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

COMPRESSED AIR BEST PRACTICES

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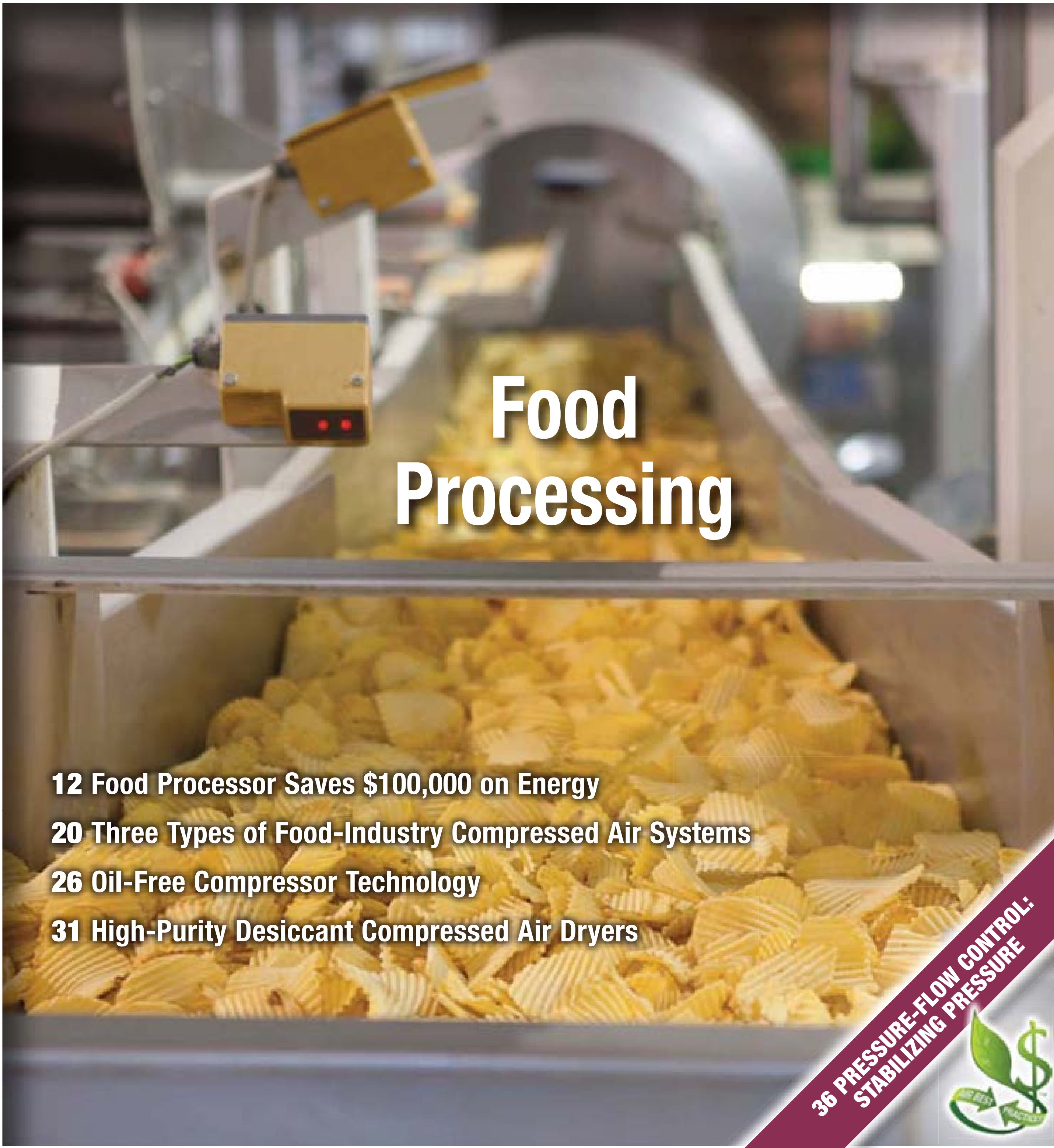
October 2012



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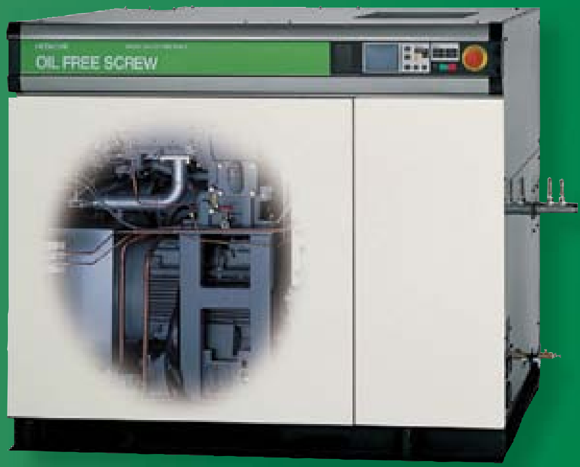

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SUSTAINABLE MANUFACTURING FEATURES

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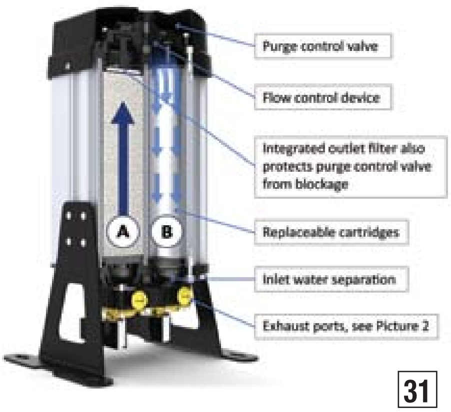

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FROM THE EDITOR | Food Processing

➤ The food industry is extremely competitive. Factories are typically extremely well run as there is no room for inefficiencies or quality issues. This issue of Compressed Air Best Practices® Magazine provides some knowledge on two areas; air quality and energy-efficiency.

Veteran system assessment expert, Hank van Ormer, kicks things off with a food processing plant — where nothing needed to be fixed! Plant pressure and air quality were fine. A closer look, however, found heatless desiccant dryer purge and variable displacement controls needing repairs that would provide energy savings. Coupled with other demand-side flow-reduction actions, four air compressors were turned OFF and the plant saved $100,000 per year on their energy bill.

What kind of compressed air system should be installed in a food processing plant? Nitin Shanbhag, from Hitachi America, provides the answer. "Three Types of Food-Industry Compressed Air Systems" asks plants the right questions as to how they are using compressed air — and then provides the recommended system.

With regards to air quality, we have a technology profile article on Anest Iwata — a leading manufacturer of oil-free air compressor technology. Another profile on "High-Purity Desiccant Air Dryers" is written by Colin Billiet, from nano-porous systems. Mr. Billiet is one of the most experienced in our industry and we hope you profit from his knowledge.

Last but not least, Mr. Bob Wilson on behalf of the Compressed Air Challenge®, provides us with an excellent review of Pressure-Flow Control. As obsessed as we can be with energy savings, this article is an appropriate reminder that compressed air reliability remains the number one priority for compressed air users. The role that Pressure-Flow Control technology can play is very interesting.

We thank the authors above for sharing their knowledge and thank you for your support and for investing in ***Compressed Air Best Practices®***. BP

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

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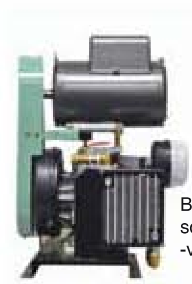
OEM PRODUCT OFFERINGS

Base mounted scroll compressors -horizontal configuration



Base mounted scroll compressors -vertical configuration

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COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

Compressed Air Systems From A Single Source

New BOGE Anlagenbau Company focused on turnkey projects and special solutions. The newly established BOGE Anlagenbau GmbH & Co. offers complete systems consisting of compressed air components, pipework, cabling and ventilation — all from a single source. Generally speaking, customers need only specify the intended application, volume, quality and required pressure for the experienced BOGE experts to plan the optimal, tailored compressed air station for them. Customers are assigned a central project manager as their personal contact throughout the entire process from enquiry to site acceptance.

With compressed air systems, sustainable energy concepts provide the most scope for savings, so the BOGE project team places the emphasis on the most efficient solution every time they set about developing a system. Efficiency hinges on the energy consumption of a compressed air system, and with large systems in particular, there are considerable amounts of energy to be saved. The BOGE engineers achieve these savings to the full by conducting a detailed needs analysis, a tailored engineering concept with suitable compressor types and treatment components, intelligent controllers, heat recovery solutions and a well-wrought pipework concept. For customers, this boils down to a potential reduction of 30% in energy and maintenance costs. Especially with oil-free compressed air stations with highly specific heat recovery, energy-optimized systems have been developed which meet the very highest standards.

Base frames and turnkey container solutions account for an increasing proportion of the business of BOGE Anlagenbau GmbH und Co. KG. In addition to pure compressed air production, the company also offers components for nitrogen production and compression as well as steam-turbine driven compressors. Compressed air contracting constitutes another business line: here, customers only pay for the volume of compressed air used, allowing them to concentrate fully on their core business. The team at BOGE Anlagenbau provides a comprehensive advisory service for everything to do with compressed air.

www.boge.com/us

Atlas Copco Acquires Compressor Manufacturer in Turkey

Atlas Copco has agreed to acquire the Ekomak Group, a Turkish manufacturer of industrial screw compressors, strengthening its market position in the region. Ekomak has a strong domestic position in industries such as metal works, textile and manufacturing.

Ekomak was established in 1992 and has around 160 employees. It is privately owned and had revenues in the last 12 months of approximately MEUR 23 (MSEK 200). The company develops, produces and sells stationary, oil-injected screw compressors, including variable frequency drive options.

Headquartered in Istanbul with manufacturing in Edirne, Turkey, Ekomak also has its own sales and service operations in Russia and Germany and a network of distributors for other countries. "By acquiring Ekomak, we will further expand and strengthen our presence in Turkey and Russia. Ekomak is a well-established brand within its segments and markets. It has a strong potential for further growth and is a good complement to our existing offering," says Stephan Kuhn, Business Area President for Compressor Technique. Ekomak will be part of the Industrial Air division within Compressor Technique. The acquisition is expected to be closed during the third quarter of 2012.

Atlas Copco

www.atlascopco.com

class zero

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COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

Metalplan Receives ISO 50001 Certification

Metalplan, a Brazilian air compressor manufacturer located in São Paulo, has been granted the ISO 50001 Certification.

Not a small deed for a medium size, world class, manufacturer, in the booming, competitive Brazilian environment. Air compressors are used by almost all industries, and consume great amounts of energy, but as ISO Secretary-General Rob Steele states. "Individual organizations cannot control energy prices, government policies or the global economy, but they can improve the way they manage energy in the here and now. Improved energy performance can provide rapid benefits for an organization by maximizing the use of its energy sources and energy-related assets, thus reducing both energy cost and consumption."

This is exactly the path Metalplan is following, says Edgard Dutra Jr. a partner at Metalplan. According to ISO, the International Organization for Standardization, ISO 50001 is intended to provide organizations with a recognized framework for integrating energy performance into their management practices. Multinational entities will have access to a single, harmonized standard for implementation across the organization with a logical and consistent methodology for identifying and implementing improvements. The ISO 50001 standard is intended to accomplish the following:

- Assist organizations in making better use of their existing energy-consuming assets
- Create transparency and facilitate communication on the management of energy resources
- Promote energy management best practices and reinforce good energy management behaviors
- Assist facilities in evaluating and prioritizing the implementation of new energy-efficient technologies
- Provide a framework for promoting energy efficiency throughout the supply chain
- Facilitate energy management improvements for greenhouse gas emission reduction projects
- Allow integration with other organizational management systems such as environmental, and health and safety

www.metalplan.com.br

DEKKER VACUUM TECHNOLOGIES, INC.

Dekker Vacuum Technologies Receives ISO 9001:2008 Certification

Dekker Vacuum Technologies announced it has received ISO 9001:2008 certification from Integrated Management Systems Group, LLC, an accredited registrar. The scope of Dekker's ISO certification covers the design, manufacture and service of vacuum pumps and systems, along with the sale of related products and spare parts.

Rick Dekker, President and CEO of Dekker Vacuum Technologies, Inc. stated: "Achieving ISO 9001 Certification is an important accomplishment for our company. We strive for excellence in every aspect of our business and having ISO 9001 certification confirms that our people not only embrace quality management, but are committed to continuous improvement in everything we do. We trust that our customers will recognize our commitment to continuous quality improvement, and that our ISO 9001 certification will yield real benefits for their business."

Dekker Vacuum is an industry leader in the manufacture and distribution of vacuum pumps and systems for diverse markets; such as Plastics, Pharmaceuticals, Laboratories, Metal Processing, Food, Chemical, Power Generation and many others. Established in 1998, Dekker Vacuum Technologies is a privately held company with over 50 employees, operating in a 45,000 square foot manufacturing, distribution and warehouse facility in Michigan City, Indiana.

www.dekkervacuum.com

The AICD Opens Up Membership

The Association of Independent Compressor Distributors (AICD) has opened its membership to all independent compressor distributors — regardless of the manufacturer they represent. "We believe this will make for a truly independent group that allows for each member to be better equipped to face the challenges of distributing and servicing an engineered product," said AICD President Manny Cafiero. "Our type of distribution is unique and to be able to network with others dealing with similar issues is priceless."

Founded in 1985, the AICD provides many tools to help compressor distributors grow and better run their businesses. The annual conference provides distributors with a forum to exchange ideas, learn about new products and services from attending exhibitors, and learn from the great line-up of speakers that inform and enlighten. The next AICD Conference is scheduled for June 2-4 at the Gaylord Opryland Resort in Nashville, Tennessee.

AICD members are entitled to use the AICD's web-based service skills training that delivers an efficient way to evaluate and train compressor service mechanics. AICD members also benefit from a vehicle incentive program that allowing members to purchase vehicles at a significant discount. The AICD Board looks forward to welcoming new compressor distributors as members and working with them in the future.

www.aicd.org

A.I.C.D. ASSOCIATION OF INDEPENDENT COMPRESSOR DISTRIBUTORS

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

THE SYSTEM ASSESSMENT

Food Processor Saves $101,000

By Hank van Ormer, Air Power USA

October 2012 System Assessment of the Month

Where: North America
Industry: Food Processing
Issues: Dryer Purge and Air Leak Losses
Audit Type: Supply and Demand Side

System Assessment Win/Win Results*

Energy Savings per year: $100,855
Project Investment: $100,000
Simple ROI: 12 months
Reduction in Energy Use: 2,521,375 kWh
Equivalent CO_2 Emissions: 1,810 metric tons*
Equivalent CO_2 for homes: 235 homes
Equivalent CO_2 for vehicles: 346 vehicles

*Source: CO_2 Calculator on www.airbestpractices.com

The Facility

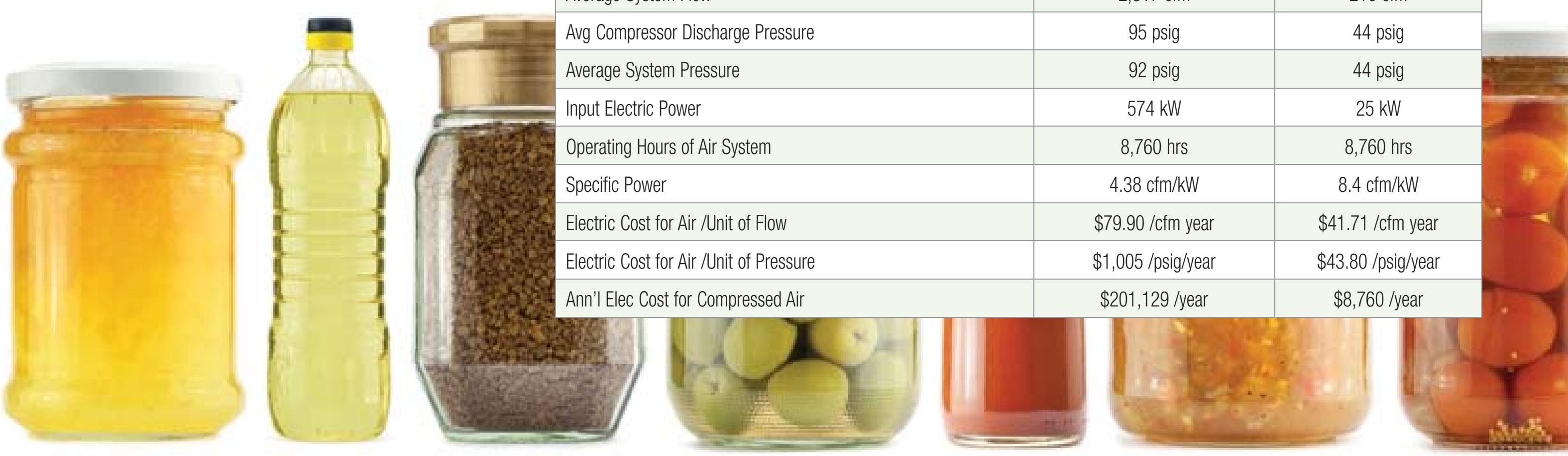
This facility is part of a major corporation with dozens of manufacturing facilities where consumer good food products are processed and packaged for shipment to retail outlets. The factory was spending $210,000 annually on energy to operate their compressed air system. This system assessment detailed four (4) project areas where yearly energy savings totaling $100,855 could be found with an investment of $100,000. The over-all strategy for improving this air system centers on getting the controls of the installed air compressors to translate reduced air demand into reduce kW consumption and to reduce over-all demand with compressed air savings projects.

TABLE 1. THE BASELINE: CURRENT SYSTEM COMPRESSOR USE PROFILE

		FULL LOAD		AIR FLOW (SCFM)		ACTUAL AIR FLOW	
ROOM #	COMPRESSOR: MODEL	DEMAND (KW)	AIR FLOW (SCFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL SCFM
All Shifts: Operating at 95 psig discharge pressure for 8,760 hours							
1	Compressor #1	172	888	93%	161	76%	675
1	Compressor #2	172	888	82	161	77%	683
2	Compressor #3	136	620	96%	131	87%	539
2	Compressor #4	136	620	100%	141	100%	620
3	Compressor #5	192	OFF				
			TOTAL (Actual):		**574 kW**		**2,517 acfm**
Wastewater Shift: Operating at 44 psig discharge pressure and 8,760 hours							
4	Compressor #6	45.5	210	55%	25	100%	210
			TOTAL (Actual):		**25 kW**		**210 acfm**

TABLE 2. THE BASELINE: CURRENT SYSTEM KEY CHARACTERISTICS

	MAIN PRODUCTION	WATER TREATMENT
Average System Flow	2,517 cfm	210 cfm
Avg Compressor Discharge Pressure	95 psig	44 psig
Average System Pressure	92 psig	44 psig
Input Electric Power	574 kW	25 kW
Operating Hours of Air System	8,760 hrs	8,760 hrs
Specific Power	4.38 cfm/kW	8.4 cfm/kW
Electric Cost for Air /Unit of Flow	$79.90 /cfm year	$41.71 /cfm year
Electric Cost for Air /Unit of Pressure	$1,005 /psig/year	$43.80 /psig/year
Ann'l Elec Cost for Compressed Air	$201,129 /year	$8,760 /year



This plant is similar to the majority of plants we encounter. On the surface, there are no problems. Plant pressure and air quality are satisfactory and the air compressors, in general, are performing well with the usual maintenance requirements. This system assessment discovers demand-side opportunities to reduce the consumption of compressed air (from 2,727 acfm to 1,460 acfm) which then allows us to TURN OFF four air compressors — and realize reduced energy and maintenance costs.

Measurement Actions Establish the Baseline

You can't manage what you don't measure and the first step of any system assessment is to use the measurement instruments necessary to see what's happening. The following actions were taken to establish the baseline for flow, power and pressure.

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

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

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

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

THE SYSTEM ASSESSMENT

Food Processor Saves $101,000

TABLE 3: COMPRESSED AIR DRYERS		
MANUFACTURER	COMPRESSOR ROOMS #1 AND #2	COMPRESSOR ROOM #3
Unit Type	One Heatless Desiccant Dryer in Each Room	Heatless Desiccant Dryer
Rated Flow @ 100 ºF/100 psig	2 x 2,400 cfm	1,000 cfm
Purge: cfm	2 x 360 cfm	150
% Load w/ Dew Point Demand Control	not functioning	Back-up unit
Total Annual Cost ($) @ $79.90 /scfm – Table 1	$57,528**	$11,985***

* Based on blended electric rates of $0.04 per kWh and operation of 8,760 hours per year.
** Two units ***Unit runs in back up.

TABLE 4: IDENTIFIED LEAK LIST (PARTIAL)					
NO	LOCATION	DESCRIPTION	EST SIZE	EST CFM	COMMENTS
1	Bagger	Blue hose fitting	small	2	67914
2	Bagger	Blue hose fitting	small	3	44979
3	Scales	Regulator	small	3	Line O
4	Scales	Filter Drain	medium	5	Line J east
5	Scales	regulator underneath	small	3	Line H east
6	Scales	Fitting on filter	small	2	Line E east
7	Scales	Regulator	medium	5	Line E west
8	Scales	Fitting on wall	small	3	Line F
9	Scales	Filter Drain	small	3	Line F
10	Blue Print	Solenoid	small	3	Line W
11	Blue Print	Cylinder	medium	5	Line W
12	Bagger	Blue hose fitting	small	2	755A Line 4
13	Bagger	Filter Drain	medium	5	790A Line L
14	Line O	regulator gauge	small	1	backside of machine
15	Line Q	Lubricator	small	2	Marq Tuff
16	Scales	Cylinder hose fitting	small	2	Line S
17	South Peeler	Lubricator	large	10	—
18	Specialty Sorter	Lubricator	small	3	819A
19	North Peeler	Filter drain	small	3	2nd level control box
20	South Peeler	Solenoid	small	3	2nd level control box
			Total cfm	**68 cfm**	

TABLE 5: LIST OF CABINET COOLERS IN PLANT							
LOCATION	TYPE	SIZE (CFM)	QUANTITY	CURRENT UTILIZATION %	COOLER BTU/ HR RATING	ACTION OR RECOMMENDED COOLER	SAVINGS (CFM)
Prime 1	Vortex	10	8	100	1,500	Pelletier	80
Prime 2	Vortex	10	2	100	1,500	Pelletier	20
Prime 3	Vortex	11	4	100	1,500	Pelletier	44
						Total CFM Saved	**144**

5. An accurate compressor operating performance curve was created for the modulating controlled unit. Each unit has its full load kW measured and its no load (without) blow down kW measured. These were then entered on the appropriate charts. The measured and recorded kW as a percent of full load power was then aligned to the appropriate percent of flow. The recorded kW curves can then be accurately transformed to flow (cfm).

The Baseline: Supply-Side System Overview

The plant works 8,760 hours per year and has three different compressor rooms all using rotary screw air compressors piped to heatless desiccant air dryers. There is an additional air compressor being used solely for wastewater aeration. The system pressure runs from 75 to 101 psig in the headers during production. Total air demand is 2,517 acfm for plant use plus 210 acfm for wastewater aeration. Specific power is 4.38 cfm/kW for plant use and 8.4 cfm/kW for the wastewater. Specific power is an important compressor efficiency metric as it measures how much cfm is produced per kW of input power.

The first compressor room has compressors #1 and #2. Compressor #1's variable displacement control system has been changed to two-step control. This unit could not be manually unloaded when compressor #5 was running. Compressor #2's variable displacement control system was not working properly-the valve would stick in the partially open position. The oil cooler, on this unit, is not performing as designed. These air compressors are in good shape but need to have these items repaired for them to get back to peak performance.

Compressor's #3 through #6 are all in good working order. Compressor #6 is delivering 45 psig air to the wastewater aeration application and is an example of an inappropriate use of compressed air.

The compressed air dryers are heatless (pressure-swing) desiccant air dryers. They are providing a -40 ˚F (-40 ˚C) pressure dewpoint. The concern here is that they are using the full 15% purge air requirement to regenerate the desiccant beds in the off-line tower. This is an example of artificial demand.

Overall the supply-side of this plant appears to be running smoothly and relatively efficiently for the existing demand levels.

TABLE 6: KEY AIR SYSTEM CHARACTERISTICS — PROPOSED SYSTEM

MEASURE	CURRENT COMPRESSOR AND COMPRESSOR ROOM
	ALL SHIFTS
Average System Flow	1,466 cfm
Avg Compressor Discharge Pressure	95 psig
Average System Pressure	92 psig
Input Electric Power	301 kW
Operating Hours of Air System	8,760 hrs
Specific Power	4.85 cfm/kW
Electric Cost for Air /Unit of Flow	$72.23 /cfm year
Electric Cost for Air /Unit of Pressure	$527.35 /psig/year
Ann'l Elec Cost for Compressed Air	$105,470 /year

*Based on a blended electric rate of $0.04 per kWh, 8,760 hours/year.

THE SYSTEM ASSESSMENT

Food Processor Saves $101,000

Demand-Side Projects to Reduce Compressed Air Consumption

The overall strategy for improving the air system centers on repairing purge controls on compressed air dryers and reducing overall demand. The recommended projects include:

Air Flow Reduction Projects	Air Flow Reduction
Repair purge control on dryer #1	180 acfm
Replace vortex cabinet coolers with thermoelectric units	144 acfm
Repair compressed air leaks	377 acfm
Use low-pressure blower for wastewater	210 acfm
Shut-off dryer #2 and eliminate purge air	360 acfm
Total Compressed Air Flow Reduction	1,271 acfm

Project #1: Air Dryers and Dewpoint Monitors

During our site visit, we asked plant personnel remove desiccant samples from all three dryers. The two 2400 cfm heatless dryers, in compressor rooms #1 and #2, have desiccant beds that appeared to be well worn and discolored. The desiccant in both of these dryers should be replaced and monitored/topped off every six months. Topping off the desiccant provides a dual benefit — first, it maintains a bed height for proper contact time to ensure dewpoint integrity. Second, it adds weight to keep the desiccant less mobile and help to alleviate some bed movement and help keep dusting to a minimum.

Both dewpoint monitors on the heatless desiccant dryers, in compressor rooms #1 and #2, are apparently not reading correctly. This is the opinion of plant personnel and Air Power USA personnel. By repairing or replacing the dewpoint monitors, working monitors will help plant personnel have a better handle when the operation of the dryers needs attention — e.g., desiccant condition.

This project completely turns OFF the desiccant dryers in compressor rooms #2 and #3 while keeping #3 available for back-up. This eliminates the 15% purge (360 cfm) generated by dryer #2. The project recommends installing a new dew point demand purge controller on the dryer in compressor #1. This will allow the purge rate to be reduced to approximately 7.5% (180 cfm) during partial load conditions in the plant on this dryer.

Project #2: Leak Identification and Repair

Most plants can benefit from an ongoing leak management program. Leak levels in most plants represent 15-25% of total compressed air demand. Generally speaking, the most effective programs are those that involve the production supervisors and operators working in concert with the maintenance personnel. Accordingly, it is suggested that all programs consist of the following:

- **Short Term** — Set up a continuing leak inspection by Maintenance Personnel so that for a while, each primary sector of the plant is inspected once each quarter to identify and repair leaks. A record should be kept of all findings, corrective measures, and overall results.
- **Long Term** — Consider setting up programs to motivate the operators and supervisors to identify and repair leaks. One method

that has worked well with many operations is to monitor the air flow to each department and make each department responsible for identifying its air usage as a measurable part of the operating expense for that area. This usually works best when combined with an effective in-house training, awareness, and incentive program.

TABLE 7. COMPRESSOR USE PROFILE – PROPOSED SYSTEM

UNIT #	COMPRESSOR: MANUFACTURER/ MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (SCFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL SCFM
All Shifts With Current Compressors: Operating at 95 psig discharge pressure for 8,760 hours							
1	Compressor #1	172	888	100%	172	100%	888
2	Compressor #2	172	888	75%	125	64%	578
			TOTAL (Actual):		301 kW		1,466 acfm

The area surveyed in the partial leak study included a great deal of high background ultrasound noise that shields many of the smaller leaks. In continuing the leak management program, plant staff should perform leak detection during non-production hours in order to eliminate some of the high ultrasonic background noise. We expect a total of at least 377 cfm in air leaks to be found.

Project #3: Cabinet Coolers

Cabinet cooling is often required to obtain reasonable life and performance of the electronic equipment in control cabinets. Blowing straight compressed air into the cabinet for cooling is generally not an efficient or cost-effective use of compressed air.

A very effective cooler that can cool below ambient when the heat load is within its capability is a Thermoelectric Air Conditioner which uses the "Pelletier effect" to convert low electric flow into refrigeration. The electric

THE SYSTEM ASSESSMENT

Food Processor Saves $101,000

current's effect on the dissimilar metals pulls the heat from the cold sinks and pushes it through the heat sink and out.

This project replaces 14 cabinet cooling applications from Vortex-type to thermo-electric type using the Pelletier effect. The estimated reduction in compressed air flow is 140 cfm representing a net annual electric savings of $11,297 per year.

Project #4: Misapplied High-Pressure Air

High-pressure air being used for very low-pressure applications is not an efficient use of energy. A close review of the plant's system should be made and measurements taken to identify whether there are any potential energy savings from using an alternate source of low-pressure or high-pressure air for specific applications in the production area.

Potential misapplications of high-pressure air include aeration and spraying, where fans, blowers, or low-pressure compressors can reduce energy costs. Low-pressure applications can range from 7 to 60 psid, while typical air systems are set at 90 to 120 psid.

This project replaces the current air compressor providing 210 cfm at 44 psig for wastewater aeration. It will be replaced with a low pressure blower providing annual energy savings of $6,750.

Project #5: Adjusting Air Compressor Controls

The two most common controls used for rotary screw compressors are **modulation** and **online/offline.** Modulation is relatively efficient at very high loads, but inefficient at lower loads. Online/offline controls are very efficient for loads below 60%, when properly applied with adequate time for blow down. There are several other control types — e.g., "variable displacement" (75% to 100% load) and "variable speed drive" (25% to 75% load) — that have very efficient turn down when applied correctly.

The current units have variable displacement capacity controls capable of translating "less air used" into a comparable reduction in electric cost. These controls will work effectively with the current piping and air receiver storage situation.

These variable displacement controls, on compressors #1 and #2, need to be repaired.

"Most of the overall system assessment energy savings of $100,855 are realized due to compressed air demand reductions in dryer purge air, air leaks, different cabinet coolers, and misapplied compressed air."

— By Hank van Ormer, Air Power USA

They must be re-installed correctly to operate efficiently. For only a $5,000 bill in repair costs, these two units will now efficiently take care of total plant demand that has been reduced to 1,460 cfm.

Conclusion

Most of the overall system assessment energy savings of $100,855 are realized due to compressed air demand reductions in dryer purge air, air leaks, different cabinet coolers, and misapplied compressed air. This allowed us to TURN OFF four air compressors.

Compressor control knowledge — and the ability to repair control systems — is what allows the ROI to be only one year. Variable displacement controls can be very effective and in this case, they just needed some repair work to get them back into the "energy-saving" mode. All too often we see plants "give up" prematurely on the control systems of older compressors that still have many good years left in them. BP

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Three Types of Food-Industry Compressed Air Systems

By Nitin G. Shanbhag, Senior Manager, Charlotte Business Operations / Air Technology Group, Hitachi America

Compressed air is a key utility supporting the food packaging and food processing industries in North America. Compressed air must be contaminant-free to ensure the protection of the food products processed in each facility. The U.K. Code of Practice for Food-Grade Air helps define three types of compressed air systems and air purification specifications required for each.

Compressed Air Supports the Food Industry

The production facilities of the different segments within the food industry all have different applications for compressed air. The U.S. fruit and vegetable processing industry, for example, operates approximately 1,300 facilities in the U.S. and employs roughly 112,000 people. These manufacturing plants are primarily engaged in the canning, freezing, and dehydrating of fruits and vegetables. This segment represents approximately 7.5% of the dollar value of shipments of the entire U.S. food industry.[1] 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.[2]

There are tens of thousands of factories operating in other segments of the food industry — all using compressed air. Many segments, like bakeries, use compressed air in blow-off applications. Other segments use compressed air to clean containers before filling the containers with food. Compressed air is also used to sort, cut, and shape food products.

Another application comes from machines forming, filling and sealing gable-top cartons in the dairy and juice industries. These machines must be washed-down constantly to maintain sanitary conditions. They are not just subjected to water, but are also exposed to chemical cleaners and sodium potassium hydroxide. Pneumatic systems are preferred over hydraulic systems in these machines because in a wet environment, having leaked oil on a polished tile floor becomes a real safety hazard. Low maintenance and downtime associated with pneumatics is also a key reason why compressed air is preferred.[3] This is an example of where compressed air does not come into contact with food — but there is a high risk that it may occur.

Compressed air has been likened to a "muscle" which is strong and flexible. Compressed air is used in a range of pressures from high-pressures up to 750 psi for blow molding and also at lower pressures of 15 psi for blow-off applications. The food industry has taken full advantage of the benefits of compressed air.

Compressed Air Must Be Contaminant-Free

Compressed air must be purified of contaminants before use in the food industry. The contaminants are water vapor and

moisture, solid particulates (including spores) and oil aerosols and vapors.

The presence of moisture is the primary concern for the food industry because moisture creates the ideal habitat for microorganisms and fungus. Moisture may reside in the piping system near point-of-use applications where compressed air comes into contact with food products. Microorganisms and fungus can grow inside the piping system and then be blown into food products or food containers.

In order to inhibit the growth of microorganisms and fungi, pressure dewpoints must be below -15 ˚F (-26 ˚C). Drying the compressed air to a specified pressure dewpoint is the simple way to eliminate moisture in the compressed air system. The dewpoint specification will be of either +37 ˚F (+3 ˚C) or -40 ˚F (-40 ˚C). In some facilities, both of these specifications may be used to reduce energy costs associated with drying the compressed air — depending upon whether compressed air has any possibility of coming into contact with food products.

THE U.K. CODE OF PRACTICE FOR FOOD GRADE AIR

CONTACT RECOMMENDATION	DIRT (SOLID PARTICULATE) MAX NUMBER OF PARTICLES PER M^3			HUMIDITY (WATER VAPOUR)	TOTAL OIL (AEROSOL + VAPOUR)	ISO8573.1 EQUIVALENT
	0.1-0.5 MICRON	0.5 – 1 MICRON	1-5 MICRON			
Contact	100,000	1,000	10	-40 ˚C PDP	0.01 mg/m^3	Class 2.2.1
Non Contact - Low Risk	100,000	1,000	10	+3 ˚C PDP	0.01 mg/m^3	Class 2.4.1
Non Contact - High Risk	100,000	1,000	10	-40 ˚C PDP	0.01 mg/m^3	Class 2.2.1

Reference Conditions from ISO8573.1 : Absolute atmospheric pressure 1 bar, Temperature = 20 ˚C.
Humidity is measured at air line pressure.

THREE TYPES OF FOOD-INDUSTRY COMPRESSED AIR SYSTEMS

Compressed air pressure dewpoints must be below -15 ˚F (-26 ˚C) to inhibit the growth of fungi and microorganisms in the piping system.

Solid particulates must be removed with filtration products from the compressed air system. When compressed air is dried below -15 ˚F (-26 ˚C), harmful microorganisms and fungi are converted into spores. These spores are now a "solid particulate" which must be filtered. Other sources of solid particulates are coatings on the air compressor rotors, pipe-scale from the compressed air piping system, and ambient dust and particulates which may be ingested by the air compressor. It is recommended, when selecting compressed air filtration products, that care is taken to request coalescing filters tested to the new ISO Standard 12500 Parts 1-3.

Oil aerosols and vapors are another significant concern. One myth in compressed air systems is that the use of an oil-free air compressor frees the system of any compressed air treatment requirements. This is not the case. Ambient air ingested by air compressors will carry water vapor, particulates, and hydrocarbons and compressed air dryers and filters are always therefore required.

Three Types of Compressed Air Systems

The food industry, faced with the question, of how to specify a safe and efficient compressed air system, must first define how compressed air is used in their facility. The U.K. Code of Practice for Food Grade Air provides a comprehensive resource on compressed air systems in the food industry. The Code was jointly developed, in 2006, by the British Retail Consortium (BRC) and the British Compressed Air Society (BCAS). For more information on acquiring a copy of the Code, visit www.bcas.org.uk. The Code defines three specific types of compressed air systems in the food industry; systems with contact with food, non-contact high-risk, and non-contact low-risk.

System #1: Contact

"Contact" is defined in the code as, "the process where compressed air is used as a part of the production and processing including packaging and transportation of safe food production." Another way of defining this is simply if compressed air comes into direct contact with food products. If this is the case, the end user must know that the compressed air must be purified to the "Contact" purity-level as defined in the Code. We often hear the term "incidental contact" used in the U.S. This is an ambiguous term. It is recommended that engineers clearly define between "Contact" and "Non-Contact".

Here is a application example of compressed air coming into "Contact" with food. Vegetable peeling machines utilize compressed air to prepare raw food stocks for packaging and consumption. The vegetable peelers use a jet nozzle of air to peel onions and other vegetables.[4]

In this type of "Contact System", The U.K. Code of Practice recommends a -40 ˚F

(-40 ˚C) pressure dewpoint which will ensure that no microorganisms can grow. This can be accomplished with desiccant (adsorption) type compressed air dryers located in the compressor room (centralized air treatment). Each facility will have to determine if further point-of-use air dryers (de-centralized) are required to ensure the dewpoint specifications. Point-of-use air dryers may be of either desiccant (adsorption) or membrane-type technology.

Coalescing filters are required to remove solid particulates and total oil (aerosol + vapor) to the specification levels. Please note that activated carbon filters will be required as well to remove oil vapors. As with the air dryers, each facility will have to determine if de-centralized filtration is required in addition the centralized filtration.

System #2: Non-Contact High-Risk

Non-Contact is defined in the code as, "the process where compressed air is exhausted into the local atmosphere of the food preparation, production, processing, packaging or storage." Within this section we have a High-Risk and Low-Risk distinction. A Non-Contact High-Risk situation may be where compressed air is used in a blow-molding process to create a package — and then product is introduced into the package later in the day. Many food processors and have their own in-house production lines to create their own

The U.S. Compressor Lubrication Standard[5]

The only current code in the U.S. applicable to compressed air is centered upon what lubricants are permitted to be used — namely by the air compressor. It is up to each factory to determine what lubricants are required in the factory. The Food and Drug Administration (FDA) specification is identified under "Lubricants with incidental food contact". The specification is summarized as allowing:

1. H1 lubricants are food-grade lubricants used in food-processing environments where there is the possibility of incidental food contact
2. H2 lubricants are nonfood-grade lubricants used on equipment and machinery where there is no possibility of contact
3. H3 lubricants are food-grade lubricants, typically edible oils, used to prevent rust on hooks, trolleys and similar equipment

THREE TYPES OF FOOD-INDUSTRY COMPRESSED AIR SYSTEMS

Compressed air is used to blow crumbs off of bread in a commercial bakery.

packaging. Without proper air treatment, it is possible that oil, moisture, and particulates (notably bacteria) could be present on the packaging — waiting for the food product!

The U.K. Code of Practice clearly states that "Non-Contact High-Risk" compressed air systems should establish the same compressed air purity specifications as "Contact" systems.

System #3: Non-Contact Low-Risk

In "Non-Contact Low-Risk" systems, The U.K. Code of Practice recommends a +37 ˚F (+3 ˚C) pressure dewpoint. This can be accomplished with refrigerated type compressed air dryers located in the compressor room (centralized air treatment). Each facility will have to determine if further point-of-use air dryers (de-centralized) are required to ensure the dewpoint specification.

Defining a Non-Contact Low-Risk system is equally important to define because it is common to see food industry systems "over-protect" their compressed air systems. Most plants have significant portions (over 50%) of their compressed air going to "plant air" applications. These "plant air" applications will have absolutely no contact with food products or food-packaging machinery. It is important to understand this relationship and design your system accordingly. We often see desiccant air dryers used to dry all the compressed air in the facility to a -40 ˚F (-40 ˚C) dewpoint — when only 40% of the compressed air needs this dewpoint.

It is worth noting that refrigerated type compressed air dryers normally have significantly lower associated energy costs than desiccant air dryers. Desiccant air dryers will use a portion (can be 15%) of the compressed air to regenerate the desiccant bed and/or use electric

heaters. Refrigerated dryers use relatively small refrigeration compressors and can be cycling or non-cycling.

Coalescing filters are required to remove solid particulates and total oil (aerosol + vapor) to the same specification levels as "Contact" systems. Please note that activated carbon filters will be required as well to remove oil vapors. As with the air dryers, each facility will have to determine if de-centralized filtration is required in addition the centralized filtration.

Conclusion

Compressed air efficiently supports the food industry as long as care is taken to remove contaminants from the system. Food industry professionals should define how compressed air is used in their facility and define a specification for compressed air purity based upon the three system types defined by the U.K. Code of Practice for Food-Grade Air. BP

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Hitachi DSP Oil-Free Rotary Screw Air Compressor

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Endnotes

1 Eric Masanet and Ernst Worrell, Lawrence Berkeley National Laboratory, "The Energy Star for Industry Program", Compressed Air Best Practices Magazine, October 2006, page 14.

2 Eric Masanet and Ernst Worrell, Lawrence Berkeley National Laboratory, "The Energy Star for Industry Program", Compressed Air Best Practices Magazine, October 2006, page 15.

3 Kjell Lyngstad, Bosch Rexroth Pneumatics, "Milking the Benefits of Pneumatics", Compressed Air Best Practices Magazine, October 2006, page 28.

4 Rod Smith, "Harris Equipment Company", Compressed Air Best Practices Magazine, August, 2007, page 20.

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OIL-FREE TECHNOLOGY FROM ANEST IWATA

Compressed Air Best Practices® Magazine interviewed Mr. Tom Fermann from Anest Iwata Air Engineering

The Anest Iwata Oil-Free Scroll Air Compressor Package.

Good morning! Please describe Anest Iwata's history manufacturing air compressors and vacuum pumps.

Anest Iwata Corporation is a leading manufacturer specializing in painting equipment, turn-key coating systems, air compressors and high-end dry vacuum pumps. Anest Iwata began manufacturing air compressors in 1926. Reciprocating air compressors were the first technology manufactured. We began manufacturing rotary screw air compressors in 1977 and launched our oil-free reciprocating compressors in 1984. Anest Iwata was the first company to develop a fan-cooled, oil-free scroll air compressor. In 1989, a joint venture company began selling oil-free scroll air compressors in the United States. The oil-free scroll air compressor technology was launched worldwide, in 1991, through joint ventures and OEM relationships.

We have been at the forefront of green technology in Japan where sustainability has been a business requirement for many, many years. Our company strongly believes in the sustainability benefits of oil-free technology. Our oil-free air compressor market share, in Japan, is estimated to be 30 percent in the 1-30 horsepower range. Air compressor sales represents almost fifty percent of company revenues worldwide.

Anest Iwata was the first company in the world to develop the air-cooled, oil-free (dry), scroll vacuum pump. We provide a very compact package with lower vibration and noise levels than competitive offerings. Our oil-free vacuum pump market share, in Japan, is estimated to be fifty percent in the <600 L/min flow range.

The company has manufacturing locations in Japan, India, Italy, China, and Korea. Our manufacturing sites produce air compressors, dry scroll vacuum pumps, and finishing equipment (spray guns and painting systems).

Our global employees number approximately 1,040 people.

What is your role and describe your U.S. operations.

Anest Iwata USA, and Anest Iwata Air Engineering are the North American subsidiary of ANEST IWATA Corporation in Japan. Based in Cincinnati, Ohio, we have a 50,000 square foot facility housing our air compressor, vacuum pump, and spray equipment businesses. Anest Iwata Air Engineering was incorporated and formed in February 2011 with the idea that the oil-free market and demand for it's "green benefits" will do nothing but continue to grow internationally.

Our oil-free reciprocating and the oil-free scroll air pumps are manufactured at our Fukushima plant and shipped here to our Cincinnati plant. This facility is an assembly facility where we purchase U.S.-made components to create an air compressor package. Tanks, pressure-switches, enclosures, motors, belts, belt guards, check valves, safety valves, cooling package, dryers, drains, interconnecting piping — all the assembly is done here in the U.S. Using local vendors has increased our speed-of-delivery and reduced the over-all package cost.

With a significant inventory investment of pumps, our local assembly capability gives Anest Iwata the ability to provide custom compressor and vacuum packages that meet the needs of our clients – with fast deliveries! This facility performs full sound, flow, and pressure testing on every air compressor package before shipping. We also have a spray booth where we paint enclosures and the packages.

A tank-mounted Anest Iwata 5 horsepower oil-free, reciprocating compressor package.

I am the Sales Manager for the air compressor and vacuum pump business. We are actively setting up Anest Iwata channel partners and distributors in the U.S. for air compressors

OIL-FREE TECHNOLOGY FROM ANEST IWATA

The Anest Iwata oil-free scroll compressor pump.

and vacuum pumps. Our team also handles all marketing, customer service, repair and technical service support requirements.

Please describe Anest Iwata's spray equipment business.

Anest Iwata USA, Inc. has been actively involved in the spray equipment industry in the United States since the late 1980's. Anest Iwata is one of the leading producer of spray guns in the world and has captured more than sixty percent of the high-quality industrial spraying equipment market in Asia. In certain Asian countries, we own market shares over eighty percent. During the 1980's, Anest Iwata strengthened partnerships in Europe to build the company that is now Anest Iwata Europe. Anest Iwata sales locations have been established in England, France, Germany, Italy and Sweden and distributors have been set up to cover all of Europe.

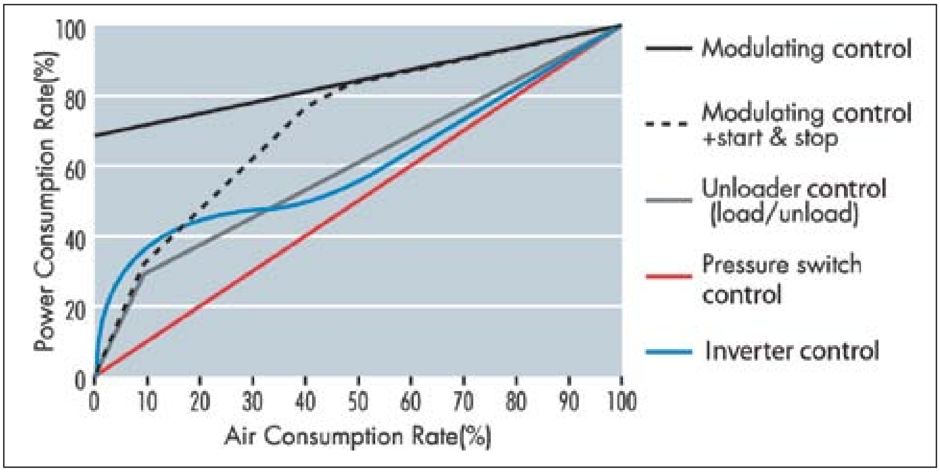
In North Amercа, we have been providing many of these spray guns into the general industrial market, while most have been utilized in automotive refinish operations. Starting in 1989, the primary thrust of the initial Anest Iwata sales effort in North America has been aimed at the auto refinish market. Since that time, Anest Iwata has been recognized as an innovative leader in development of many types of spray guns, equipment and air brushes that are commonly used in North America.

What markets purchase the Anest Iwata vacuum pumps?

We truly offer a product for the most demanding applications. These include; dry foods, vacuum food packaging, vacuum food cooking, vacuum bottles, deposition, vacuum tweezers, accelerating devices like radiation light, liquid crystal display, and semiconductor manufacturing. Our technology is also used in many prestigious radiant research facilities where synchrotrons and accelerators require the highest possible quality vacuum pumps.

Anest Iwata has significant experience applying our high-end, dry vacuum pumps into R&D Laboratories in North America. Our air compressors and vacuum pumps have had, for many years, a strong presence in the medical and hospital markets through our OEM partners and with joint ventures. With the Anest Iwata brand, we are focusing on applications such as food & beverage, and R&D laboratories located in universities and pharmaceutical firms.

We market and sell the dry vacuum pumps to university laboratories where ultra high vacuum systems are required. Our existing channels of distribution sell turbo-mechanical pumps into ultra-high vacuum systems. Our sales channels supply vacuum system components to support, for example, scanning electron microscopes used in nanotechnology areas, mechanical engineering labs, physics labs and chemical



Pressure-Switch Control Offers Energy Savings.

> "Our sales channels supply vacuum system components to support, for example, scanning electron microscopes used in nanotechnology areas."
>
> — Tom Fermann, Anest Iwata

labs. Our dry scroll technology is used as a "roughing pump" — it's a vacuum pre-pump to a turbo-mechanical pump. We take vacuum down to 7.5 millitor (1 Pascal) and then the turbo-mechanical pump takes it further.

There's a natural fit for our oil-free scroll air compressors in these same markets. The market is proving highly receptive to our air compressor technology.

How is Anest Iwata Air Engineering leveraging experience in the automotive market?

Our spray and finishing equipment products (air guns and air brushes) have been marketed and sold in the U.S. for twenty-five years. Anest Iwata today is a leading spray and finishing equipment supplier in the U.S. and there is a lot of value in our brand name. Our focus here has been to go to market through large paint manufacturers and through representatives calling on individual autobody shops in the collision & repair industry.

We have also found that our oil-free scroll technology is of great interest to any one working with bodyshop painting. As this industry has matured, collision & repair shops have improved their processes and they have no tolerance for reductions in through-put created by moisture and oil (in the compressed air) ruining a paint job. We have found that the Anest Iwata oil-free scroll technology is very competitive in price versus the oil-flooded rotary screw compressors common in this market. Plus, customers realize the reduced maintenance benefits of oil-free technology.

Please describe your oil-free scroll compressor packages.

Our oil-free scroll air compressors are sold on the premise of low maintenance requirements and energy efficiency. Two strong sustainability arguments. Our big advantage, in an autobody shop for example, is low maintenance. There is no oil maintenance and change-outs like you are burdened with when operating an oil-flooded system. Our scroll compressors only require tip-seal replacement and the re-greasing of bearings every 10,000 running hours. Our dba rating, on a 5 hp scroll system putting out 15 cfm of air, is 68 dba without an enclosure. With an enclosure the rating is 61 dba. Our systems come fully prepackaged with optional receiver tanks, compressed air dryers and filters.

We carry a significant inventory of 3 and 5 horsepower scroll pumps for both 116 psig and 145 psig pressure ratings. We then create a full air compressor package with a control system based upon pressure-switches. This "ganging" concept allows pumps to turn on and off quickly and provides very low energy costs under fluctuating demand conditions. Our compressor packages range from 3 to 40 horsepower. We use tank-mounted enclosures. The most recognizable packages in the U.S. are where we are ganging multiple 5 hp pumps. This keeps our power consumption rate very linear with the air consumption rate. We do this with 20, 30, and 40 horsepower units. This is for the universities, R&D areas and medical device manufactures.

We carry a significant inventory of 7.5 and 10 horsepower oil-free reciprocating compressors here in Cincinnati. We are experienced in providing the duplex packages (2 x 10 hp recips) common in the medical market. BP

Thank you for your insights.

For more information contact Tom Fermann, Sales Manager, Anest Iwata Air Engineering, tel: 513.260.0842 cell, email: tomf@anestiwata.com, www.anestiwata.com

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

Reliable Operation of High Purity Desiccant Compressed Air Dryers

By Colin Billiet, Chief Executive, nano-porous systems limited

Introduction

Desiccant compressed air dryers offer a simple solution where very dry compressed air is required however there are some key issues which must be considered to make their operation reliable. In particular, excessive flow, low pressure, silencer back pressure and purge air must be carefully monitored and controlled. This paper discusses common issues affecting the reliability of compressed air desiccant dryers which lead to loss of performance.

Background

High-efficiency compressed air dryers are used in critical applications where humidity levels (pressure dew point) are specified to ISO 8573.1 Quality Classes. Typical applications are for use in dental, medical, laboratory, automotive, electronics, telecommunications, pharmaceutical and laser cutting, etc. Desiccant air dryers are selected when the air purity is critical for the application. The design of such products must therefore ensure high levels of performance and reliability.

Compressed Air Systems

Compressed air contains contaminants such as water, oil and particulate, all of which must be removed before use. ISO 8573.1 specifies air quality standards for these contaminants. New nano dryers will produce air quality levels for humidity classes 1-3 corresponding to pressure dewpoints (PDP) of -70/-40/-20 ˚C (-94/-40/-4 ˚F). Classifications for oil and particulate can be met by filtration to meet any of the quality classes. Humidity is expressed in terms of pressure dewpoint. Dewpoint is 'the temperature at which air is saturated with moisture, or in general, the temperature at which gas is saturated with respect to a condensable component'. When the temperature of the air reduces to or below the dewpoint, condensation will occur.

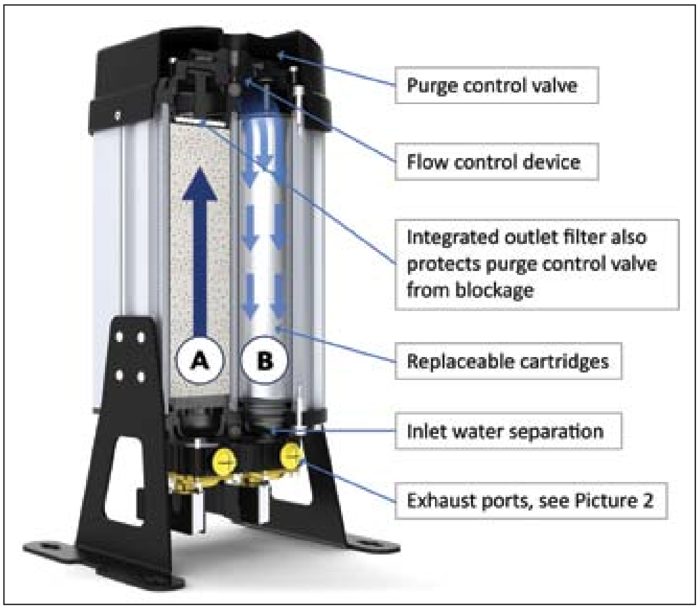
Desiccant Dryers

Adsorption is a process whereby specific molecules (the adsorbate) adhere to the surface of a highly porous solid (the adsorbent) by electrostatic and molecular forces. The adsorbent has a specific pore structure which will be a combination of larger or macro pores, slightly smaller or mesopores, or very small pores known as micro pores. The adsorbent is normally made into granules or beads which are used to form packed beds through which the adsorbate is passed and the process of adsorption can take place. The rate of adsorption is affected by several factors which ultimately determine the adsorption isotherm profile and thus the size of the packed bed.

Principles of Operation

Heatless desiccant dryers are the most common due to their simplicity and low cost. A heatless twin tower dryer (see Picture 1) operates by removing moisture through adsorption onto a granular desiccant bed from the feed air typically at 7 barg (100 psig). As compressed air flows up through a packed bed of desiccant (column A) water vapor is adsorbed. Meanwhile column B (having been previously used in drying the inlet air) is rapidly depressurized and dry purge air from the outlet of column A is fed through a purge valve, expanded to near atmospheric pressure, and counter-flowed down through column B to effect the regeneration of its granular desiccant bed. When the desiccant in column A becomes saturated with water vapor (usually determined by

RELIABLE OPERATION OF HIGH PURITY DESICCANT COMPRESSED AIR DRYERS



Picture 1 — Principles of Operation for Heatless Desiccant Dryer.

a simple timer controller) the feed air is switched back to column B after it has been re-pressurized and the cycle continues.

Silencers are required when the column that has been on duty is rapidly depressurized as part of the regeneration process prior to purging with now expanded very dry air. The noise created, especially during depressurization, needs to be controlled using silencers to reduce to an acceptable level for the installation.

Purge air loss or reduction is a common problem which results in incomplete regeneration and loss of dew point leading to serious failure if left unchecked. Such problems are caused by purge air control valves becoming blocked or back pressure build-up of desiccant dust in the exhaust air silencers. Both conditions lead to reduced volumetric purge air flow which result in incomplete regeneration.

Heatless desiccant dryers at a basic level are a simple product but many people do not fully understand their operation and this can lead to misuse and failure, resulting in a reluctance to use them.

The basic principle is that compressed air which has been compressed and cooled to 7 barg (100 psig), thus reducing its volumetric flow by 8 fold, passes through the first adsorption column where water vapor is adsorbed with the resultant outlet air dried typically to -40 ˚C/˚F. A percentage of the dried outlet air is depressurized to near atmospheric pressure and is directed in counter-flow down the second column, which has previously been used for drying, and is thus regenerated.

A typical example follows:

Ambient air at 25 ˚C (77 ˚F) and 65% relative humidity (rH) contains 15 g/m^3 of water vapor. When compressed to 7 bar (100 psig) and cooled it will be delivered to a dryer at about 35 ˚C (95 ˚F) and 100% rH containing 5 g/m^3 of water vapor. 10 g/m^3 will have been condensed and removed at the compressor aftercooler. Purge air volumes claimed by manufacturers in the market vary between 15 and 25%. 20% is perhaps a safe figure to work with.

Ambient air of 8 volumes becomes 1 volume at 7 bar
(ratio of absolute pressures).

Purge air at 15% at atmospheric pressure is 8 x 15% = 1.2 volumes.

Purge air at 20% at atmospheric pressure is 8 x 20% = 1.6 volumes.

Purge air at 25% at atmospheric pressure is 8 x 25% = 2.0 volumes.

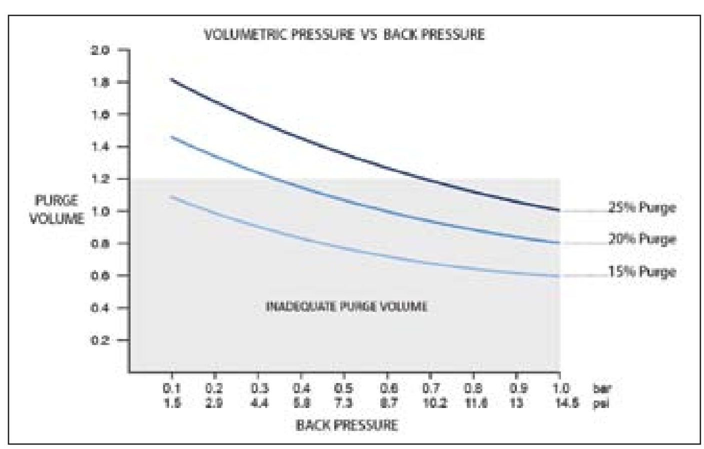
It is only reasonable to accept that the volumetric flow of the purge air would be greater than that of the inlet volumetric flow. However, if the purge air is not at atmospheric pressure (unlikely) the volumetric flow is reduced and regeneration may be incomplete which leads to a falloff in performance and an eventual failure of the adsorption columns.

For the theoretical ideal efficiency in regeneration from 7 barg (100 psig), the purge air would at best be 12.5% (1/8,) but even with as little as 100 mbar (1.4 psi) back pressure, the best theoretical purge to maintain volumetric flow would be 1.1/1x12.5=13.75%

It is typical for some silencers to be serviced with a back pressure of up to 0.7 bar!

Graph 1 shows the reduction in volumetric purge flow for increasing back pressure.

The shaded area shows where in all likelihood inadequate purge air volume is available due to its volumetric reduction caused by back



Graph 1 — Volumetric Pressure vs. Back Pressure.


LASERSHOWS.
FIREWORKS.
ROLLERCOASTERS.

RELIABLE OPERATION OF HIGH PURITY DESICCANT COMPRESSED AIR DRYERS

Picture 2 — Atmospheric Exhaust Silencer.

pressure. Typically, back pressure should be limited to no more than 200 mbar (3 psi).

The choice of silencers is critical but generally limited to the following:

Open mesh type which are noisy but with lower back pressure; or, porous plastic or fibrous media which are quieter but have higher back pressure. Desiccant dust trapped by silencers leads to an increase in the build-up of back pressure and regular servicing is required.

A back pressure of 0.7 bar (10 psi) has a significant effect on the volumetric flow of the purge air.

Purge air at an initial 15% but with 0.7 back pressures reduces from 1.2 volumes to 0.71 volumes

Purge air at an initial 20% but with 0.7 back pressures reduces from 1.6 volumes to 0.94 volumes

Purge air at an initial 25% but with 0.7 back pressures reduces from 2.0 volumes to 1.2 volumes

Silencing is therefore a critical issue for designers. Ideally the exhaust air would be quiet but this generally leads to high back pressure. A silencer which is quiet and has low back pressure which will not block with adsorbent dust is desirable. Such a solution is possible through innovative design such as available in the new nano NDL dryers. Picture 2 shows an integrated silencer which requires no routine serving, has low noise levels and low back pressure.

Another issue to consider is unfiltered purge air leading to blockage of the fine purge valve/orifice. While external dust filters protect the downstream application, they do not protect the purge orifice and valving. The integration of dust filters is therefore a significant benefit to reliable operation. See Picture 1.

Dryer overflow is common due to excessive demand for air from the dryer.

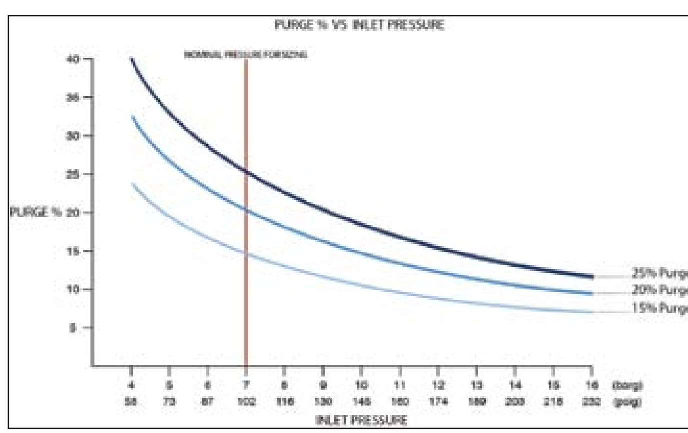
Where the air flow is limited by the compressor size, reduced pressure causes excessive volumetric flow and higher moisture loadings. This leads to incomplete regeneration and loss of dew point.

Where a desiccant dryer is used for point of use applications and the air is supplied from a compressed air ring main, it is often difficult to know the actual air demand. Therefore excessive flow coupled with reduced pressure can easily occur. This is a common problem since equipment makers typically under estimate the air they require leading to excessive flow through dryers. The new nano design has addressed such conditions with each dryer fitted with a volumetric flow limiter to prevent overflow. See Picture 1.

Many suppliers only state the inlet flow rating of their dryers and do not state the outlet flow (inlet flow less the purge flow). This omission is misleading since users who are not familiar with dryer selection may assume the inlet flows stated are those which are delivered from the dryer outlet. This leads to user's undersizing their dryer which can lead to overflow, resulting in poor performance and eventual failure. Any reduction in inlet pressure will need to be accounted for since it is necessary to increase the purge to maintain the volumetric flow to achieve regeneration. See Graph 2.

Case Study

A client requested a terminal dryer for a prestigious motor company to purify the air for 2 laser cutting machines producing dash boards. The



Graph 2 — Purge % vs. Inlet Pressure

dryer was sized for the flow specified by the equipment maker and an extra allowance made for safety. When fitted, the dryers exhibited a high pressure loss of 4 bar (60 psi). The high pressure loss was due to the application requiring much higher flow than thought. It was however immediately identified as an issue since the flow control device fitted limited excessive flow protecting the dryers adsorption beds, while the high pressure loss highlighted the issue to be addressed. The solution was simple, a second dryer was fitted and problem solved. Had the flow control device not been fitted, the dryer would have been overflowed and when it failed, it would have been the dryer that was deemed to be at fault and a lengthy investigation would have been required. This way the issue was solved by a simple phone call and everything resolved to the user's satisfaction.

Conclusions

Desiccant air dryers can provide a simple solution to the needs of many applications but designs vary significantly. Users should be aware, to meet their needs, they must size the dryer based on its outlet flow. Maintenance of silencers is critical to operation if they are subject to increased back pressure. Purge air may be affected by a dust build up in the purge control valve/orifice requiring regular maintenance. Low pressure increases volumetric flow and reduces purge air leading to incomplete regeneration, reduced performance and possible failure. Safeguards which are designed into nano dryers prevent accidental misuse and provide users with reliable operation. BP

For more information contact nano-purification solutions, tel: 704-897-2182, email: support@n-psi.com, http://n-psi.com

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Colin Billiet, Chief Executive of nano-porous systems limited.
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Past President of the British Compressed Air Society, now an honorary member
Past activities with Pneurop, CAGI and ISO committees led to ISO 8573.1, Quality Classes for Compressed Air

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PRESSURE-FLOW CONTROL: IT'S MORE THAN STABILIZING PRESSURE

By Bob Wilson, PEMCO Services,
for the Compressed Air Challenge®

The Compressed Air Challenge Fundamentals and Advanced training discuss the benefits of using central controllers to efficiently control system compressors. These systems are called "System Master" controls. Modern day System Master Controls use advanced technologies to network air compressors in a preprogrammed sequence. A properly configured network with the right size and type of trim compressor can typically hold the supply air pressure in a tight band of +/- 2 psi. Because of this capability, many users feel the application of System Master Control negates the benefit of applying Pressure-Flow Control to stabilize the plant air pressure. For most compressed air systems, controlling pressure in the main header +/- 2 psi is satisfactory. But there are other considerations to take into account before making a decision about investing in Pressure-Flow Control.

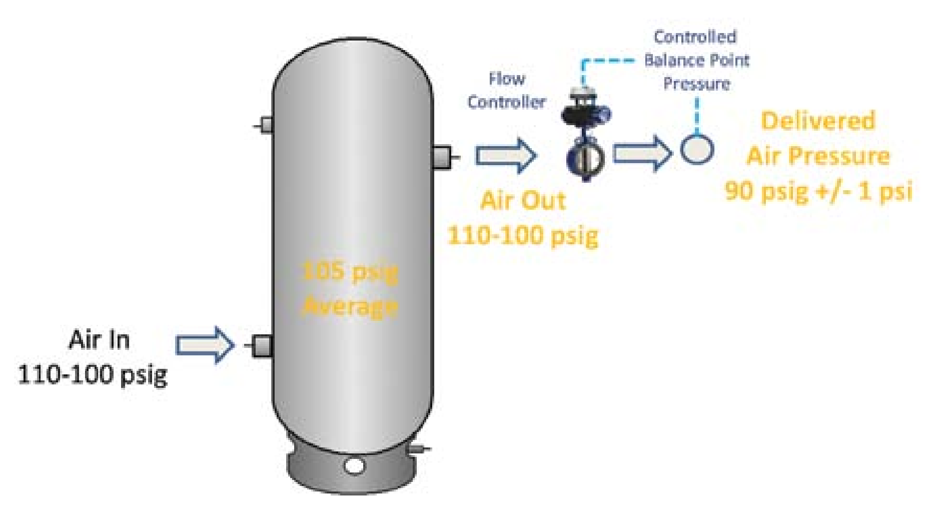

Figure 1: The control valve releases air from storage to correct for pressure deviations.

Pressure-Flow Control Ensures a Reliable Stable Source of Air is Always Available to Production.

In a recent survey conducted by the Department of Energy, 71% of the people reported *reliability* as the most important objective in a compressed air system.* Air quality and controlling costs followed in the order of priorities at only 12% and 9% respectively. Plant personnel weigh *reliability* very heavily when evaluating changes, upgrades, and energy efficiency improvements. Consider the following scenario.

To comply with Corporate's new reliability standards, two new variable displacement rotary screw compressors with poppet valve control were purchased and installed as the priority lead compressors. The existing compressors were relegated to low priority standby status to act as back up compressors to the primary units. A System Master Control was installed to network the compressors. The System Master Control sensed the pressure in the common receiver and, by taking

*US Department of Energy, Assessment of the Market for Compressed Air Efficiency Services, EERE advantage of the poppet valve control on the new rotary screw compressors, held it +/- 2 psi. Everything was stable and balance point pressure at the main header supplying the plant was held at a minimum acceptable level to sustain production under all operating conditions. Then an unanticipated failure of the lead priority compressor occurred resulting in a rapid decay in the supply pressure. The System Master Control sensed the decline and called for the next compressor programmed in the sequence to start and load. As the standby compressor came on line, ran through its permissives, and began to contribute air, the supply pressure continued its rapid decline. Because the event occurred when pressure was at the bottom of the band, critical processes began to approach automated shut down due to the low pressure condition. Had the pressure fallen below the minimum acceptable pressure the lost production would have been very costly.

Fortunately, the actual system in the above example was equipped with Pressure-Flow Control as an additional safeguard to ensure reliability. The Pressure-Flow Control released supplemental air from the storage receiver to sustain production through the duration of the event. Production never saw the pressure dip and was not even aware that an event had occurred. The Pressure-Flow Control paid for itself by preventing work stoppages because of the unanticipated compressor failure.

Pressure-Flow Control: The Science is Simple.

The term Pressure-Flow Control is the generic name chosen by the Compressed Air Challenge to describe a system consisting of:

- A large air storage receiver
- Precision motor driven control valve
- Pressure transducer or pneumatic servo pilot device
- Control panel

The arrangement uses the controlled release of air already in storage to stabilize the air pressure delivered into the main piping header leaving the compressor room. Pressure at control valve outlet is sensed and air flow is continuously adjusted to correct the deviations from set point. It works on the principle that when compressed air expands, the pressure decreases and, conversely, when air compresses, the pressure increases.

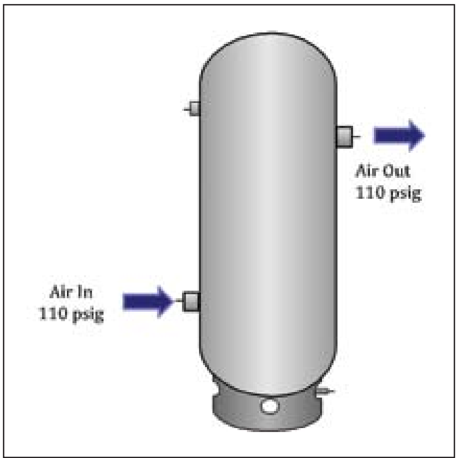

Figure 2: No storage is created if pressures in and out are equalized.

PRESSURE-FLOW CONTROL: IT'S MORE THAN STABILIZING PRESSURE

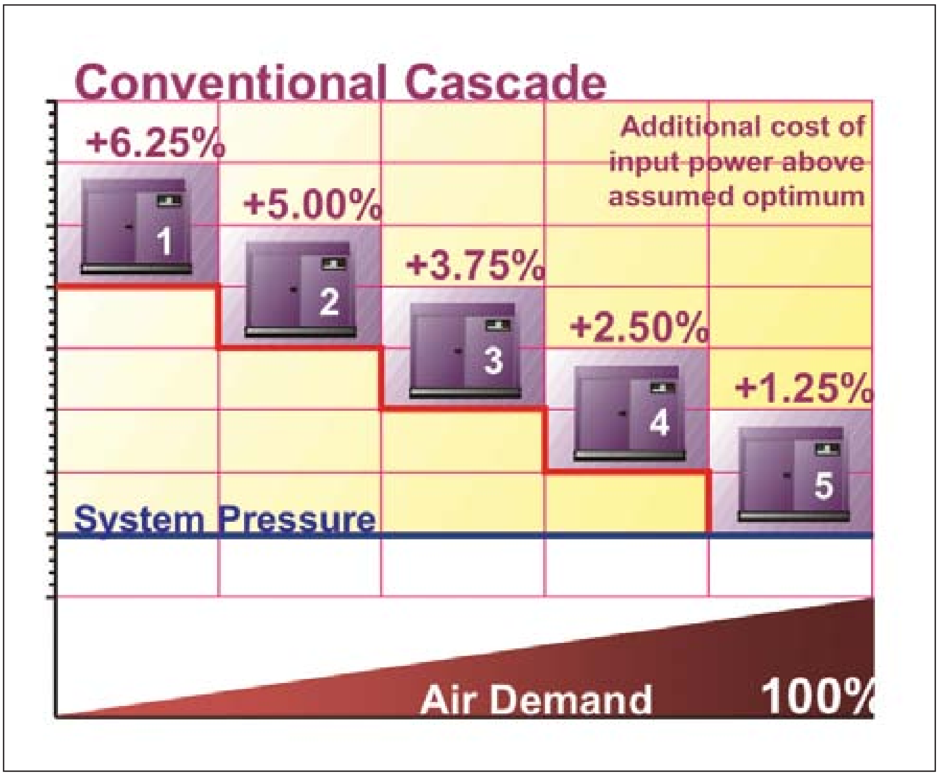

Figure 3: Conventional cascade arrangement.

Therefore, if more air is flowing away from the balance point than in, the pressure goes down and the control valve modulates open to release more air from storage to bring it back to the set point. The opposite action occurs if more air is flowing into the balance point than away as the valve modulates closed to hold air back in storage. **Figure 1** is a schematic illustration of a typical arrangement.

Understanding the Concept of Useable Storage

Volume alone does not equate to useable air storage. There must also be a corresponding change in pressure to increase or release the energy content imparted in the stored air during the compression process. Consider the condition as depicted in **Figure 2.**

Pressure "in" is the same as pressure "out". There can be no flow through the receiver. A quiet zone has been created but no useable storage. If the pressure on the outlet changes, the pressure on the inlet will also change and instantaneously equalize. While the receiver adds volume and, as such, potential energy to the system, the energy released from storage is a result of the pressure gradient across the entire plant air system and is not useable for controlling and stabilizing the pressure of the delivered air leaving the compressor room. If no further steps are taken, the addition of only volume will reduce pressure variations, smooth out rates of change, and buffer the control response of the compressors. It will not, however, stabilize and allow a reduction of the delivered air pressure. A Pressure-Flow Control will be required if the goal is to lower the plant air pressure beyond the capability of readjusting the discharge pressures at the compressors.

The benefit from applying Pressure-Flow Control is that the plant air pressure can be maintained the lowest optimum level needed to reliably sustain production. The example depicted in Figure 1 shows the delivered air pressure is reduced from 105 psig on average +/- 5 psi to a stable steady 90 psig +/-1 psi. The use of the Pressure-Flow Control to lower pressure instead of simply adjusting the compressor pressure settings ensures air treatment equipment performance does not deteriorate. The immediate pay back is less air is consumed by leaks and unregulated points of use. The savings amounts to a flow reduction of about 1% per psi reduced.

Pressure-Flow Control also prevents the plant air pressure from rising as leaks are repaired and air waste is reduced. If nothing is done to control the pressure, it can creep up and cause more air to vent out of other escape points in the system such as condensate drains, open air blowing devices, unrepaired leaks, and unregulated points of use. There are also operational savings from reducing leak

> "The benefit from applying Pressure-Flow Control is that the plant air pressure can be maintained the lowest optimum level needed to reliably sustain production."
>
> — Bob Wilson, PEMCO Services

demand and optimizing air use. Air flow across filters and dryers will be less. Pressure drops in the piping distribution system will decrease. Maintenance costs will go down. Pressure-Flow Control is an excellent tool to use for controlling air leakages of all types.

Operate at the Minimum Pressures Needed to Sustain Production

The air supply pressure into the receiver is determined by the compressor settings. The air pressure in the receiver at any point in time is determined by the flow of air into the main header supplying production. With the delivered air pressure held steady at a reduced level, the opportunity to lower the discharge pressure at the compressors becomes available. The savings amount to about a 1 percent power reduction for every 2 psi of compressor discharge pressure reduction. This is in addition to the already mentioned flow reduction.

Figure 3 shows the typical pressure band in a conventional cascade arrangement.

Figure 3 depicts a conventional cascade style of pressure settings for a multiple compressor setup. Note additional input power of between +1.25 and 6.25% incurred due to operating at pressures above the optimum system pressure. Also, the lower the air demand, the greater the inefficiencies because this results in higher average pressure.

Tightening and lowering the pressure band will reduce the power requirements based upon satisfying demand but there is a risk of short cycling the lag compressors or forcing them to operate unloaded rather than shutting down. An unloaded operating compressor will use 25-40% of its full load energy without contributing any air to the system. Running unloaded is much more inefficient than

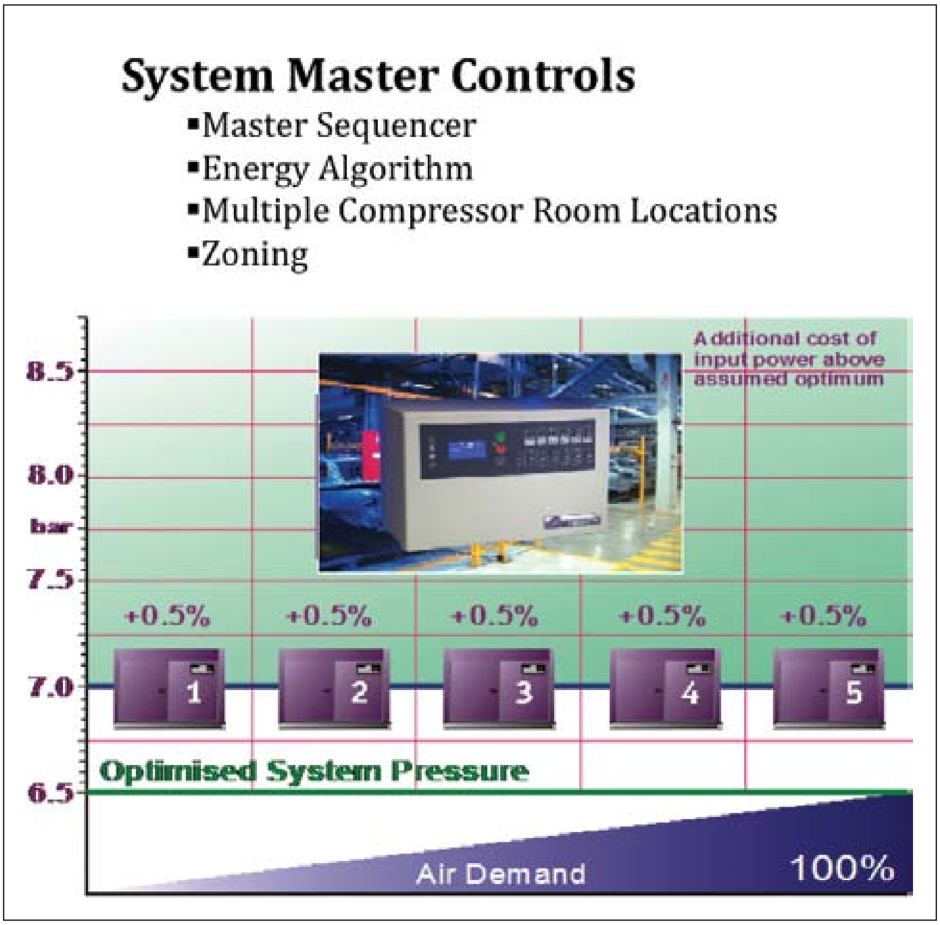

Figure 4: System Master Control networks compressors in a preprogrammed sequence. Illustration courtesy of EnergAir Solutions.

PRESSURE-FLOW CONTROL: IT'S MORE THAN STABILIZING PRESSURE

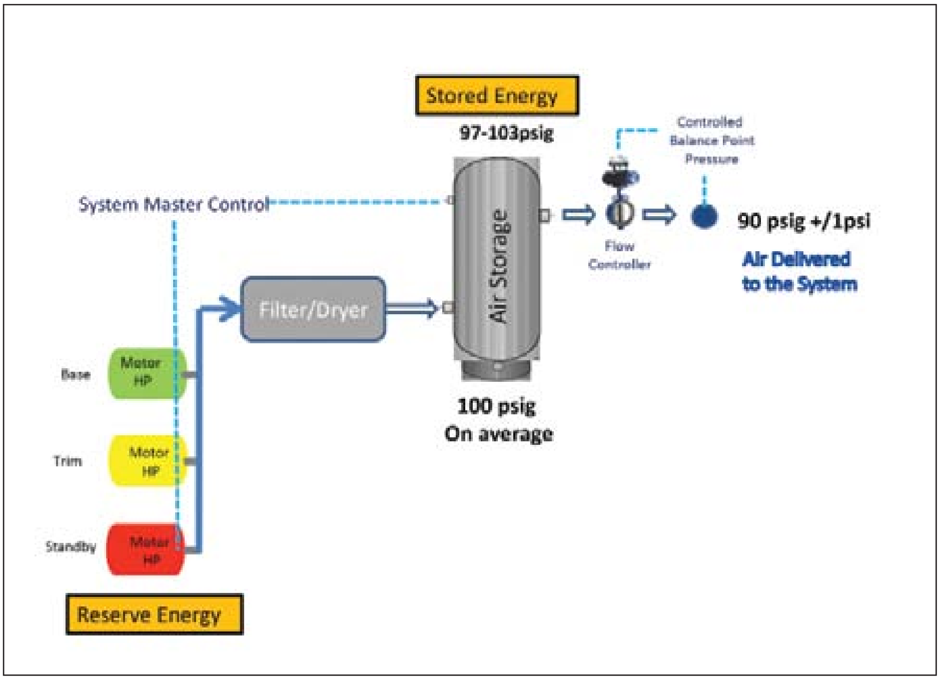

Figure 5: The final configuration.

slightly over pressurizing The application of Pressure-Flow Control allows the compressor to operate within a wider pressure band which mitigates the short cycling and allows unloaded compressors to time out and shut down. Compressors no longer have to react to the peak short duration demand events because these are now satisfied with air from storage. In most systems, the storage required to cover the unanticipated failure of an operating compressor will be sufficient to cover surge loads. It should be checked using the following equation.

$$Vs = Vf \times \Delta P / Pa$$

Where Vs = stored event volume (cubic feet)

ΔP = change in pressure allowed for event (psi)

Pa = atmospheric pressure (psia)

Vf = fixed volume (cubic feet)

Convert the calculated fixed volume and pick the next largest standard stock size receiver.

$$7.48 \text{ gallons/cf} \times Vf = \text{gallons}$$

While the application of Pressure-Flow Control improves the part load efficiency of compressors operating in a cascade pressure profile, greater savings can be realized from the application of System Master Control to network the compressors as illustrated in Figure 4 and operate with a single pressure band.

Note the additional required input power remains at only .5% above the optimum regardless of the demand load.

System Master Controls are available in many different arrangements at prices to fit most budgets. Basic sequencers using timer rotation are designed for smaller systems and can be economically justified with compressors as low as 15 hp. More sophisticated designs incorporate real time sequencing schemes allowing for table technology scheduling and energy algorithms to take advantage of the latest energy efficient VSD and Variable Displacement compressor control arrangements. More complex System Master Controls can deal with multiple compressor rooms using pressure averaging and pressure zoning of a plant in the sequencing scheme. In most systems, Pressure-Flow Control will enhance the performance of System Master Control by isolating the compressor response from the dynamic demands, allowing them to sequence in the most efficient manner instead reacting and chasing the system. **Figure 5** is a representation of the final layout for the system described in the opening example of

> "Pressure-Flow Control interconnects the supply side of the system with the demand side and becomes the device that maintains the energy balance at an optimum level at all times, under all operating conditions."
>
> — Bob Wilson, PEMCO Services

how Pressure-Flow Control can enhance the reliability of the plant air system.

A number of factors must be considered in determining the best configuration for a specific system. The objective for every system is to operate at the minimum pressures needed to reliably support production. Deliver air at the lowest possible pressure to minimize waste due to leaks and unregulated uses. Then set the compressor pressure band as low as possible, consistent with the reliable operation of the compressors. For this example, the variable displacement compressors were equal in size and the poppet valve control suggested a 6 psi pressure band would be adequate to ensure the reliability of the system. The Pressure-Flow Control supplements the air supplied by the compressors while the System Master Control draws upon the reserve energy of the trim compressor and standby compressor, if necessary. Air storage is sufficient at the 90 psig outlet pressure/7-13 psid to cover an unanticipated failure of an operating compressor. The savings from lowering the plant air pressure and networking the compressors with System Master Control amounts to about 20%. Plus, a production interruption due to a catastrophic event was avoided. The investment in the Pressure-Flow Control produced a good return. A different mix of compressor types and sizes would have different requirements to consider and the configuration could be quite different. Every system must be reviewed and the alternatives must be explored to determine the best way to deal with the site specific conditions. Pressure-Flow Control should be included in the evaluation process as a means to:

- Ensure a reliable stable source of air is always available to production
- Reduce waste and inefficiencies due to leaks and unregulated air use
- Save energy
- Allow consumption savings to translate into real dollar cost savings
- Enhance the automated sequencing of networked compressors

In Summary:

Pressure-Flow Control interconnects the supply side of the system with the demand side and becomes the device that maintains the energy balance at an optimum level at all times, under all operating conditions. It does this through the controlled release of air stored in an upstream receiver. The compressors generating the air sense the pressure in the receiver and proactively replenish the supply to maintain the level of stored energy and ensure the system integrity. The total energy required by the system constantly changes and therefore must be supported by a method that can vary and quickly adjust to the changes. Pressure-Flow Control does this and, in combination with applied energy of the compressors, allows the plant air system to operate reliably at an optimum energy balance. Most compressed air systems will benefit from the application of Pressure-Flow Control. The potential for improving the energy efficiency and reliability of the system justifies looking at a system upgrade to include the addition of Pressure-Flow Control. BP

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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

New Aircom 110 mm (4") Aluminum Pipe Fittings

Modular pipe systems for compressed air, gas and vacuum distribution, have reached the next plateau. Aircom expanded their Quick Line Aluminum range of pressure die cast aluminum fittings to include 110 mm (4") diameter with 160 mm (6") on the horizon. The simplicity and uniqueness of their fittings promote Quick, Easy, Reliable and Safe assembly of the pipe to the fittings.

Pipe fittings are constructed of high-tensile strength marine grade aluminum together with a pressure die cast molding process that results in optimum quality. Similar in design to the smaller range, the 110 mm fittings utilize a stainless steel "Clinch Ring" to secure the pipe in the fitting and a captive "O" Ring seal. Assembly and installation is quick and simple. Using only a tube cutter or band saw, the pipe is cut to length. The end is chamfered and then inserted into the fitting. Tighten (3) hex head bolts. It's that easy. No pipe end grooving, hole drilling or any other pipe end preparation is required. No bulky expensive "Specialty Tools" are needed and no clamps are used to attach the fitting to the pipe. Total weight of a 110 mm flange & 20 foot long pipe assembly is less than 10 lbs.

The smooth bore aluminum extrusion alloy is marine grade aluminum, sub surface treated with a Titanium-based, Chrome-Free, Rohs complying treatment. The exterior of the pipe is electrostatic dry polyester powder coating. Combined, the material of construction and treatments of the system ensure corrosion free operation, promotes high flow rates with a very low resistance to flow and less pressure drop. The overall system weight is about 1/10th that of a similar carbon steel and is as structurally strong. A 20 foot long 110 mm pipe and flange assembly weighs less than 10 Lbs., so it can be assembled on the floor or in the air.

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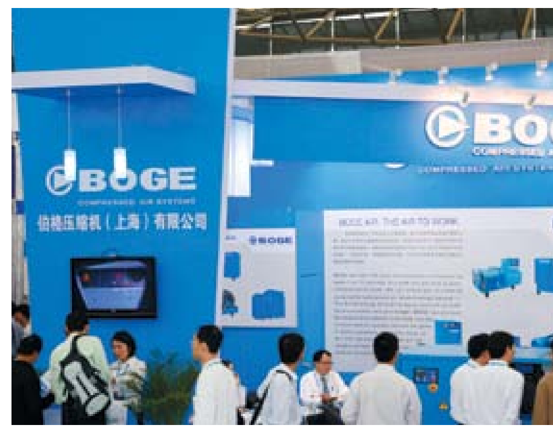

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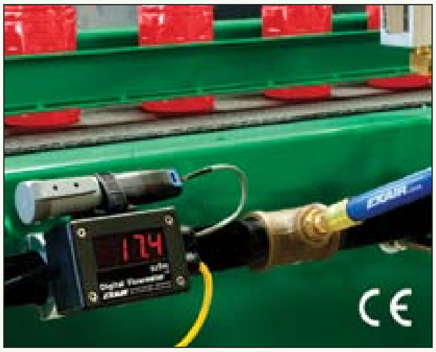

Regular monitoring of compressed air usage makes it possible for companies to save thousands of dollars per year in compressed air waste by identifying costly leaks or inefficient air products. When the Data Logger is removed from the Digital Flowmeter and plugged into a computer, the data can be viewed in the included software or exported directly into Microsoft Excel®. This allows you to track flow rate easily on your computer. The Data Logger is available pre-installed on the Digital Flowmeter. Summing Remote Displays, that make it easy to monitor compressed air consumption from a convenient location, are also available. Prices start at $109.00.

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