc. assembly plant in Smyrna, Tenn.

The Toyota Motor Engineering & Manufacturing North America, Inc. assembly plant (NUMMI passenger) in Fremont, Calif.

The Toyota Motor Engineering & Manufacturing North America, Inc. assembly plant in Princeton, Ind.

The Toyota Motor Engineering & Manufacturing North America, Inc. assembly plant in Georgetown, Ky.

Cement

The Ash Grove Cement Company plant in Chanute, Kan.

The Ash Grove Cement Company plant in Seattle, Wash.

The California Portland Cement Company plant in Colton, Calif.

The California Portland Cement Company plant in Mojave, Calif.

The Lafarge North America plant in Calera, Ala.

The Lafarge North America plant in Sugar Creek, Mo.

Wet Corn Milling

The Penford Products Company plant in Cedar Rapids, IA

The Tate and Lyle Ingredients Americas, Inc. Sagamore plant in Lafayette, Ind.

For more information on the WEEC visit www.energycongress.com

> "The manufacturers' efforts not only cut pollution but also lowered energy consumption and reduced costs."

JOB MARKET

Job Openings in the Compressed Air Industry

Consulting Services • Career Opportunities • Compressor Products • Clean Air Treatment Products

Sales Professionals

At Kaeser, we pride ourselves on being the world's leading innovator in air system technology. Being a leader means making a commitment to attracting the best and brightest professionals to become part of our company. As we continue to grow we are searching for aggressive, self-motivated Sales Professionals.

Successful candidates will have the following skills and attributes:

- ✓ A minimum of 2-5 years air compressor or industrial equipment sales experience
- ✓ Time and territorial management skills
- ✓ Professional presentation skills
- ✓ PC skills including Word, Excel, PowerPoint, and ACT Database

We offer a competitive salary and commission program, as well as a comprehensive benefit package.

Kaeser has opportunities in various locations throughout the US. For the most up-to-date information on specific openings, contact our Human Resources department.

PO Box 946, Fredericksburg, VA 22404
800-984-9930 ext. 530 ■ Fax: 540-834-4506 ■ hr@kaeser.com
Visit our website at **www.kaeser.com/careers**

KAESER COMPRESSORS
Built for a lifetime.™

Equal Opportunity Employer M/F/D/V

Compressed Air Best Practices

JOB MARKET ADVERTISING RATES

MAGAZINE ADS

For smaller classified-type ads use the following rates per column inch:

1x per year: $94.00* per column inch
3x per year: $90.00* (i.e., this is a 6 col. inch, reversed ad)
12x per year: $84.00*

*reversed ads = 1.5x normal price

Add $50.00 to post the job opening on www.airbestpractices.com when you purchase an ad in the magazine

Contact Patricia Smith for 4 color full page, 1/2 page and 1/3 page ad rates

ONLINE ONLY ADS

Each job posting is up on the site for 60 days. Postings can be purchased in bulk quantities per the rates below. The customer has twelve months to put the postings on the site. After twelve months, any unused postings will be charged at the minimum quantity.

Small Qty.	Price Per Posting	Bulk Qty.	Price Per Posting
1	$250	5-9	$185
2	230	10-24	170
3	210	25-49	150
4	195	50+	135

patricia@airbestpractices.com, tel: 251-510-2598

Validated Process Filters

including
sterile & culinary steam filters
aeration & vent filters

also specializing in
refrigerated dryers
adsorption dryers
microfiltration
breathing air

5900-B Northwoods Pkwy.
Charlotte, NC 28269
Toll free: 1-800-543-0851 Fax: (678) 924-1111
email: zanderusa@zanderusa.com
web: http://www.zanderusa.com

ZANDER®

Chances are, you'll retire before your Kaeser compressor.

If you're looking for the best lifetime value in air compressors today, look no further than Kaeser. When you consider our durability, performance and easy maintenance – all rolled into one – we're the most reliable compressed air equipment you can buy, hands down.

Every compressor we build stands up to the toughest conditions, for years of trouble-free operation. Superior energy efficiency and easy service just add to the benefits and savings you receive. Plus, with a full range of sizes and models to choose from, there's a Kaeser compressor that will meet your specific needs.

To learn more about Kaeser value and "built for a lifetime" engineering, call us toll-free or visit **www.kaeser.com**.

KAESER COMPRESSORS

Built for a lifetime.™

www.kaeser.com

Member of COMPRESSED AIR AND GAS INSTITUTE CAGI www.cagi.org

Kaeser Compressors, Inc., P.O. Box 946, Fredericksburg, VA 22404 USA ■ (800) 777-7873 ■ info.usa@kaeser.com

Certified Management Systems ISO 9001:2000 Quality 14001:2004 Environmental