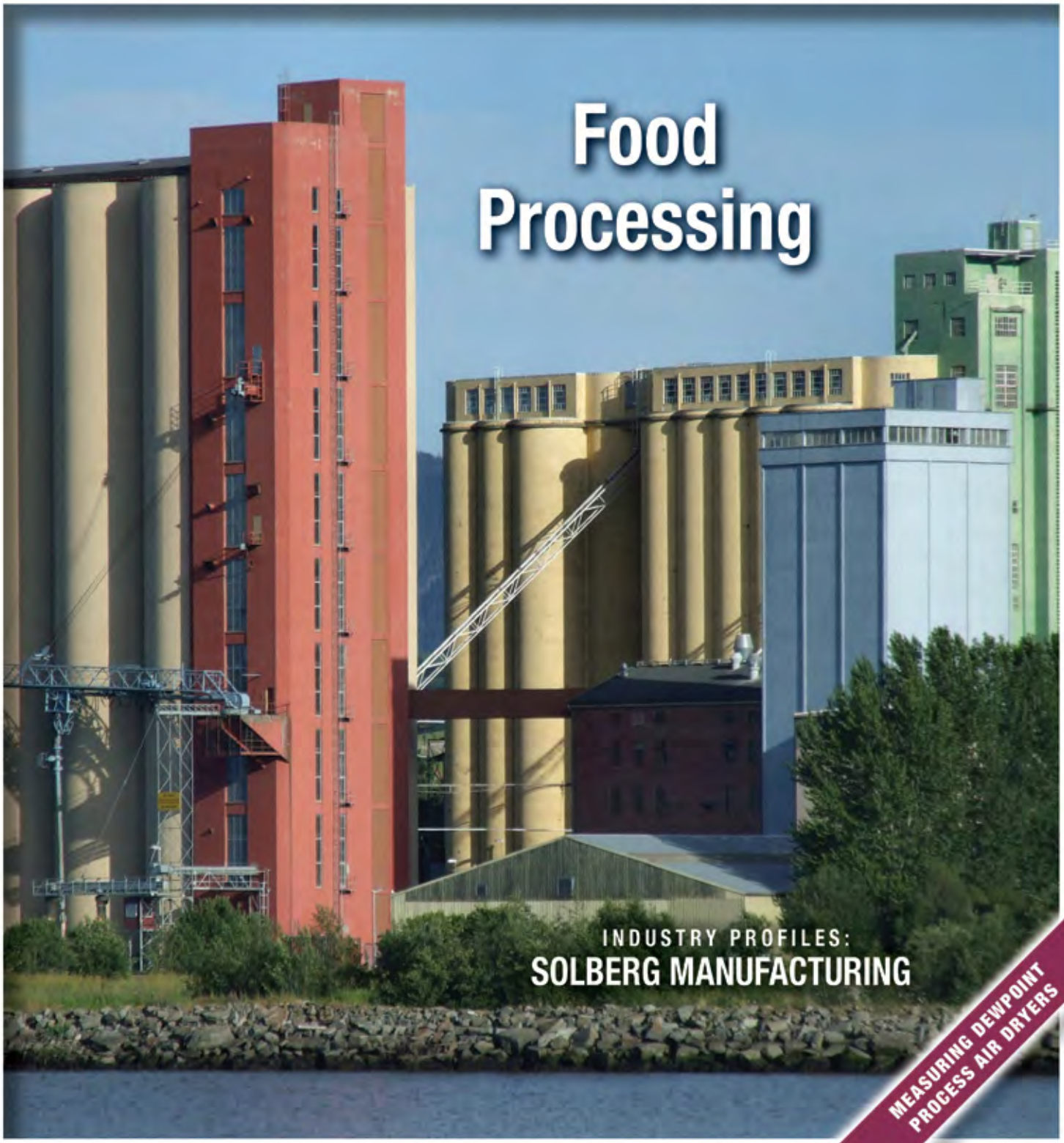
Auditing Rotary Screws at a Bakery

Blower Audit Saves Energy

March 2008

COMPRESSED AIR BEST PRACTICES



Food Processing

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MEASURING DEWPOINT
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10

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FROM THE EDITOR

Auditing and Air Quality

We are fortunate, in this March 2008 edition, to be able to publish two exceptional auditing stories on factories in the food processing industry. The work done by the auditors, the plant energy engineers, and the local utilities (with rebate funding) is inspirational. We also have articles on Air Quality, which is, of course, important to food processing. The articles cover dewpoint measurement, process air refrigerated dryers and compressed air filtration.

An audit of Midwest Bakery by Mr. Jim Timmersman of Power Supply Industries walks us through a very "typical" audit. Multiple rotary screw air compressors are operating independently in three different compressor rooms. Air treatment problems exist and there is little storage for compressed air. When the plant wants to expand, engineering requests an additional rotary screw compressor. The audit shows that with synchronizing the rotary screw compressors and introducing storage and flow control solutions, the existing system is more than enough for the plant expansion.

The March Audit of the Month reviews the audit performed by Mr. Andrew Balberg of HSI at a bakery ingredient processor in Canada. The opportunities in the low-pressure air system, in their yeast production process, lay in the fluctuating demand characteristics of the installation. Energy savings of 6,793,000 kWh per year worth $543,440 per year were realized with the installation of HSI centrifugal blowers equipped with VFDs.

Air Quality in terms of dry air remains elusive at many factories. Drying the air to a specified dewpoint is not as simple as it might seem. Mr. Donald Van Ormer provides us with an article, which discusses dewpoint measurement devices and (particularly for food processing industries) recommends point-of-use dewpoint measurement. ZEKS provides us with an interesting article which outlines the options in the market for refrigerated air dryers and discusses the benefits of multi-module refrigerated air dryers for process air.

Air Quality provided by filtration is of critical importance to remove solid contaminants and liquids (notably oil). Solberg Manufacturing provides us with interesting information on their range of intake filters for air compressor and vacuum systems. Numatics also provides us with an article on how coalescing filters do their job and an overview of how they build filter elements to get the job done.

In closing I'd like to thank you, the readers, for the overwhelming response you've given to our digital magazine. Thanks go, in particular, to the large number of international readers for whom we're happy to be able to provide the magazine quickly now with just the push of a button.

ROD SMITH

UTILITY-AIR NEWS

Fortune 500 Corporations Surpass EPA Green Power Goals

The U.S. Environmental Protection Agency (EPA) announced that in response to the EPA's nationwide challenge issued in December 2006, 53 Fortune 500 corporations are now collectively purchasing more than 6 billion kilowatt-hours (kWh) of green power annually. These purchases surpassed the goals set by the EPA's Green Power Partnership by 130% and equal the avoided carbon dioxide emissions of more than 570 million gallons of gasoline each year or the equivalent amount of electricity needed to power nearly 670,000 average American homes annually.

"EPA applauds our Fortune 500 partners for protecting our environment by purchasing green power," said EPA Administrator Stephen L. Johnson. "By voluntarily shifting to renewable energy, EPA's environmental partners are proving you don't need to wait for a signal in order to go green."

Intel Corporation leads the group as the top buyer with a purchase of 1.3 billion kWh per year. PepsiCo is second, followed by Wells Fargo & Company, Whole Foods Market, The Pepsi Bottling Group and Johnson & Johnson. Cisco Systems and Kohl's Department Stores recently made sizable purchase increases to place them at seventh and eighth on the list, respectively. Rounding out the top 10 green power purchases are Starbucks and DuPont Company.

EPA's Green Power Partnership works with more than 850 partner organizations to buy green power voluntarily as a way to reduce the environmental impacts associated with conventional electricity use and to support the development of new, renewable generation resources nationwide. Overall, EPA Green Power Partners are buying more than 13 billion kWh of green power annually.

New President for SPX Dehydration & Filtration

SPX Flow Technology segment recently announced the appointment of Richard (Rick) Ruebusch as President of SPX Dehydration & Filtration. He replaces Tony Renzi, who has been appointed Senior Vice President, Flow Operations.

Rick brings more than 20 years of experience in global business leadership and general management having worked for companies including MTD Products Inc, Tecumseh, Clopay and General Electric.

Ruebusch said, "I am excited to be taking over responsibility for such a prestigious selection of brands and products. Hankison, Pneumatic Products, Dollinger, Jemaco and the others are well known global brands offering world-leading products in the compressed air dehydration and filtration markets. I am looking forward to using my industry knowledge to continue to build on the success of the last few years."

Commenting on his successor, Tony Renzi said, "Aside from his great strategic skills and business track record, Rick brings deep technical strengths to the position of President. I am confident that he and his team will bring renewed momentum to SPX Dehydration & Filtration's future performance."

www.spxdehydration.com

SPX DEHYDRATION & PROCESS FILTRATION

Atlas Copco Specialty Rental First to Get Triple Certification for Quality, Environment and Health by Lloyd's Register Quality Assurance

Atlas Copco's division Specialty Rental has become the first rental company in the world to be granted the triple certification by Lloyd's. The triple certification is valid for multiple Specialty Rental sites around the world and includes ISO 9001 (the international standard for quality management systems), ISO 14001 (environmental management) and OHSAS 18001 (occupational health and safety).

"Our customers' demands on quality, environmental and safety processes are high and they do not accept business partners without a strong focus on these areas," says Ronnie Leten, President of Atlas Copco's business area Compressor Technique. "This certification sets the standard for the industry and will serve as a door opener for us to new customer segments and applications." Atlas Copco's division Specialty Rental was created on January 1, 2007 and it is active in 50 countries. The triple certification has a fundamental place in supporting the Specialty Rental division's mission to become and remain the market leader worldwide in rental for oil-free, high pressure and compressed air applications. It is the target of the Atlas Copco Group that all employees shall work in a unit with an environmental management system and that all of its production companies shall be ISO 14001 certified.

www.atlascopco.com

Atlas Copco

Parker Domnick Hunter and GE Healthcare Collaborate in Biopharmaceutical Purification

GE Healthcare and Parker domnick hunter, a division of Parker Hannifin (NYSE:PH) announced today that they have entered into an exclusive agreement for the supply and distribution of products for biopharmaceutical purification. Under the terms of the agreement, GE Healthcare will have exclusive global rights to market a new range of microfiltration cartridges and disposable filters manufactured by Parker domnick hunter. Financial terms were not disclosed.

The new line of disposable filters for liquid filtration applications in biopharmaceutical manufacture will be marketed by GE Healthcare's global sales and marketing organization under the ULTA™ brand. The products increase the range of technologies available for the purification of vaccines, antibodies and other biomolecules.

"This agreement allows us to expand the range of products for biopharmaceutical purification that we are able to offer our customers," said Ann O'Hara, General Manager of Bioprocess for GE Healthcare. "Building on our reputation as a supplier of cutting edge technologies, the ULTA™ line of normal flow cartridges will be a significant addition to our purification portfolio."

"We developed an outstanding line of cartridge filters with an eye to making significant inroads into the pharmaceutical market, expanding on our past successes in this area," said Jeff Porter, Managing Director, Process Division, Europe at Parker domnick hunter. "We are very excited about the prospects of this agreement, which enables us to bring our advanced purification technologies to the biopharmaceutical production industry."

Parker domnick hunter will continue to market its own brand of air and gas filters to the biopharmaceutical industry.

www.domnickhunter.com

Parker

Compressed Air Audit of the Month

Saving Energy with Blowers in Canada

By Andrew Balberg

Optimizing Low-Pressure Systems

A bakery ingredient processor initiated a plan to improve its existing low-pressure compressor system. The project was conceived as a means to upgrade capital equipment through the assistance of the local electrical utility's energy reduction rebate program. The project created an annual savings in electrical consumption of $543,440 per year

This equipment upgrade might not have been considered in a routine Compressed Air System Energy Audit because it involved compressed air under 25 psig — not the 100 psig utility air circuits that we usually read about. This process air system project generated power savings that were better than claimed by replacing three multistage blower packages with the same horsepower motors, better frame performance points and sequenced variable speed controls.

In cooperation with HSI, Inc (www.hsiblowers.com) and the electrical utility, the food processor purchased, installed and verified a production energy savings of 29.76% at the same level of production. That's over 910 hp saved on a continuous basis.

March Audit of the Month

Where: Canada

Industry: Food Processing — Bakery Ingredients

Issue: High Energy Costs and Fluctuating Demand

Audit Type: Supply-Side Low-Pressure Air (11 psig)

Utility Verification: Verified by local utility and partially financed

Audit Summary:

1. Replace three existing blowers with new centrifugal blowers with higher efficiencies at base-loads
2. New VFD blower control system replaces inlet throttle system on first two blowers for increased turn-down capabilities and efficiencies at reduced load
3. New master control panel for automatic sequencing of blowers
4. Energy savings of 6,793,000 kWh per year worth $543,440 per year at the local rate of $0.08 per kWh

Blowers Using Variable Frequency Drives Replaced Inlet Throttle-Valves Controls

Fresh and Dry Yeast for Bakeries

The facility manufactures fresh and dry yeast for bakeries. Yeast is grown using an aerobic fermentation process. Starter yeast is grown from test tube quantities through a series of five fermentations that progressively increase in size. Fermentation consists of combining a starter portion of yeast with the controlled addition of nutrients, including sugar and oxygen. Oxygen is supplied by compressing air and bubbling it through the fermentation mix. Even though the fermentation is done at atmospheric pressure, the air pressure must be approximately 11 psig in order for it to flow from the bottom of the fermenter. A small amount of air is used to start and as more yeast grows the airflow is increased. The facility has multiple commercial size fermenters that are typically at different stages of the process.

Mr. Ed Ball of Process Air Solutions (www.processairsolutions.com) identified this fermentation process as a good candidate to realize energy savings through the use of a HSI variable frequency drive blower and control system, and a subsequent evaluation was initiated.

Replacing inlet throttle-valve blower controls with VFD's saved 2,502,000 kWh per year.

PROCESS AIR SOLUTIONS

COMPRESSED AIR AUDIT OF THE MONTH

Saving Energy with Blowers in Canada

HSI, Inc. is a leading manufacturer of centrifugal blowers, exhausters and control systems. An ISO 9001-2000 certified company located in Houston, Texas, the products manufactured offer performance ranges up to 25 psi (1.7 bar) pressure or to 18 inHg (457 mmHg) vacuum. Flows range from 100 to 40,000 cfm (170 to 70,000 m^3/hr).

HSI manufactures multistage centrifugal blowers and process control systems as well as providing complete blower packages with accessories to meet a wide variety of applications (www.hsiblowers.com).

HSI MULTISTAGE CENTRIFUGAL BLOWERS

Measuring The Existing Low-Pressure Air System

The existing blower system consisted of three 1,750 hp multi-stage centrifugal blowers controlled by modulated inlet throttle-valve control as well as a blow-off control on the common header discharge. The existing system utilized static set-point surge-amp shutdowns and alarms to regulate the minimum allowable flow per blower. The system also utilized bearing vibration transducers on the bearing housings to monitor mechanical condition.

The air blowers used are all connected to a common header system that provides air for the commercial fermenters. The demand for 11 psig air in these fermenters fluctuates rapidly and total flow variations range from a minimum of 12,000 Icfm to a maximum of 66,000 Icfm.

Historical data showed the trended usage of this system accounts for 22,826,000 kWh per year. At $0.08 per kWh, the food processor was spending in excess of $1,826,080 per year in electricity cost.

The control system, on the existing blowers, was an inlet throttle-valve control that allowed a very small amount of turn-down (reduced flow capacity). In addition, the existing control incorporated a blow-off valve to vent excess pressure in the header as the blowers could not reduce the flow demand to the required amount set by the process nor could it respond quickly enough to the rapidly changing flow demands. It was also noted that the existing blowers were operating near a surge condition which caused excess heat on the discharge bearing and was very susceptible to process upset conditions putting the blower into surge. The plant had frequent unscheduled maintenance and repairs on this blower system.

HSI Supplied Optimized Blowers with Improved Efficiencies

To gain the necessary data to evaluate the air usage, we took a look at their historical recorded flow data gathered from a common mass flow meter at the discharge of three blowers. After plotting the amps and pressure trend data on the existing blowers, we discovered there was an error in the recorded flow measurement due to the placement of the existing mass flow meter. The flow meter was placed in a turbulent part of the main discharge header and, being an insertion type mass flow meter, did not give accurate readings. Instead we relied on plotting the recorded amp usage and discharge pressure to determine the actual flow used over time using the existing blower curves. This took quite a bit of work, but the conclusion was that the total flow produced far exceeded anyone's expectations.

With this base line process data, the HSI team went to work on a proposal to improve both the efficiency and reliability of this low-pressure system.

The Proposal Focuses on VFD Blower Controls

The audit recommendations focused on the tremendous variations in flow. The proposal suggested that the three existing blowers be replaced with three new centrifugal blowers equipped with variable frequency drives, which could deliver energy savings during the partial load conditions. Under base-load conditions, the new centrifugal blower designs also offered improved mechanical efficiencies due to modern impeller and casing designs using today's latest Computational Fluid Dynamic programming.

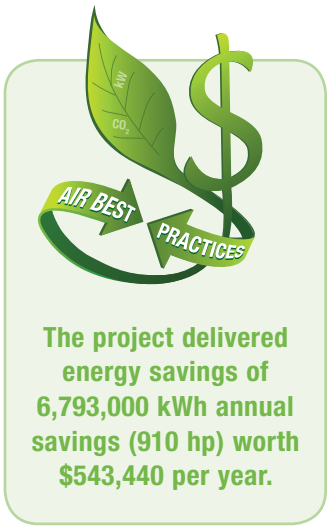
The new system was designed to meet continuous flow and pressure range from 8,000 scfm to 66,000 scfm without any gap or interruption in flow — eliminating the need for blow-off control.

Using a local control panel and operating with a variable frequency drive, the new blowers offered a greater turndown range (65% reduction from maximum flow) than any conventional throttle-valve control. Each proposed blower could operate from 8,000 scfm to 22,000 scfm.

The expected efficiency gain (offered in the audit recommendations) over the installed system was to save 6,204,000 kWh per year — the equivalent of 831 hp running on a continuous basis under these operating conditions.

COMPRESSED AIR AUDIT OF THE MONTH

Saving Energy with Blowers in Canada



The project delivered energy savings of 6,793,000 kWh annual savings (910 hp) worth $543,440 per year.

Measuring and Managing with Local and Master Control Panels

A new control system was proposed to completely replace the existing system. This included three HSI 3100 LCP (Local Control Panel) variable frequency drive control logic controllers and one HSI 3100 MCP (Master Control Panel).

The 3100 LCPs included sensors for the blower bearing temperature and vibration RTDs, inlet and discharge temperature and pressure, motor bearing and winding RTDs and surge and overload protection. The local control panel uses a combination of thermodynamic calculations and physical "fingerprinting" through detailed performance testing of the blower, motor and VFD package to allow for above-average blower turndown which results in energy savings. The local control panel can also revert to inlet throttle-valve control as well.

The 3100 MCP (Master Control Panel) permits complete sequencing and total power optimization of the three blower units. It includes a complete connection to the plant's SCADA system through an Ethernet port. Plant DCS can tell the MCP to operate to any control variable including total pressure or total flow and it will operate the blowers to its most efficient combination.

Finally, the audit proposed two new 1750 hp, 4160 volt, VFDs — reusing the one existing soft starter for the third unit. The third unit, used for backup, would still operate with inlet throttle-valve control. The blower supplier, HSI, also incorporated the design to reuse the existing electric motors to save on capital expense. Also included in the proposal were new actuated valves, check valves, expansion joints and modified bases.

The food processor evaluated the performance gains from a variety of blower designs including single stage type blowers. The proposed system offered the lowest 20-year life-cycle cost when considering efficiency and total capital cost.

Verification and Qualifying for Cooperative Capital

This energy-saving project was eligible for cooperative capital from the local utility. In order to qualify for a complete change in system, the verification was broken up into four stages. Each stage was to demonstrate the payback in terms of reduction in energy that the new system offered. Measurements were taken and documented by the utility company to verify the new performance levels after each stage of the project:

1. **Stage 1:** Replace (1) existing blower with the new optimized HSI blower. The measured and verified savings were of 1,742,000 kWh per year
2. **Stage 2:** Replace the second existing blower with another new optimized HSI blower. The measured and verified savings were 2,049,000 kWh per year
3. **Stage 3:** Replace the third existing blower with another new optimized HSI blower. This was not measured and was not part of the utility companys' project due to the lack of summer weather to prove results. The expected savings were 500,000 kWh per year
4. **Stage 4:** Install the VFD control system on the new blowers. The measured and verified savings were of 2,502,000 kWh per year

Energy Savings at the Food Processor

		kWh Annually
Stage 1	1st New Blower Saved	1,742,000
Stage 2	2nd New Blower Saved	2,049,000
Stage 3	3rd New Blower Saved	500,000
Stage 4	New VFD/Controls Saved	2,502,000
	Total Measured Savings	6,793,000
	Existing System Total	22,826,000
	New System Total	16,033,000
	Total Energy Savings as a Percentage	29.76%
	Total Energy Savings in Capital Dollars at $.08 kWh	$543,440.00

Conclusion

Expected total kWh annual savings was 6,704,000 based on HSI's original estimate. The actual measured documented results were as follows: Total savings tested and verified was 6,293,000 kWh per year. Stage three was not part of the project, but it will save 500,000 kWh annually for a total of 6,793,000 kWh annual savings (910 hp).

As a result, the food processor exceeded each of the performance evaluations recorded by and was reimbursed for nearly 75% of the capital investment.

Operating at an average rpm of 3100 (instead of the constant speed of 3600) offered extended bearing life. The HSI 3100 MCP (Master Control Panel) offered automatic sequencing capabilities without operators interfacing the starting and stopping of blowers.

Start-up power costs also dramatically reduced peak amp power factors when using VFDs. This was not used as additional energy savings in this project but would be in other power rebate programs. BP

For more information please contact Andrew Balberg, HSI, tel: (713) 947-1623, email: abalberg@hsiblowers.com, www.hsiblowers.com

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Do you Provide World-Class

BY MICHAEL GULD

Today's business environment is becoming increasingly complex and competitive due to globalization, new technology, increasing product proliferation, brand erosion, market segmentation, consumer skepticism and time poverty and rendering traditional business plans obsolete. For just about every product or service, there is an overwhelming number of choices to choose from, leaving consumers dazed and confused. So how can you stand out from a sea of competitors promoting similar offerings? Become known as THE company in your field that provides world-class service.

What is world-class service? It is the talk of many but the reality of few. When a company provides a client with world-class service, it often becomes a legendary experience that the client retells to others in a form of free publicity, which can't be bought.

What companies come to mind when you think of world-class service? What establishments do you patronize whose service exceeds your expectations on a continual basis? Typically, these are not the places that have the lowest prices. They do not have to — their value is created by elevating the customer experience to a point where paying a premium is not an issue.

First of all, companies should understand the difference between "the product," the commodity or service being delivered, and "the process," the method by which that product is delivered. Pike Place Fish Market in Seattle, Washington has become world famous for this differentiation. While their *product* is fish, their word-of-mouth fame was created by the *process* in which that product is delivered; throwing fish. The *product* of a doctor is clinical expertise, whereas most people would agree that the *process* by which that product is delivered (bedside manner) may be just as important. Since realtors do not have exclusives on the homes *(product)* they show and sell, their sole value is created by the service they provide *(process)*. Here's the point: your reputation in your field may be created more by the customer experience you deliver than the product or service you sell.

There are six simple actions that will determine your level of customer service (from the customer's perspective). When a realistic and objective assessment is made in each coupled with systems and strategies to improve (with training), it can result in immediate and transformational changes in your business:

1. **How well you listen —** Do you clearly understand the needs of your customers? As Mark Twain once said, "We have two ears and one mouth so that we can listen twice as much as we speak." You do not need to start out offering all the answers — first, begin by asking all the right questions. What do your customers *really* want and how can you better serve them?

2. **What you say —** How well do you answer questions, provide information, guidance or direction? Helping your customers understand the range of offerings available (pros and cons) and what best fits their unique needs will build loyalty. Helping them all along the way and being available for service after the sale will build customers for life.

3. **How you say it —** Have you evaluated your non-verbal communication such as body language, tone and inflection? In his book, "Silent Messages," Dr. Albert Merhabian found that communication is 57% non verbal, body language, eye contact, a warm smile and open gestures, 38% voice quality, volume, tone and inflection, and only 7% the words you say. Yet most people tend to focus their time, energy and training only on the words they say.

4. **What you do —** Do you consider your actions taken or not taken? The only thing worse than doing nothing is saying you are going to do something and you don't. It creates disappointment and a loss of trust. Taking the time upfront to address your customer's every need, want and desire will keep them coming back.

5. **How you do it —** Are you there to please or appease? Do you find that it's just a job for some people as they are going through the motions while others take pride in their company, their work and truly care about the well-being of their customers? Making customers feel special and appreciated creates an emotional bond that is not easily broken.

6. **When you do it —** Do you consider your response times? Immediate response times that exceed expectations create a positive perception, while long wait and response times create frustrations leading to a negative perception. We are now living in a "drive-thru" world where communication expectations are now greater than ever before with the advent of emails, cell phones, PDAs and text messaging.

SERVICE?

Most service experiences are unremarkable. We tend to remember only those experiences on the extremes of either side. Poor customer service tends to leave consumers frustrated and disappointed. In the restaurant business there is famous saying: "You are only as good as your last visit." An exceptionally long delay in receiving food may be as damaging to a restaurant's reputation as a bad meal.

Why is it important to create a world-class service culture? Because not only are the products or services in most categories being commoditized by your competitors — where the lowest price wins — but more and more often the service component is playing a greater role in your customers' *buying decision*. For example, if you look in the Yellow Pages under "Automobile Repair and Service," you will find pages of ads with every company communicating basically the same message. Since most people don't truly understand what is being done underneath the hood, their loyalties lie with the way they are greeted, on the phone or first meeting, and the way they are treated.

And finally, when talking about world-class service, it all comes down to people. When asked, "Why everyone working at Disney seemed so happy?" Michael Eisner replied, "Easy… we don't hire grumpy people." Robert Spector, author of, *The Nordstrom Way*, relays that Bruce Nordstrom's hiring philosophy was to, "Hire the smile and train the skill," noting that he could teach anyone to sell shoes, but he couldn't teach everyone to smile. If you look at the organizations that provide world-class service, you will usually find they hire the best people and then provide a supportive culture where those employees can flourish.

Now is a time to stand up and provide a WOW factor that will create customers for life. BP

Michael Guld is an author, speaker, entrepreneur and radio commentator whose business development expertise lies in increasing sales performance, marketing exposure, employee productivity and creating a world-class service experience. He is the president of The Guld Resource Group and creator of "Talking Business with Michael Guld," airing on Central Virginia's public radio. He can be reached at (804) 360-3122 or at michael.guld@guldresource.com.

Managing Rotary Screw Air Compressors at Midwest Bakery

BY JIM TIMMERSMAN

Financial Summary

Investment	**$64,141**
Energy Cost Before Investment	**$198,686**
Energy Cost After Investment	**$120,014**
Energy Savings/Year	**$78,672**
Input kW Before Investment	**500 kW**
Input kW After Investment	**302 kW**
Power Cost/kWh	**$0.045**
Operating Hours/Year	**8760**
Project Life (Years)	**10**
Power Cost Escalation/Year	**2%**

10-Year Summary

Energy Savings Before Tax	**$797,295**
Payback Period Before Tax (Years)	**0.82**
Energy Savings After Tax	**$414,594**
Internal Rate of Return After Tax	**70%**

Power Supply Industries was contacted by Midwest Bakery's corporate engineering office informing us that the plant was about to expand and that the engineering manager wanted to purchase an air compressor for the expansion. The corporate engineering contact was aware of our previous successes auditing the food industry and asked for a detailed audit to assess the situation and determine the proper size of the new compressor or, at our request, determine if one was needed at all. The plant estimated that a 150–300 hp air compressor would be needed and was looking for guidance on the correct size air compressor to install.

The audit Power Supply Industries performed was very detailed, including measurement of power (kW), air flow (scfm), pressure dewpoint (F) and pressure (psig). This detailed analysis of the supply side of the system was important in determining the current demand. All three measurements were recorded every second to show percentage of time at various loads and power required for each load period. This information helped to calculate the dynamic efficiency rating of the compressed air system, determined by measuring the scfm delivered per kilowatt. The bakery's rating of 3.57 CF(cubic feet)/ kW left much room for improvement by simply managing the compressed air system.

Managing the air system involved:

1. Sequencing the air compressors
2. Controlling the compressed air system to the lowest allowable pressure
3. Adding 10,000 gallons of storage for peaks in demand.

These improvements enabled us to increase the dynamic efficiency rating to 5.58 CF/kW. Implementing compressed air management allowed the plant to avoid the purchase price and annual energy cost of a new compressor, resulting in an annual energy savings of $35,411. The supply side energy savings totaled $114,083 with very little capital investment and a less than 10-month simple return on investment.

Air System Configuration Review

There are three compressor rooms at Midwest Bakery:

1. The first room is the Buffer Compressor Room. This room contains one 100 hp oil flooded rotary screw compressor, one refrigerated dryer and one 400-gallon tank. The air is discharged from the compressor through a 2" pipe and enters a wet 400-gallon storage tank. From the 400-gallon wet receiver, the air is filtered and enters the air dryer. After the dryer, the air is discharged to the plant through a 2" pipe that connects to the plant air system.

2. The East Compressor Room contains one two-stage oil flooded rotary screw compressor, but air can also be fed from a small oil flooded rotary screw compressor downstairs. This room also contains one blower purge regenerative dryer and two 600-gallon tanks. Air flows from the downstairs compressor through a 2" pipe where it connects with 4" pipe from the two-stage compressor. A 4" pipe connects the water cooled after cooler and the wet 600-gallon storage tank. The air flows in 4" pipe through a pre-filter and into the blower purge regenerative blower, then back out through an after filter and into a dry 600-gallon storage tank before connecting with a 3" pipe T and continuing on to the plant.

3. The West Compressor Room contains five oil flooded rotary screw compressors, a blower purge regenerative desiccant air dryer and one 600-gallon tank. The air flows through a 3" pipe from the rotary screw air compressors #1 and #2, compressor #3 begins with 4" pipe, and both compressors #4 and #5 have a 1.5" discharge. All five compressors feed a 4" main that flows to a wet 600-gallon storage tank. The air then continues through a 4" pipe and flows through a pre-filter before entering the purge regenerative blower. From the discharge of the dryer, air flows through an after filter in the 4" pipe before connecting to a 3" T in the plant.

The first step to understanding your air system is to write out (or draw) a list of all the equipment and where the air flows from each air compressor.

Jim Timmersman and Power Supply Industries Inc. have many years of successful auditing experience in the food industry.

MANAGING ROTARY SCREW AIR COMPRESSORS AT MIDWEST BAKERY

Typically, large differentials between static and dynamic pressures indicate the following conditions:

- **Improperly sized inlet regulators**
- **The air hose feeding the tool/process is too small (hose diameters are notoriously small and result in poor transportation of compressed air)**
- **Undersized couplings**
- **Multiple couplings at a single distribution point**
- **Poor compressed air distribution (piping)**

> "Static Pressure is the gauge pressure with the tool at rest. Dynamic pressure is the gauge pressure with the tool at work."

Flow Measurement

The flow measuring equipment used in this survey was an Accu-Flo Insertion Mass Flow Meter calibrated for the corresponding pipe size transmitting a -5 to +5 VDC. The signal was transformed into meaningful data and a data sample was recorded every 0.5 seconds. Data was then transferred onto computers and analyzed with print-out data summaries and data details. The probe locations were as follows in the piping system:

- 3" Buffer
- 4" West
- 4" East

Air Quality Measurement

The compressed air in the Buffer Compressor Room was saturated with water, and we were therefore unable to take dewpoint readings. Drains on the after cooler and receiver were found to be malfunctioning and were going to be serviced. The air quality in the East Compressor Room is very poor. While the contaminant level is low, the measured pressure dewpoint of 64 °F is extremely high. The dryer and drains in this room should be serviced to make sure they are operating correctly.

The air quality in the West Compressor Room is excellent. The measured pressure dewpoint of -36 °F is at the design level for the blower-purge regenerative dryer and the contaminant level is very low. An AQT-4 Air Compressed Air and Gas Analyzer was used to measure dewpoint. This equipment measures and records contaminant level, pressure, temperature and pressure dewpoint with an accuracy range for dewpoint of +/- 3 °F.

Piping Pressure Drop and System Pressure Measurement

The audit has reviewed the approximate surge flows at various distribution points to identify possible problems with pressure drop. The information gathered in this study indicates the plants ability to run substantially lower pressure than the compressor rating of 110/125 psig. We have outlined a plan to reduce horsepower on-line and overall usage in Section 10.

We used pressure transducers and calibrated gauges to test the facility's compressed air system for static and dynamic air pressure. This test provides insight into the actual air pressure being delivered to the points of use, typically less than thought or shown on air regulator gauges, or other pressure gauges located throughout the compressed air system. Midwest Bakery has very good main header distribution lines with some major problems in sub-headers with static versus dynamic pressure.

The second objective in the test is to determine the compressed air system's potential for an energy-saving intermediate flow controller application. Throughout our time walking through the facility, we asked different Midwest Bakery personnel what they thought the minimum acceptable air pressure required for their application was. The acceptable range was from a high of 100 psig to a low of 85 psig.

Audit Recommendations

Recommendation #1: Install Air Storage and Intermediate Flow Controller

Reduce artificial demand of the air system through the use of storage and an Intermediate

Controller to maximize horsepower on-line. Please note, Midwest Bakery's rotary screw air compressors are set to run at 110/125 psig, yet we are operating equipment from 86–109 psig in the main distribution system. Artificial demand is demand created by increasing the pressure above the point actually necessary to run the plant.

Existing Conditions	
Average Flow	1787 cfm
Horsepower On-Line	644 bhp
Pressure Range	86–109 psig
Avg. kW Usage	500 kWh

Proposed Air System	
Average Flow	1587 cfm
Horsepower On-Line	389 bhp
Stable Pressure	85 psig
Avg. kW Usage	302 kWh

Potential Savings	
Cfm Savings	200 cfm
Bhp Savings	255 bhp
kWw Savings	198 kWh
Operational Hours	8760/Year
Cost Per kW	$0.045322
Total First Year Savings	**$ 78,672**

Equipment Required:
Five Compressor Sequencer, PC Visualization, 10,000 Gallon Receiver,

Flow Controller	
Start Up Installation Estimate	$35,000
Investment	$ 64,141
ROI Estimate	1.26 Years

This recommendation will convert the plant air system from a "REACTIVE" system to a "MANAGED" system. The combination of proper storage and an intermediate controller will result in energy savings and eliminate excess horsepower on-line while ensuring system integrity. Receiver capacity is needed to absorb the cfm demand spikes and keep the input source(s) sensing average demand rather than peak demand. Without a controlled pressure differential on both sides of the receiver, there is no useful storage.

Without storage, the system must allow system pressure to decay in order to use it. Without proper storage, the system must operate at a higher-pressure with enough input generation on-line to adequately support any change or event which may occur in the system. No system can afford the financial and operational consequences of not having enough storage (capacity) to adequately satisfy the largest event without requiring additional horsepower.

MANAGING ROTARY SCREW AIR COMPRESSORS AT MIDWEST BAKERY

Inappropriate Uses of Compressed Air in Bakeries

Midwest Bakery was very similar to most manufacturing plants with normal leakage and some large inappropriate uses of compressed air:

1. **Bakeries tend to use compressed air as a broom and production lines are often set up with air knives blowing high-pressure air continuously. This plant used air knives as air curtains on freezer openings and to blow crumbs off of lines and product. Most of these inappropriate uses were eliminated by installing centrifugal blowers that do a better job and reduce load on the high-pressure system.**
2. **Much of the packaging equipment for the food industry uses vacuum generators to provide vacuum to suction cups to box product. This is an inappropriate use of compressed air for which we recommend using plant vacuum instead.**
3. **Another big inappropriate use of compressed air is cabinet coolers that blow compressed air continuously to provide low temperature air inside a hot electrical enclosure. We recommend cabinet fans wherever possible for this application.**
4. **Another common problem found in food plants is air quality, and as noted in our study the plant was pushing too much air through the main compressor room dryer. We recommended an energy saving reduced purge air dryer to save energy in regeneration.**

Recommendation #2: Rotary Screw Compressor Sequencer Control

The air system at Midwest Bakery needs a compressor sequencer control to maximize energy efficiency. We have included the sequencer savings in step one and this step covers in detail the functions and importance of this control. The eight compressors are currently being controlled by their own local controls. Normal operation is to run three of the eight compressors. All eight compressors are started and stopped manually. Plant pressures range, from as low as 86 psig to as high as 110 psig using the existing control methods. If a compressor were to shut down (fault) plant operators need to manually start the spare compressor after low pressure has caused production problems. Typically the plant runs excessive horsepower resulting in wasted energy consumption.

High-energy cost, excessive maintenance and premature compressor failure are all attributed to poor compressed air management. All compressors are being controlled by independent compressor control receiving pressure signals from four separate pressure points. Significant improvements could be made by installing a compressor sequencer to properly match the supply compressors more efficiently. The current rotation of compressors is being done manually on an as perceived basis. Automation should be installed to properly rotate lead/lag machines. A properly applied sequencer will fill this need.

The compressed air supply and demand pressures are maintained as much as 10–15 psig higher than they could be. Energy savings will be realized by keeping the pressure from rising above the 100 psig compressor's set point, and simultaneously using an efficient compressor sequencer to turn the correct compressors off or on based on the rate of rise or decay in the dry storage receiver.

The existing compressor control arrangement lacks control integrity. There is no form of automatic sequencing/interfacing or monitoring being done at this time. All of the compressors are equipped with electro pneumatic controls. Although these controls were "state of the art" at the time they were manufactured, they are inefficient and difficult to regulate when compared to what today's technology has to offer. The existing system arrangement demonstrates excessive horsepower on-line at all times in order to accommodate worse case or heaviest demand.

We recommend a microprocessor-based sequencer. The sequencer will be connected to the five compressors located in the West Compressor Room.

The sequencer will:

- Start, load, unload and stop the compressors automatically
- Rotate the compressors automatically
- Maintain +/- 2 psig control band

Recommendation #3: Use Buffer Room Compressor as Back-Up and Fix Dewpoint

The stand-alone 100 hp oil flooded rotary screw compressor is located in the Buffer room. The compressed air from the 100 hp does not meet Midwest Bakery standards because of the +40 dewpoint refrigerated dryer. We found the air to be completely saturated and the air is of very poor quality. The main air dryers in the plant are all regenerative twin tower -40 PDP dryers. The plants' air quality will significantly increase if all the compressed air supply is dried by the regenerative type air dryers. With the improvements outlined in step one — implementing compressed air management — the 100 hp can be relegated to back up duty only.

Recommendation #4: Install Low-Pressure Blowers for Blow-Off Applications

Most of the lines at Midwest Bakery incorporate low-pressure blow off of the product using air knives. This represents a significant opportunity for savings. We recommend detailed testing to properly size low-pressure centrifugal blowers to convert these applications from high-pressure air. The air knives at a 10 psig setting consume an estimated 418 cfm of compressed air. We recommend low pressure centrifugal blowers be adapted to provide this air because any time you compress air to 100 psig to use it at 10 psig, energy is wasted. Any place the plant is blowing compressed air on a continuous basis where high-volume and low-pressure is required, the power required to operate a centrifugal blower is less than 10% that of using high-pressure compressed air.

Recommendation #5: Manage Air Leaks

The leakage estimate at Midwest Bakery is typical to other facilities in your industry and the plant would benefit from a semi-annual leak review to keep the leakage rates below 5% of average demand. The plant can purchase a detector for $2,500 or have PSI provide the service.

Recommendation #6: Improve Performance of Condensate Drains

We recommend zero loss drain valves be installed on the compressor after coolers, separators and on the filtration to remove oil. The wet receivers should also have a zero loss drain installed. These drains are very high quality and very reliable to ensure proper drainage without wasting compressed air. The air system generates 436-gallons per 24-hours and this water must be removed from the system.

Conclusion

Midwest Bakery implemented most of the corrections and solutions offered by Power Supply Industries. Today, Midwest Bakery has completed the expansion and still operates less rotary screw air compressor horsepower than when the audit began by eliminating inappropriate uses and implementing compressed air management practices. BP

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THE DIFFERENCE BETWEEN ACFM AND

BY DOCTOR VACUUM

Understanding the difference between acfm and scfm is critical to correctly size vacuum pumps

One of the most perplexing topics in vacuum technology is the concept of flow inside a vacuum system. Vacuum flow is sometimes termed pumping capacity or the pumping "speed" of a vacuum pump. Manufacturers of vacuum equipment have their own special language regarding pumping capacity and new users will have a difficult time following nomenclature in and around what a vacuum pump can deliver to their system. One of the root causes of this confusion is that the term "cfm" is used interchangeably to describe every type of flow in a vacuum system. What we find is that the term cfm, while accurate, is not descriptive enough to be helpful in sorting this out.

Acfm and Scfm

Flow from vacuum systems can be boiled down to two terms — scfm and acfm. There are other designations but these are the most essential and provide the essence of what we are seeking to understand. Delivered capacity of a vacuum pump is also described with these same two terms. The trick is to match the system demand requirement with the correct vacuum pumping capability. Correctly matching demand with supply will ensure that adequate vacuum will be attained and production equipment will function properly. We must understand the meaning of each type of flow before these two flow concepts can be matched.

Scfm is straightforward and stands for, "standard cubic feet per minute." In other words, it is the flow of one cubic foot of air per minute at standard conditions. This can be loosely described as the air that is drawn into a vacuum system from the ambient environment. Note that standard conditions of pressure, temperature and relative humidity vary from industry to industry and can significantly affect any conversion to volume flow. Other terms that are used loosely in place of scfm are mass flow, free air and standard air.

Acfm stands for, "actual cubic feet per minute" and is the flow inside the vacuum system through distribution piping and at the inlet to the vacuum pump. This air is less dense than air at atmospheric pressure and becomes proportionately less dense as vacuum increases. A good way to illustrate acfm is to use a balloon as an example. A slightly inflated balloon is tied off and placed inside a vacuum chamber. As the chamber is evacuated, the balloon expands under vacuum even though it is sealed and no additional air is let in. As vacuum increases so does the volume of the balloon. Consequently, the air inside the balloon becomes less dense as the balloon volume increases. This is the nature of acfm — more volume and less density. This is exactly what happens at the inlet to a vacuum pump. As vacuum increases, inlet air becomes proportionately less dense. Each revolution of the vacuum pump draws less air than the last as vacuum increases. When the amount of air entering the system is equal

SCFM FOR PROPER VACUUM SIZING

to the amount of air being drawn out, the ultimate vacuum level is attained. If more air is let in, vacuum will decrease, and if less air is let in, vacuum will increase. Other terms that are used for acfm are volume flow, expanded air, inlet air and aspirated air. Note that many vacuum pump manufacturers rate vacuum pump capacity in acfm.

Know Your Flow

If applications are rated in scfm and most vacuum pumps are rated in acfm (or vice versa), we must convert between the two to match application demand to vacuum pump capacity. Without too much detail, the conversion is scfm x P1/P2 = acfm where P1 is the starting pressure in absolute terms and P2 is the target pressure in absolute terms. A simple example is an application that generates 100 scfm at 20" HgV. The conversion to acfm is 100 x 29.92/9.92 = 302. With this formula, it is evident that as vacuum increases, so does the volume flow requirement. To attain 29" HgV with this same 100 scfm starting point requires a vacuum pump capacity of at least 3,252 acfm or over 200 hp. Conversely, attaining only 5" HgV would require a minimal 120 acfm or about 5 hp. The bottom line is that there is a cost associated with attaining higher vacuum. It is important to make sure the requirement for higher vacuum is real or that the payback in production throughput is greater than the additional energy cost for operating larger vacuum pumps.

> "Many vacuum pump manufacturers rate vacuum pump capacity in acfm"

This illustrates why the term cfm is not descriptive enough. The example shows that matching a 100 "cfm" vacuum pump with a 100 "cfm" application can get you into trouble if you make invalid assumptions regarding scfm or acfm. Keep in mind that in this example we did not consider temperature. As inlet air temperatures increase or decrease, acfm will increase or decrease. In addition, stock vacuum pumps are typically rated for pumping air. If the inlet gas stream is a mixture of gases other than air there are other factors to consider before deciding on the right pump.

There are additional flow designations other than cfm that can be found in production vacuum system specifications. Some of the more frequent ratings are in cubic meters/hour, cubic meters/minute and liters/second. In these cases, you will have to perform conversions that match vacuum pump capacity with application demand. Be sure to know which side of the vacuum pump these ratings are based on and you will be well on your way to making the right decisions. BP

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Best Practices –
MULTI-MODULE PROCESS AIR DRYERS

The Optimal Air Treatment Solution for Large Systems

BY C. JOHN BERGH AND CHRIS URSILLO

Modern manufacturers cannot tolerate downtime that results from equipment or process failure. Sustained output is required to accommodate reduced inventory and narrow shipment windows. When a critical malfunction occurs, many downstream processes can be affected.

Often compressed air is an essential utility that enables large-scale manufacturing. Even in large compressed air systems, air treatment is often given second billing to the compressors, where pressure delivery performance is easily monitored. However, properly performing air treatment equipment is every bit as necessary as the air source upstream.

When designing a compressed air system or upgrading an existing one, the designer must take into account more than just product sizing and initial capital investment. Questions that cause consideration of other factors are necessary: What happens to the facility should a component fail on the compressed air cleanup equipment? How can scheduled maintenance be carried out without disrupting critical processes? How much room do I have to free up for dryers? How much does the equipment actually cost to install? A comprehensive compressed air treatment design requires addressing all aspects of the system.

Take for example a system sized to deliver 8,000 scfm at 100 psig and 100 ˚F after the compressor's aftercooler. The compressed air treatment requirement may be addressed in one of the following approaches:

a) Multiple, Independent Small Dryers

This is often the result of an ever-expanding system whereby the customer purchases only the amount of drying equipment necessary to address the incremental increase in capacity. In this scenario, we will assume the customer has six compressors and matching dryers of varying capacity, ranging from 500 scfm to 2,000 scfm.

b) One Large, Full Capacity Dryer

On new installations, many specifiers will provide a dryer sized to process the full load of the compressed air. We will assume this is a single-refrigeration system dryer sized to address the air load of the conditions noted.

c) Two Large, Full Capacity Dryers

This method is often used by those recognizing the value of clean dry air to their processes. A brut force approach, it makes use of two of the dryers described in "b)" above. One dryer is operational while the other, valved off by a three-valve bypass, is in a standby mode.

d) One Multi-Module Dryer Rated for the Full Capacity of the System

Multi-module dryers are large flow (process) air dryers assembled from two or more small dryer modules operating in parallel requiring only a single connection for air flow, electrical and (if required) cooling water. Cycling operation enables refrigeration power to modulate to accommodate varying loads.

BEST PRACTICES — MULTI-MODULE PROCESS AIR DRYERS

Each of the four approaches above provides some benefits when considering a compressed air design. They can be critiqued against the guidelines of a comprehensive system:

- **Initial Capital Cost —** Perhaps the most visible of the criteria, the purchase cost of the equipment, drives many decisions on equipment selection. While certainly an important consideration, it should not be the sole motivation for equipment selection.

- **Cost of Operation —** Different approaches and technologies used in the design of compressed air equipment can yield very different operating costs. Costs associated with operation of inefficient equipment may quickly overshadow capital cost savings. For example, some inefficient dryers will continue to operate at all times regardless of the system demand.

- **Installed Cost —** Costs associated with connecting the equipment to the compressed air system. For compressed air dryers, this refers to costs associated with connecting the air piping, electrical connections and if required, cooling water piping for water-cooled equipment.

- **Footprint —** The physical size of the equipment plays an important part in the proper selection of a compressed air dryer. The size and location of equipment, if not carefully considered, could severely hinder future expansion, as floor space within the compressor room can become increasingly more valuable.

- **Continuity of Operation —** Interruptions in the supply of clean dry air can have a major impact on manufacturing productivity, product quality and critical processes. Recognizing the "what-if's" and planning accordingly can minimize or even eliminate the problems associated with unexpected downtime of equipment.

- **Maintainability —** Most all manufactures establish preventative maintenance programs to ensure optimal operation of their equipment. Time and resources necessary to execute program tasks must be addressed to meet these requirements. Factors such as planned equipment downtime or provisions within the equipment for on-the-fly maintenance must be considered for proper system design.

"When a critical malfunction occurs, many downstream processes can be affected."

With a ranking structure designating numeral 1 as the least desirable and numeral 5 as the most desirable, the total accumulated score for each approach reveals the one best suited to large scale manufacturing.

a) Multiple Small Dryers of Various Size

Initial Capital Cost	3
Cost of Operation	5
Installed Cost	1
Footprint	3
Continuity of Operation	4
Maintainability	4
Ranking Total	**20**

With a multitude of individual dryers in the system, there is a good probability that one of the dryers can be serviced or maintained without significant disruption to the compressed air system. That is, of course, dependent upon how the dryers are connected within the air system and whether the offline dryer is of particularly large capacity.

It is plausible that such a system may only use the dryers that are needed for a given load situation. This may require manual activation of the standby dryers to address increases in compressed air usage if an automated control system is not in place.

The shortcomings of this approach are numerous. With dedicated power, air and possible water connections, this scenario is the most expensive to install. In addition, without being able to take advantage of economies of scale with the equipment, this approach also has a very high capital cost. Lastly, taking into account not only the physical size of the dryers but the access area required around each, this approach predictably uses the most real estate in the compressor room.

b) One Large Non-Cycling Dryer

Initial Capital Cost	5
Cost of Operation	3
Installed Cost	5
Footprint	5
Continuity of Operation	0
Maintainability	0
Ranking Total	**18**

Purchasing the exact amount of dryer for a given compressor output will translate into the optimal capital cost. With a single connection, installed costs are also quite favorable for this approach. Taking into account the service area requirements for a single dryer, this approach is among those that consume the least amount of floor space in the compressor room.

Provided the sizing of the dryer matches the compressor capacity and provided the air usage does not vary, the cost of operating this dryer would be very desirable. However, most all facilities have varying load profiles, taking into account varied processes, shift changes, reduced workload, etc. A non-cycling dryer will continue to operate at full load regardless of the compressed air load. Such operation can result in significant energy consumption during times of low compressed air usage.

With the economical upfront cost of this approach, it may be difficult at first to see its shortcomings. That is until one considers the "what if" of component failure or maintenance requirements for the dryer. By using this all-eggs-in-one-basket approach, failure of even a simple component in the dryer could shut the entire compressed air system down. Similarly, if the compressed air system approaches a 24-hour per day, 7 day a week operation, opportunities to conduct preventative maintenance on the dryer are minimal. Avoiding preventative maintenance will only result in more frequent and unpredictable component failure.

c) Two Large Non-Cycling Dryers

Initial Capital Cost	1
Cost of Operation	3
Installed Cost	2
Footprint	2
Continuity of Operation	4
Maintainability	5
Ranking Total	**17**

With 100% backup, this approach takes into account the peril that can result from poor planning for maintenance and component failure. However, with the dryer valved off from the air system, it will only be after a failure has occurred and the downstream process is interrupted that the standby dryer is operational. Conceivably, sensitive processes may be severely impacted during the time between the dryer failure and the activation of the standby dryer. This approach does, however, allow for preventative maintenance on the standby dryer — a measure that will likely have a positive effect on the continuity of operation of the online dryer.

Since the design of the dryers in this approach match those of scenario "b)," the same operational cost caveats apply.

d) One Multi-Module Cycling Dryer

Initial Capital Cost	4
Cost of Operation	5
Installed Cost	5
Footprint	5
Continuity of Operation	5
Maintainability	5
Ranking Total	**29**

This approach ranks highest when considering the comprehensive requirements of a well-designed system. ZEKS Compressed Air Solutions, West Chester, Pennsylvania examined the broad requirements and associated implications faced by large-scale manufacturers and used the findings to guide development of the MultiPlex™ multi-module dryer concept. What resulted is a large capacity dryer composed of multiple modules, each of which is comprised of a dedicated refrigeration

BEST PRACTICES — MULTI-MODULE PROCESS AIR DRYERS

system, air circuit and condensate removal system, and a shared chilled glycol system. Given the unique attributes and associated benefits of this multi-module design, it is worth examining each of the six critical factors in detail for this approach.

Initial Cost: While not the least expensive of the four approaches, the multi-module dryer provides the redundancy of small individual dryers with the compactness and economy of scale of the single large dryer. The design features a circulating chilled glycol loop with the dedicated refrigeration system of each module contributing to the cooling of the glycol, which is ultimately stored in a central glycol storage tank.

Without the need for a second, full-capacity dryer, the multi-module approach affords the security of inherent redundancy without the initial cost of a full size standby dryer.

Cost of Operation: With the MultiPlex™ design, cycling operation enables the dryer to match energy consumption to the compressed air load through thermal energy storage and by turning on and off individual refrigeration systems. When the glycol/water temperature is higher than the operating set point by 1 ˚F, a refrigeration module is turned on. If the glycol/water temperature is 2 ˚F off the set point, two systems are turned on (as available). When the operating temperature is lower than set point by 1 ˚F a system is turned off, and so on. Energy matching saves operating cost by reducing electrical power consumed. Additional savings of this design can be realized from increased compressor operating efficiency and power delivered at lower ambient air temperatures (both daily and seasonal) with the capability of ramping down smoothly to zero air load. Through each module's dedicated digital performance controller, refrigeration on/off set points can be easily adjusted to equalize refrigeration compressor operating hours.

To illustrate the savings afforded by the cycling design of the MultiPlex™ dryer, consider our 8,000 scfm, 100 psig system operating at an average reduced load of 6,550 scfm at 100 psig. This average figure takes into account a peak demand of 8,000 scfm but also reduced loads associated with varying usage of processes and second and third shift workloads. When compared to a non-cycling dryer, which will run continuously regardless of load, the MultiPlex™ cycling design will save the user, based on $0.10/kWh and 8,736 hours of operation, $25,000 or more annually, taking into account the effects of daily and seasonal changes of the ambient temperature, which in turn reduce the compressed air inlet temperature and refrigeration condensing temperature.

Pressure drop is also a significant factor in the operating cost of large volume air systems. Every psi of added pressure drop adds 0.5% to the cost of operating the compressor. MultiPlex™ multi-module dryers are designed to minimize their contribution of pressure drop on the compressed air system. For this example, the 8,000 HSFM model's 3.0 psi pressure drop, when compared to the 5 psi pressure drop of typical dryers, results in significant energy savings. Based on $0.10/kWh, a system running 8,000 scfm at 8,736 hours per year will save over $15,930 annually.

In addition, because of a unique heat exchanger design, inlet filtration is not required for most system conditions thereby further reducing the dryer's contribution to system pressure drop and operating cost of the air compressor.

Footprint: Even with the recommended minimum of three feet of space around the dryer required for maintenance, the multi-module dryer configuration occupies less floor space than the other three approaches to air dryer installation. For air-cooled installations, condensers are mounted on the top of the dryers, eliminating the additional compressor room space to accommodate remote or out-board air condensers.

Continuity of Operation: Perhaps the most valuable feature of the multi-module design is the ability to continue to operate the dryer during an upset condition. Should a problem occur with one of the dryer's modules, provisions exist on the dryer to allow it to continue to operate at slightly reduced performance. Take, for example, our 8,000 scfm, 100 psig application. These conditions would typically size to a four-module, 8,000 scfm dryer. Should a problem arise in one of the dryer's modules, the module can be de-energized and the balance of the dryer permitted to continue operation. In this upset condition, the two remaining refrigeration systems, both focused on cooling the glycol common to all modules, will continue to use their full capacity to reduce the temperature of the glycol. With the unique piping arrangement of the glycol system, the remaining glycol circulation pumps (one per module) will continue to pump chilled glycol to all three modules. Although the pressure dew point will decay from 38 ˚F to 42 ˚F, the compressed air system remains on-line until the repair is completed.

With this unique feature, continuity of operation of the compressed air system is preserved under upset conditions without the need for a full-size back of dryer. As such, significant savings on initial capital cost, installation cost and compressor room space are realized.

Maintainability: Unique to the MultiPlex™ design is the ability to execute preventative maintenance tasks and dryer repairs while the dryer remains operational. While preventative maintenance tasks are minimal, each module is equipped with the means to electrically isolate the module from the balance of the dryer. This allows for

COMPRESSED AIR

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Compressed Air Best Practices is a technical magazine dedicated to discovering **Energy Savings** and **Productivity Improvement Opportunities** in Compressed Air Systems for specific **Focus Industries**. Each edition outlines "Best Practices" for compressed air users — particularly those involved in **managing energy costs in multi-factory organizations**.

Utility and Energy Engineers, Utility Providers, and Compressed Air Auditors share techniques on how to audit the "demand-side" of a system — including the **Pneumatic Circuits** on machines. This application knowledge allows the Magazine to recommend "**Best Practices**" for the "supply-side" of the system. For this reason we feature **air compressor, air treatment, measurement & management, pneumatics, compressor cooling, blower and vacuum** technologies as they relate to the requirements of the monthly **Focus Industry**.

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BEST PRACTICES — MULTI-MODULE PROCESS AIR DRYERS

the service and replacement of major refrigeration components, up to and including the condenser and refrigeration compressor. Having the means to keep the dryer online with a slightly reduced capacity permits the compressed air system to remain operational even during major servicing of the dryer.

When compared to large process air dryers that incorporate a single or, at best, dual large refrigeration compressors or cylinder unloading semi-hermetic compressors to match cooling energy to variable loads, the multi-module solution provides better reliability as each refrigeration system operates at the optimal velocity for internal oil circulation and return. The optimized modules use less refrigerant charge (22 lb. max charge per module) than large heat exchanger dryers of equal capacity, especially flooded evaporator dryers. This is an important consideration in the cost of leak repairs.

MultiPlex™ refrigerated dryers create an optimal drying solution for large flow installations. Operating costs are minimized by the dryer's ability to match the energy consumption with the load on the dryer, and further savings are realized by the unit's low-pressure drop. With single connection points for air, electric and cooling water, and with no requirement for a dedicated standby dryer, total installation costs are significantly lower than other approaches.

While the single dryer footprint frees up valuable equipment room floor space, the MultiPlex™ design permits comparatively inexpensive expansion possibilities, courtesy of the double-ended header design with constant height that enables the dryer to grow with the customer's compressed air requirements. To minimize the impact of downtime due to maintenance or component replacement, MultiPlex™ dryers can be oversized to allow servicing of one or two modules with no reduction in dew point. Employing this tactic further reduces operating costs due to the reduction in pressure drop.

With the impact of downtime due to air treatment equipment failure being so critical and the costs to sustain a supply of usable air so high, it's logical to consider the benefits of the multi-module dryer design. BP

Authors:

C. John Bergh, Manager of Engineering, ZEKS Compressed Air Solutions

Chris Ursillo, Marketing Manager, ZEKS Compressed Air Solutions

For more information visit www.zeks.com

Each module expands the capacity of the dryer by 1,625, 2,000 or 2,400 scfm

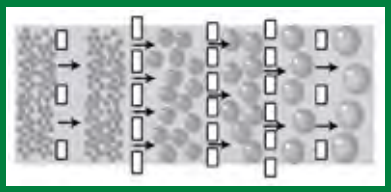
THE VACUUM FORMATION PROCESS IN BUILDING COMPRESSED AIR FILTER ELEMENTS

BY JOHN BALL

Compressed air filtration technology has evolved from a subjective art form to a quantified, highly advanced science. Today, contaminant free compressed air is a requirement in most major industries. It is specified in critical applications including pharmaceutical and semi-conductor manufacturing as well as the food processing industry. As manufacturing processes become more sensitive, the need for high purity levels of compressed air becomes increasingly important. Untreated, compressed air systems contain contaminants in the form of solids, liquids and gases.

Compressed Air System Contaminants

Solid contamination, present in ambient air, may be ingested through the intake of an air compressor. Typical industrial air contains nearly 4,000,000 particles of dirt per cubic foot of air. Liquid contamination is introduced in the form of water vapor or as oil aerosols generated by the air compressor. Even a well maintained oil lubricated air compressor, with an oil carryover rate as low as 2 ppm/w, will introduce as much as 4.8 gallons of oil into a compressed air system per year. Hydrocarbon vapors are also ingested through the intake of the air compressor, up to 5 ppm/w, which produce undesirable odors and small amounts of trace oils ending at the point of use. So what are the solutions? Each aforementioned contaminant may be addressed through the proper application of compressed air filters.

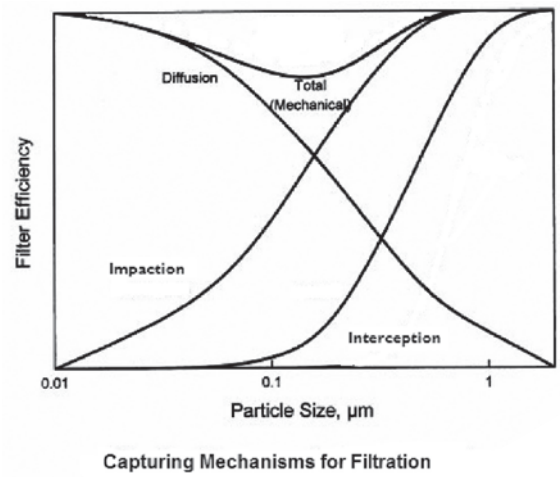


Coalescing Process: Converging-Diverging Pore Structure

Coalescing filters are utilized to capture submicronic particles and oil aerosols at highly efficient rates. In general filtration terms, coalescing is defined as a process whereby small, liquid aerosol droplets traveling through a filter element run together and form larger droplets. Media constructed of fibrous material is best suited for the removal of liquid aerosols. To achieve the coalescing effect, certain industry recognized principles of filtration must be honored. The mechanisms promoting effective removal of oil aerosols are:

Direct Interception: This phenomena occurs when a particle 2.0 micron and larger in size, collides directly with the filter media. Since most coalescing filters flow from inside of the element to the outside, direct interception takes place on the interior surface of the element. Once the droplet is directly intercepted, it extends over the surface of the fiber onto neighboring fibers.

THE VACUUM FORMATION PROCESS IN BUILDING COMPRESSED AIR FILTER ELEMENTS



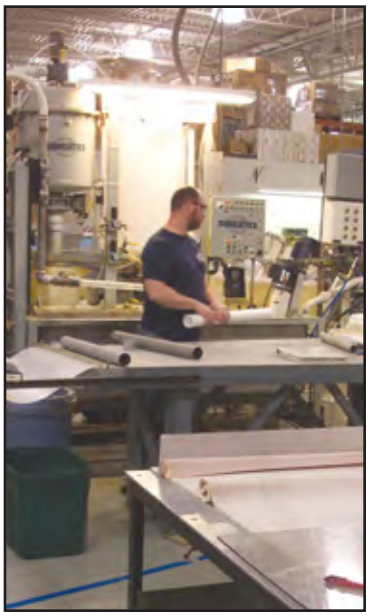
Capturing Mechanisms for Filtration

Inertial Impaction: Smaller particles in the 0.2 to 2.0 micron size range are the most challenging to capture. Particles of this size, which conform to the air stream, are collected as they travel through the torturous path of fibers inside the element. Once a particle of this size encounters a fiber approximately one half of its physical size, it is captured and adheres to the fiber.

Diffusion: The diffusion process commonly referred to as Brownian Motion captures particles 0.2 micron and smaller. Particles of this micron size are small enough to deviate from the air stream, are not affected by gravity and move in a random motion through the element. The erratic movement increases the likelihood of the particle coming in contact with a fiber within the element.

The Vacuum Formation Process

Micro-Filtration, division of Numatics, has been producing high performance filtration media since 1986. A proprietary vacuum formation process allows the manufacturing to be controlled to a point where all stages, from the selection of the raw material to the finished product are tightly governed.



Vacuum Formation Tank

1 The vacuum formation process starts with selecting the required grade of borosilicate fiberglass micro-fiber. Filtration performance, from micron retention rate to pressure drop is dictated by media grade selection. Since the micro fibers vary in diameter and length, each will exhibit unique performance characteristics.

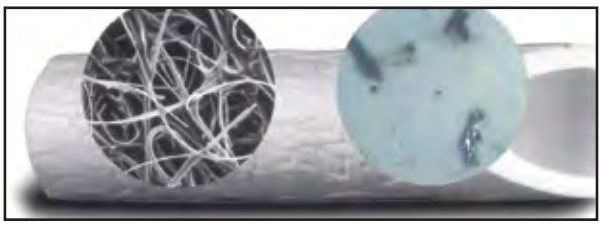
2 A pre-measured quantity of fiberglass material is added to a polypropylene mixing barrel containing into a proprietary solution. The solution is commonly referred to as slurry.

3 The slurry is mixed for a specified period of time and then added to a stainless steel formation tank. The pH level within the tank is controlled allowing the fibers to properly combine and "floc." Flocculation is defined as a "process of contact and adhesion whereby fine particles of a dispersion form larger size clusters."

4 A fixture surrounded by a corrosion resistant support is immersed in the formation tank. Hole diameter spacing as well as the circumference and length of the fixture dictate the elements' physical size, density, filtration performance and flow capacity. The inner media wrap initiates the coalescing process by acting as a disperser.

5 Vacuum is drawn on the fixture building a random matrix of glass fibers. Submersion time and vacuum pressure are regulated dependent upon desired filtration grade. Large diameter fibers are first to collect on the fixture allowing the smaller diameter glass fibers to migrate unabated. Once the fixture has collected larger fibers, smaller fibers are collected onto what is now the interior of the element. The remaining large fibers are collected creating an element with a course to fine, back to course pore structure. A torturous path has now been created. The converging/diverging pore structure captures submicronic particles to 99.9999+% efficiency.

Service life of coalescing filter elements are determined by the amount of solid contamination that is collected. Solid particulate is removed in equal efficiency to that of liquids, yet behave differently after collection. Solid particulates do not coalesce and become a permanent contaminant within the element. Due to the inherent benefit of the vacuum formation design, particles are trapped through entire cross section of the filter, lowering pressure drop, maximizing solid loading capacity and increasing service life of the element.



Magnified cross section of borosilicate fiber

6 A non-wicking fiberglass media wrap is added to the outer diameter of the support core. The support core enhances the structural integrity of the element. Cores made of either rigid, high impact plastic or corrosion resistant steel are selected based upon customer requirements.

7 After formation of the filter core, the element is cured through a heating process. Proper dehydration time allows the core to stabilize and become suitable for further handling.

8 A non-wicking, polyester drain layer is added. Multi-staging the element with a dedicated drain layer prevents re-entrainment of liquid.

9 Elements with plastic support cores are precisely cut to desired length. Element length must conform to physical dimensions of the respective filter housing.

10 An optional 3.0 micron pleated pre-filter is placed into the internal diameter of the inner support core. The added media layer extends the service life of the coalescing filter by removing solid contamination. A metal, corrosion resistant support screen is added to maintain the mechanical integrity of the pleated media under back flow conditions.

11 End caps are bonded to the element, which facilitate insertion into the filter housing. End caps made of anodized aluminum, plastic, silicone or urethane, are customer specified.

12 After sufficient curing time of the bonding agent, the elements' part number is diamond etched on the bottom end cap.

13 The product is placed is a heat sealed transparent wrap, placed in a shipping carton, then placed on the shelf as finished goods available for service.

Ultra Air Delta Series high-performance filtration products are equipped with vacuum formed filter elements. Micro-Filtration also utilizes the vacuum formation process when manufacturing a comprehensive range of Upgrade compressed air filter elements. BP

For questions please contact John Ball, Engineering Manager, Micro-Filtration, john.ball@emerson.com, www.micro-filtration.com

Helping People at Solberg

Compressed Air Best Practices spoke with Mr. Clint Browning (Director of Sales) of Solberg Manufacturing.

Good morning. How does Solberg Manufacturing help people?

Good morning. Helping people is a culture here at Solberg that began with our founder, Charlie Solberg Sr. He believed that when we help and take care of our customers, they also take care of us. Helping our employees be successful has also provided great rewards to Solberg. It's our customers and our employees who have built Solberg into what it is today.

Our customers come to us with specific problems related to their equipment and processes and we apply our knowledge with applications and separations technology to provide solutions. Instead of rapidly referring them to a standard catalog product, our culture and resources are focused on welcoming the opportunity to provide a customized and ideal solution for the customer. This culture has been with us since Solberg was founded in 1968.

The LRS Liquid Removal System for Vacuum Pumps

How did Solberg Manufacturing get started?

Charles H. Solberg Sr. created a filter silencer design for small air compressors in 1966. Solberg Manufacturing was founded two years later. Our growth over the years has come from new innovations designed to help customers. In 1978 we introduced a filter line for blowers and in 1982 we introduced inlet vacuum filters for regenerative blowers and rotary vane vacuum pumps. In 1982 Solberg also introduced a line of oil mist exhaust filters for direct drive high-vacuum pumps and in 1986 we introduced a Filter/Silencer product line for small horsepower (below three horsepower) air compressors.

What is the size and scope of Solberg Manufacturing?

We are an international company with operations all over the world. Our headquarters and largest manufacturing facilities are located in Itasca, Illinois. We operate two facilities here with a combined 75,000 square feet dedicated to manufacturing and rapid-delivery distribution. Our distribution center in Itasca ships 90% of our products within two business days and boasts 95% on-time shipments.

We also operate assembly and manufacturing facilities in the U.K., Brazil, China and Belgium. We have sales offices in many other countries including Mexico, the Czech Republic, Germany and Spain. Solberg products are currently sold in over 50 countries worldwide.

What are the primary product lines manufactured by Solberg?

The three main product lines are inlet air filters/silencers (which go on air compressors and blowers), vacuum filters and oil mist coalescers. The fourth product category is specialty-filtration products. This is our fastest-growing segment.

Our air compressor intake filters/silencer products range from 2 cfm filter to 50,000 cfm filters used on centrifugal air compressors. Inlet connection sizes range from ¼ inch to 50 inches.

Can you describe your "High-Value Customization" process?

Sure. We help our customers with their specific problems through our High-Value Customization process. Our application engineers will listen to a customer (either in person or on the phone) who will commonly describe a unique filtration problem with demands beyond the range of our standard products. The customer will often simply say that liquid is continually getting past the filter and forcing him to continually rebuild his vacuum pump (for example). We go through a process which identifies why this is happening and then recommend a customized solution such as an LRS (liquid removal system) or STS (see through knock-out system with ball float).

We are able to mix and match parts from our standard product lines (special connections options, dual elements, special elements, stainless steel elements, stainless steel housing, 90˚ inlet pipe, to name a few options). This allows us to create a specialty filter, which matches the unique requirements of the application. Vacuum, blower and air compressor OEM's often request special sizes or unique features, which we can accommodate. Our resellers regularly call in with problematic applications and unique filtration requirements and we help them deliver solutions to their customers. We call this process "High-Value Customization," and it is driving the rapid growth of our specialty-filtration product category.

The challenge presented to Solberg was chocolate shavings were clogging the system and it was difficult to gauge when to service the filter element. The ST Series Filter housing with a fine filtration element removed the shavings from the system and the see-through housing allowed for easy visual inspection and easy access to the filter element.

What is the importance of intake air filtration?

Quality intake filter designs minimize pressure differential, which in turn reduces power consumption. Our filter element designs maximize the filtration surface area in order to minimize the pressure loss at the intake to the pump. For air compressor intake filters, the pressure differential will be between 1–3 inches of water. For Filter/Silencer combinations with noise attenuation tubes, pressure loss will range between 3–5 inches of water. The recommended change out is at 15–20 inches of water (.5–.7 psig). One psig is equivalent to 27.7 inches of water.

Air Compressor Intake Air Filters Increase Efficiencies

A compressor intake air filter should be installed in, or have air brought to it from, a clean, cool location. The better the filtration at the compressor inlet, the lower the maintenance at the compressor. However, the pressure drop across the intake air filter should be kept to a minimum (by size and by maintenance) to prevent a throttling effect and a reduction in compressor capacity. A pressure differential gauge is one of the best tools to monitor the condition of the inlet filter. As a general rule, the pressure drop across a new and clean inlet filter should be less than five inches of water.

As a compressor intake air filter becomes dirty, the pressure drop across it increases, reducing the pressure at the air end inlet and increasing the compression ratios. The cost of this loss of air can be much greater than the cost of a replacement inlet filter, even over a short period of time. For a 200 horsepower (hp) compressor operating two shifts, five days a week (4,160 hours per year) with a $0.05/kilowatt hour (kWh) electricity rate, a dirty intake filter can decrease compressor efficiency by 1%–3%, which can translate into higher compressed air energy costs of between $327 and $980 per year.

HELPING PEOPLE AT SOLBERG

Just as important is the fact that intake air filtration prolongs the life of air compressors, blowers and vacuum pumps. It keeps abrasive and damaging particles (present in the ambient air) from entering the equipment. These contaminants will cause wear in the compression areas and breakdown lubricating oils. Equipment has to be continually rebuilt if it does not have the appropriate pre-filtration of incoming ambient air. This is particularly critical in high dust and dirt environments.

Please describe your discharge silencers for blowers.

This goes back to helping customers who were asking for ways to cut costs on their blower packages without sacrificing quality or performance. When blowers operate, high noise levels can be generated. We launched a compact Filter/Silencer line for the inlet side of blowers in 1992 as an alternative to large, bulky and costly tubular silencers. The compact size and comparable noise attenuation properties allowed blower packagers to save time and money during fabrication and assembly.

As noise level requirements became increasingly more stringent, many OEMs and packagers looked to enclosures to meet the new standards (typically less than 85 dba). A properly designed enclosure, together with a discharge silencer, enabled them to meet specifications for their blower packages. Enclosures can be very costly to build on a per square foot basis so our intent was to help the packagers reduce the cost of enclosures by reducing the footprint. We created a base frame/discharge silencer where the enclosure footprint (specifically height and width) was significantly reduced. Additionally, we wanted to ensure they performed comparable to traditional discharge silencers and were easy to assemble. The result was an off-the-shelf silencer base that can be assembled without cutting, welding, drilling or painting that performed well inside or outside of an enclosure. Packagers simply and quickly connect the components to the frame, saving time and money during the assembly process.

The Blower Base Frame Sound Attenuation Package

Two inch to six inch blower connection sizes are the range we are talking about for the Blower Base Frame (BBF). The US blower market is now trending towards enclosed products, which offer sound attenuation benefits to customers.

What is ATEX Certification for Inlet Vacuum Filters and Discharge Air/Oil Separation Filters?

This is another example of how Solberg helps customers. ATEX stands for Atmosphere Explosive and is a European directive, which is commonly accepted in the U.S. Static discharges within filters are frequently cited as causes for dust explosions that occur in industrial applications. We obtained this certification in 2003 and began offering certified products for use in explosive environments. We were one of the first U.S. companies to offer the ATEX Certification for non-mining applications under Category 2 gases and dusts (zone of use 1, 2, 21 and 22). We have had a lot of success with this in the power generation industry with this product cert.

The designs center on the requirement to eliminate the creation of any static charges in the filter which could cause an explosion where explosive gases/materials are present. The filter housings are built with conductive materials and include carbon-impregnated gaskets and o-rings, which are conductive ensuring that a static charge is dissipated. The housings also have grounding terminals and the filter elements use special media. All housings and elements are individually tested for electrical continuity and conductivity.

What are the benefits of the new "See-Through" Housings for vacuum intake filters?

This is a big deal. The product line emerged from a customer request in the woodworking industry. Furniture plants in the Southeast use vacuum pumps to hold down the wood on the CNC router tables. Vacuum holds the board in place while a machine tool routes a design into the wood. As you can imagine, this process creates large amounts of sawdust and it is critical to keep this dust out of the vacuum equipment. Our customer

ATEX Classifications

CATEGORY	DESIGN OF SAFETY	DESIGN REQUIREMENTS	APPLICATION	ZONE OF USE	SOLBERG CERTIFIED
1	Very high level of safety	Two independent means of protection or safe with two separate faults	Where explosive athomspheres are present continuously or for lengthy periods	Zone 0 Zone 20	No
2	High level of safety	Safe with frequently occurring disturbances or with an operating fault	Where explosive atmospheres are likely to occur	Zone 1 Zone 21	Yes
3	Normal level of safety	Safe in normal operation	Where explosive atmospheres are likely to occur infrequently and be of short duration	Zone 2 Zone 22	Yes

*Solberg is ATEX certified under equipment groups for non-mining applications and is classified for Category 2 gases and dusts.

told us that the intake vacuum filters would clog and operators didn't pay attention to the filter until it was too late. They would then lose vacuum, causing the boards to slip on the routing table, resulting in elevated product rejections and down-time.

The customer told us it was difficult to know when to change the clogged filter element because there was no indicator or way to actually see the element through a metal housing. We first came up with the ST Spinner Series, which has an aluminum head connected with a transparent polycarbonate plastic bowl. The ST Series now allows operators to visually inspect the filter for clogging before they begin operating the router table. Solberg invested in proprietary molds to manufacture the transparent housings and the response has been fantastic!

> "Intake filtration prolongs equipment life in high dust and dirt environments"

What food processing applications do you see?

Most of these applications involve pneumatic conveying or vacuum packaging. In both instances we have a variety of products available for this market. The BBF and 2G products discussed earlier are very common in pneumatic conveying of corn, grain and their processed variants. We also provide the liquid knockout systems for many meat-packing operations where keeping fluids and liquids out of pumps is crucial. We had an interesting application in a pasta manufacturing plant where flour was getting into a heat exchanger used to remove moisture from the process. The flour was clogging the equipment and needed to be removed from the air stream. The filter they had in line was working but was clogging too quickly, so we developed a system that sent a blast of compressed air back through the filter and knocked the flour build up or "cake layer" off of the pleats thus extending the maintenance interval for the filter. The product is called an RST (Reverse-Pulse See Through) and can be operated manually or the system can be automated using a differential pressure switch or a timer.

Our mission is to partner with our customers to help them innovate and discover new possibilities. As you can see, we really enjoy taking on tough applications. Our customers can rely on Solberg's years of experience to help them solve their customer's problems.

The RST Series See-Through Housing

Thank you Solberg for your insights. BP

For more information please contact Clint Browning, Solberg Manufacturing, tel: (630) 616-4400, email: clint.browing@solbergmfg.com, www.solbergmfg.com

Real World Best Practices

by Don Van Ormer

MEASURING PRESSURE DEWPOINT IN A COMPRESSED AIR SYSTEM

What dewpoint do you require? Do you monitor it? If so, congratulations, and if not, why? The drier the air, the more expensive it is. Do you *really* need a -40 ˚F or lower PDP compressed air?

Many of the industrial plants that we encounter state that they require a -40 ˚F PDP. Our question is, "Do you monitor your dewpoint?" The majority of the responses are, no we do not! If -40 ˚F class pressure dewpoint is really important to your process, shouldn't you measure it and be sure you have it? If you don't monitor it then you are probably not getting or maintaining a -40 ˚F or lower PDP.

The reason many plants give for not ever measuring pressure dewpoint has been the "real or perceived" problems with dewpoint monitors — specifically the probes. Many of the past problems have been because of lack of knowledge of the probes capability and the resultant poor application, installation or maintenance.

Modern probes are greatly improved over past units, offering solid performance with much easier maintenance and less sensitivity to installation conditions.

Industry has long used pressure dewpoint monitors to identify the appropriate dewpoint in a compressed air line serving critical uses where liquid water or high relative humidity (water vapor) will have a negative effect on either product quality and/or productivity. Recent development in sensing probe technology have greatly enhanced the reliability and simplified the installation and maintenance requirements to achieve satisfactory performance. This article is to review the current probes on today's market with respect to industrial compressed air systems.

Most production facilities require dewpoint measurement of either refrigerated dryers (+40 ˚F class) or desiccant dryer (-40 ˚F class or lower). Some will require both. Key measurement points may be:

- Discharge air from each dryer
- Air from power house (supply) to general production system
- Air to critical user point

There are many types of sensors available today. The four most common are:

1. Chilled Mirror
2. Aluminum Oxide (also includes Ceramic Oxide, Gold Aluminum Oxide)
3. Thin Film Polymer
4. Polystyrene Core

Anytime pressure dewpoint is critical to production, it should be measured and monitored at the process. Measurement and monitoring ahead of the process will often alert personnel to a potential system malfunction before process deterioration, this will also help pinpoint the source of the problem for timely correction.

Most Common Dewpoint Sensors Used Through The Late 1980'S And Early 1990'S:

Hydroscopic Film Type Probe

These sensors use a polystyrene core coated with a hygroscopic film wrapped with a bifilar winding of palladium wire.

This sensor's operation is based on its ability to change electrical resistance with small changes in humidity. The sensor usually contains a thermistor, which changes resistance proportionately to temperature changes. The resistance is measured in terms of electrical current. As the humidity changes so does the electrical resistance. This creates a linear relationship between current and dewpoint. This system incorporates an internal vacuum pump to pull the air samples from the main system.

These types of sensors are very low maintenance, and cost due to the ability to change the probe in the field with no recalibration required.

However, this technology is being replaced with newer, more accurate and repeatable types of probes, such as aluminum oxide, ceramic oxide, thin film polymer, etc.

These are generally not recommended for continuing use in an industrial setting because the life span is shorter compared to the others. If this type of sensor ever becomes saturated it must be replaced.

Aluminum Oxide (early versions)

These were the probes of choice for almost all leading desiccant dryer manufacturers to monitor their -40 ˚F to -100 ˚F class pressure dewpoint performances.

Through the early 1990's, most commercial desiccant dryers particularly were equipped with dewpoint demand controllers and dewpoint monitors utilizing these types of sensors, which were very sensitive to transient moisture loads usually disabling the equipment until the probe could be replaced or serviced.

Subsequently, many users tired of what they perceived as nagging problems and just quit repairing and using the controllers and monitors.

The **new aluminum oxide** probes or sensors used today have dramatically changed this. They are much less sensitive and more important and will **"dry themselves"** if just left in a dry line. Plants with pressure dewpoint monitors disabled and not in use should review this new opportunity.

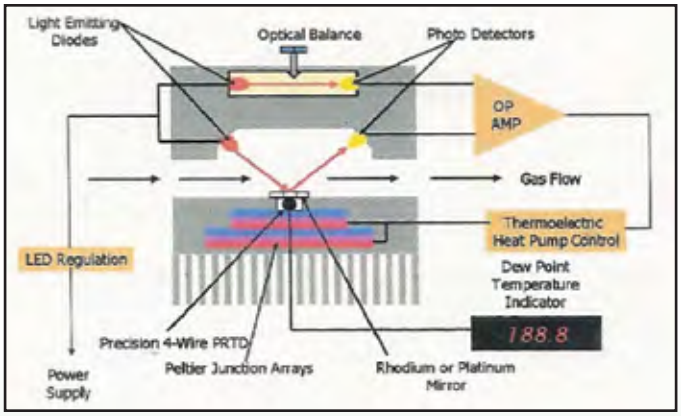
Chilled Mirror

Several companies offer chilled mirror type of dewpoint monitors. These are very accurate and have high repeatability if they are well maintained.

The operation of this type sensor uses a polished metal surface such as Rhodium or Stainless Steel attached for a Peltier-cooling module. These metals are used, because of their excellent thermal conductivity. Current is supplied to the Peltier, by a servo controller, which causes the mirror to cool. An LED is used to illuminate the mirror and the reflected light is picked up by a photo diode. When water vapor condenses on the mirror, some of the light is scattered and not detected by the photo diode. The servo controller reduces the current to the Peltier causing the metal to heat up. The control system will modulate the amount of current to the Peltier to maintain a temperature to where the mass of water on the mirror is constant. The temperature of the mirror, then, is dewpoint.

These chilled mirror systems do require a higher level of maintenance than some of the other types of sensors. They are sensitive to dirt and other contamination in the air lines. As the mirror gets dirty, the readings will become inaccurate. Most of these include self-compensating electronics to correct for the dirt on the mirror. Eventually it sets off an alarm to indicate a dirty mirror that needs cleaning.

Over time, the surface may become "etched" by some contaminates and the mirror will have to be replaced. Some models do have field replaceable mirrors.



REAL WORLD BEST PRACTICES

MEASURING PRESSURE DEWPOINT IN A COMPRESSED AIR SYSTEM

The initial cost of this type of dewpoint monitors is usually higher than other types. The calibration costs are similar.

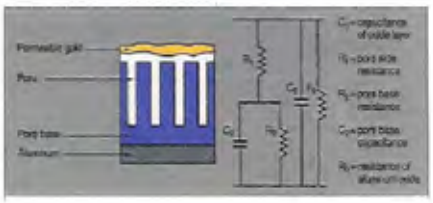
Chilled mirror units are very well adapted for laboratories use and/or where pressure dewpoint control is very, very critical, such as when compressed air used with chlorine, or other volatile chemicals.

View inside the aluminum oxide probe

Aluminum Oxide/Ceramic

In this type, an aluminum oxide probe measures the water vapor pressure, which is directly proportional to the dewpoint. The sensor is made of an aluminum strip, which is anodized to create the oxide layer. Then a very thin film of gold is evaporated onto the oxide layer. This creates an aluminum oxide capacitor. Water vapor is transported through the gold layer and equilibrates onto the pore walls of the oxide layer. The amount of water molecules absorbed onto the oxide layer determines the conductivity of the pore walls. Each value of wall resistance equals a specific value of electrical impedance, which is related to water vapor pressure.

The ceramic probe works the same way, but instead of an aluminum core, a chemically inert ceramic substrate is used.



Schematic of the aluminum oxide sensor

These probes are relatively sturdy and they are not as sensitive to dirt and debris as some other types of probes. As with all PDP sensors, a coalescing/particulate filter is recommended before the sample air reaches the probe. These filters should be inspected on a regular basis and replaced as necessary. The recommended calibration interval is one year.

The initial cost for types of probes is lower than the chilled mirror type. The calibration and maintenance cost may be somewhat lower.

This type of probe has a very accurate and fast response time for dewpoint readings. They are capable of having saturated air reach the probe and not cause damage. They will dry out in a relatively short period of time when the saturated air is replaced with dry air. The drying time is relative to dryness of the air passing over the probe. Practically speaking — if the dryer upsets the system and the sensor gets saturated, you merely have to correct the dryer problem and once the system air is dry, the probe will dry itself in a reasonable amount of time. Continued saturation of these sensors will ultimately lead to deterioration and a replacement will be required.

Aluminum oxide and ceramic sensors are often recommended for use in the production facilities, due to the low initial cost, durability, accuracy and repeatability. They can be used in either desiccants or refrigerated dryer systems. Depending on the calibration range.

Thin Film Polymer

The thin film polymer sensor consists of two parts. One is a capacitive polymer bonded with a temperature sensor. The polymer measures the amount of moisture in relative humidity. The temperature sensor measures the temperature of the polymer sensor. From these two measurements, the onboard microprocessor calculates the dewpoint.

Polymer sensors have a high tolerance to corrosive chemicals and are immune to condensation. They also have a long-term stability and accuracy. Some manufacturers offer an auto calibration feature on their monitors to compensate for wide changing dewpoint temperatures and at very low dewpoints. As the Relative Humidity reaches zero, very small changes in RH% result in large

changes in dewpoint. The auto calibration changes the sensor output to relative humidity, which changes when temperature changes. This allows it to evaluate if the low humidity reading at 0% RH is correct and then to compensate for any dry end drift.

The initial cost of these sensors is in the low to moderate range. Recommended calibration intervals are from one to two years.

The thin film polymer sensor has a very fast response time to changing dewpoint, because of the conductivity of the polymer and the temperature probe.

Most manufacturers recommend the thin film polymer type of probe for use in the production facilities with refrigerated dryer systems only. This is not usually recommended for general use in desiccant dryers due to marginal accuracy in the lower pressure dewpoint ranges.

Calibration

All manufacturers recommend factory calibration of the sensor at least once a year. We recommend having a spare probe to install and run while the other probe is being calibrated. The newly installed probe then can be used until the next calibration date.

This practice will allow for constant monitoring of the dewpoint, without several days or weeks of down time to the dewpoint monitor.

Some manufacturers offer a handheld Monitor/Calibration Unit for field calibration with the probe/electronics being sent back to the factory for calibration. There are also units available with automatic calibration feature built into the unit that will automatically calibrate the sensor while the unit is on line and running.

Installation Guidelines:

Sample Air

The sample air line for the dewpoint monitor should be taken from the top of the main compressed air line leading to the main plant or to any part of the production area to be monitored. This will help protect the probe and sampling system from liquid water that may condense in the pipeline and may saturate the probe.

The sample line should be made of stainless steel and be approximately ¼" in diameter. Actual flow rate depends on each individual unit.

This is the typical sample system available; some have a filtering system either outside or inside the assembly. If a flow meter is not standard, consider installing one inside the case to set the proper flow over the probe:

- Side mount sample system
- The air sample from the pipeline should be measured at full line pressure not at atmospheric pressure. The dewpoint changes at lower pressures. The lower pressure will cause the unit to report false readings.
- The sample system should always be installed with a pressure gauge. This will allow the operator to verify that the sample air is at full line pressure. These can be either digital or analog
- The sample system should be located as close as possible to the sample point (from the main pipeline)

REAL WORLD BEST PRACTICES

MEASURING PRESSURE DEWPOINT IN A COMPRESSED AIR SYSTEM

- Stainless steel should be used on all air-sampling lines, from the main air line to the sample system. Plastic and rubber lines should not be used because they will absorb moisture through the material. This will cause false high dewpoint readings
- There should be no low points in the sample system line from the main pipeline to the sample unit. If saturation occurs, the condensed water will collect in the low spots and give false readings until it dries out or is drained from the system
- Keep all fittings as simple as possible. These fittings should also be made of stainless steel and used wherever possible

Note: *If high dewpoint readings are present, check all fittings to the sample unit and in the sample unit itself for leaks. Moisture will travel against the flow of air through "wicking" at any "leak" and will give false high dewpoint readings.*

Direct Insertion Probes

Some probes are designed to be installed directly into the main distribution line. They are installed through a ball valve into the pipeline. This can be done while the system is still pressurized.

The perceived benefits to these types of probes are the simplicity of installation and lower material cost associated with the initial installation.

There seems to be no accuracy benefit to this type of installation. There are several issues for concern, such as:

- What does the laminar effect do to the reading?
- How do rust, scale, debris and other contaminants affect the probe itself?
- Maintenance issues: will plant personnel remove the probe for regular maintenance while the system is still pressurized?

Many feel that if the probe is installed in an off-line sample system where it is accessible to maintenance personnel, then it will be easier to maintain and will be maintained in a professional manner.

The three types of probes generally recommended for installation into air systems are the thin film polymer, aluminum oxide and the ceramic oxide.

All three have very high accuracy ratings and all are capable of a fast recovery from saturation, after the wetted probe is exposed to dry air. In the case of a refrigerated dryer application versus a desiccant dryer, the drying time is directly related to the humidity differential between the wet probe and the dry air. The desiccant dryer application will "dry out" faster then the refrigerated dryer because of the higher humidity differential.

All three probes are reasonable selections for either desiccant or refrigerated systems. However, the thin film polymer is somewhat less accurate at the lower pressure dewpoints of desiccant systems. BP

For more information please contact Don Van Ormer, tel: (740) 862-4112, email: DonaldvanOrmer@aol.com, www.airpowerusainc.com

Data and illustrations provided by:

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www.cosa-instrument.com

Vaisala Inc.
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GE Panametrics
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General Eastern
www.gesensing.com/generaleasternproducts

RESOURCES FOR ENERGY ENGINEERS

TRAINING CALENDAR

TITLE	SPONSOR	LOCATION	DATE	INFORMATION
Advanced Management of Compressed Air	Compressed Air Challenge®	Oak Brook, IL	2/27/2008	www.compressedairchallenge.org
Compressed Air Management	Power Supply Industries	Fenton, MO	4/8/2008	www.psiind.com
Fundamentals of Compressed Air	Compressed Air Challenge®	Omaha, NE	5/6/2008	www.compressedairchallenge.org
Advanced Management of Compressed Air	Compressed Air Challenge®	Omaha, NE	5/7/2008	www.compressedairchallenge.org
Compressed Air Management	Power Supply Industries	Fenton, MO	8/19/2008	www.psiind.com
Compressed Air Management	Power Supply Industries	Fenton, MO	11/4/2008	www.psiind.com

Editors' Note: If you conduct compressed air system training and would like to post it in this area, please email your information to rod@airbestpractices.com

PRODUCT PICKS

Flowmeters Offer New Approach to Air Savings

CDI Meters has developed a flowmeter that is simple, inexpensive and very easy to install. It uses thermal dispersion technology to provide wide turndown with a rugged solid-state design. Installation consists of drilling two small holes in a pipe, clamping the meter in place and connecting the power.

Because of their low cost, it is practical to install the meters at key points throughout an air distribution system, creating a clear picture of air usage and revealing savings opportunities. Because of the low cost of the meters in comparison with the losses that are commonly identified, a rapid payback can be expected.

CDI Meters
(781) 935-9600
www.CDIMeters.com

Master Controller for Compressed Air Systems

Kaeser Compressors' Sigma Air Manager (SAM) provides monitoring, sequencing and analysis of compressed air system performance. SAM balances service hours, prevents simultaneous motor starts and maintains tight pressure control. It can be adapted to almost any system and manage up to 16 compressors or vacuum pumps — including multiple types and differing brands. It also manages dryers, filters and drains. SAM is the first master controller to incorporate an industrial PC with Internet technology. SAM alerts operators to service requirements and provides trending data for plant operational analysis.

Kaeser Compressor
(800) 777-7873
www.kaeser.com

RESOURCES FOR ENERGY ENGINEERS

PRODUCT PICKS

Portal Website with Oil-less Vortex Blowers

Hitachi America, Ltd., Industrial Systems Division has launched a B2B web-based portal for their Oil-less Vortex Blower product. The portal is designed to ensure that Hitachi customers receive consistent, rapid, first-class service regardless of their location and to increase Hitachi Brand Awareness on the Internet. The new Hitachi Industrial Portal Website can be accessed at https://i-store.hitachi.us.

Hitachi Air Technology Group
(914) 631-0600,
www.hitachi.us/atg

In-Line Solenoid Valves

The CPE solenoid valve from Festo Corporation has proven its long service life and high performance with millions of installed units over many years. The classic CPE valve now has something new to offer: aluminum manifolds and M8 solenoid connections. With its slim width, the CPE valve offers the highest flow rate of any valve of its size. The valve's compact size enables it to be installed directly on the cylinders or on moving parts. These valves can withstand the toughest operating conditions. The CPE solenoid valve can be used as an individual valve or can be mounted on a sturdy aluminum manifold — a convenient way to simplify an installation.

Festo Corporation
(800) 99-FESTO
www.festo.com/usa

Direct Acting Valve Rated for Mobile Voltage Operation

Parker Hannifin offers the XM Series In-Line Valve for multiple industrial applications in a variety of pneumatic markets. XM Series direct acting valves are available in both 3-way and 4-way versions. The XM In-Line Valve is a ⅛", 2-position, single solenoid, spring return 3-way or 4-way valve with AC or DC operating voltages. The 12 and 24 VDC coils are rated for mobile voltage operation. XM Series 3-way valves can function as normally open or normally closed valves. Optional integrated individual flow controls are available on the 4-way valves that meter the exhaust flow from each working port to the exhaust port of the valve. This option eliminates additional component flow controls and fittings between a cylinder and a valve. The new XM In-Line Valve Series is direct operated; unlike a solenoid air pilot valve, there is no minimum operating pressure required to shift the valve.

Parker Hannifin
(269) 629-5000
www.parker.com

New Air Systems Package Air Compressor

Sullair Corporation has introduced its ES-6 Performance Air System Package featuring Sullair's 5-to-10 hp S-energy® rotary screw air compressors in capacities from 13 to 36 acfm and pressure ratings of 125 and 175 psig. The ES-6 Performance Air System includes:

- Sullair ES-6 compressor with enclosure
- Sullair SRS refrigerated dryer
- Sullair SCF filter
- 80- or 120-gallon storage tank

The new ES-6 Systems feature a streamlined design using 40% fewer parts than con ventional models to achieve high reliability and extremely low maintenance. In addition, the systems are designed with a small footprint to be highly compact with an enclosure that is designed to allow easy access to maintenance items. The S-energy® series features Sullair's time-proven, air-end design with low-restriction inlet value for superior cfm performance. In addition, S-energy® compressors feature a low-pressure drop air-fluid separation system to prevent energy loss and an optimal cooling system with energy-efficient, low-noise cooling fan.

Sullair Corporation
(219) 861-5159
www.sullair.com

Wall Street Watch

BY COMPRESSED AIR BEST PRACTICES

The intent of this column is to provide industry watchers with publicly-held information, on publicly-held companies, involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information in this column was gathered on February 5, 2008.

Cleveland, OH — January 17, 2008, Parker Hannifin (NYSE: PH), the world leader in motion and control technologies, today reported record second quarter sales, net income, earnings per diluted share and cash flow from operations.

For the second quarter of fiscal year 2008, which ended on December 31, 2007, sales were $2.8 billion, an increase of 12.7% from $2.5 billion in the same quarter a year ago. Net income increased 9.8% to $211.9 million from $193.0 million in the same quarter a year ago. Earnings per diluted share increased 12.8% to $1.23 as compared to $1.09 in the same quarter a year ago. Cash flow from operations was $473.6 million, or 8.4% of sales.

"Our company continues to perform very well within a challenging economic environment in North America. We attribute this to a number of factors, and chief among them is that we are consistently executing on the goals established within our Win Strategy," said president, chairman and CEO Don Washkewicz. "Specifically, providing premier customer service is our primary goal, and our measures of customer service continue to demonstrate that we have the capability to ship quality products on time to customers all over the world. In addition, helping us to temper the softness in some industrial OEM markets is our global distribution network, with thousands of locations built over decades, which continues to be strong. The distribution channel, which accounts for nearly one-half of our industrial sales, provides Parker access to higher margin and less cyclical aftermarket sales."

"It is also clear that our effort to globalize our company is paying dividends," Washkewicz continued. "We are in a better position to maintain consistent profitable growth despite the strengths and weaknesses of key regions. Of our 12.7% sales growth this quarter, 4.9 % was organic, 2.9% was the result of strategic acquisitions and the remainder was from the effects of foreign currency exchange rates. We are especially pleased with our level of organic growth. Our focus on customer service, along with our capabilities to help customers improve the profitability of their business through the use of our technologies and systems, are leading to new and growing opportunities for Parker."

WALL STREET WATCH

"Acquisitions remain an important part of our Win Strategy," continued Washkewicz. "Our strong cash flow allows us the opportunity to selectively add to our portfolio those technologies that have high growth profiles. We made four strategic acquisitions this quarter, adding approximately $223 million in sales. These acquisitions included electrical and production umbilical cables for subsea oil and gas installations, further expansion of our aerospace components and equipment capabilities, precision electro-pneumatic control systems and temperature sensing protection equipment."

"Also notable is that our Industrial International segment again delivered particularly strong results in the quarter, as revenues and operating income in that segment grew by approximately 27.7% and 43.9%, respectively," added Washkewicz.

Segment Results

In spite of a soft overall economy in the Industrial North America segment, second-quarter sales increased 3.3% to $991.4 million, and operating income increased 5.8% to $141.7 million, as compared to the same period a year ago.

In the Industrial International segment, second-quarter sales increased 27.7% to $1.2 billion, and operating income increased 43.9% to $175.2 million, as compared to the same period a year ago.

In the Aerospace segment, second-quarter sales increased 7.1% to $430.7 million, and operating income decreased 23.4% to $51.9 million, as compared to the same period a year ago. Near-term research and development expenses continue to impact this segment.

In the Climate & Industrial Controls segment, second-quarter sales increased 0.8% to $229.2 million, and operating income decreased 22.1% to $5.4 million, as compared to the same period a year ago. This segment continues to be impacted by the ongoing weakness in the automotive, residential construction and heavy-duty truck markets.

Orders

In addition to financial results, Parker also reported an increase of 10% in total orders, before the effect of foreign currency and acquisitions, for the quarter ending December 31 compared to the same quarter a year ago. Parker reported the following orders by operating segment:

- Orders increased 4% in the Industrial North America segment versus the same quarter a year ago
- Orders increased 16% in the Industrial International segment versus the same quarter a year ago
- Orders increased 19% in the Aerospace segment on a rolling 12 month average basis
- Orders decreased 6% in the Climate and Industrial Controls segment versus the same quarter a year ago

Outlook

For fiscal year 2008, the company increased its guidance for earnings to the range of $5.15 to $5.40 per diluted share. Previous guidance for earnings was $5.05 to $5.35 per diluted share.

"Fiscal 2008 continues to be strong overall," added Washkewicz. "Based on what we can see in our markets going forward, we have raised our earnings guidance. Total order growth rate this quarter reached double digits. Our orders remain strong across most segments, and are growing in Europe, Asia, Latin America and North America. In general, many of our key markets continue to grow, including aerospace. For those markets that are flat, they have been performing at this level for some time, which also positions us to benefit when they return to more normal growth levels."

CHARLOTTE, NC — January 23, 2008, SPX Corporation (NYSE:SPW), today announced its 2008 annual financial guidance:

- Revenues are expected to increase between 25% and 30% to approximately $6.1 billion. Organic revenue growth is expected to be 5% to 7%, while completed acquisitions and the impact of currency fluctuations are expected to increase reported revenues by approximately 20% to 23%
- Earnings from continuing operations are expected to increase to $6.00 to $6.20 per share, up 26% to 31%. The primary driver of this improvement is expected to be continued strength in the company's global infrastructure end markets
- Free cash flow from continuing operations (cash flow from continuing operations less capital expenditures) is expected to increase to $260 million to $300 million. This performance represents 80% to 90% conversion of expected net income

Chris Kearney, president, chairman and CEO said, "Building on SPX's strong momentum in 2007, we expect to report strong, double-digit revenue and earnings growth in 2008. With a maintained focus on driving organic growth, improving margins, expanding in our key end

markets and developing new, innovative products to meet the growing global demand for power and energy, SPX is well positioned to perform in 2008 and beyond."

"We anticipate that continued investment in global infrastructure development will remain a key growth driver for SPX in the year ahead," Kearney added. "With products and solutions that play an important role in new power plant construction, as well as refurbishments, SPX is helping to increase power capacity in new, developing and emerging markets including the Middle East, Africa and Asia."

"Additionally, we foresee opportunities in the global sanitary market. Our recent acquisition of APV greatly enhances our flow technology segment's ability to serve the dairy, food, beverage, pharmaceutical and healthcare markets. And we also see growth potential for our tools and diagnostics business, particularly in Europe and Asia," Kearney concluded.

Charlotte, NC — January 24, 2008, EnPro Industries (NYSE: NPO) EnPro Industries has acquired the assets of Sinflex Sealing Technologies, a distributor and manufacturer of industrial sealing products, located in Shanghai, China. The operations will do business as Garlock Sealing Technologies (Shanghai) Co. Ltd. and will be operated by Garlock Sealing Technologies, an EnPro Industries company. Sinflex has been Garlock's principal distributor in China for over 10 years and in recent years has expanded its manufacturing operations.

"Establishing an operational presence is key to our ability to address China's fast growing sealing products market," said Ernie Schaub, EnPro's president and CEO. "Sinflex is one more small but important step in this direction. We will continue on this path later this quarter, when Stemco begins manufacturing operations at Shuzhou, also in the Shanghai area, further expanding the sealing products we manufacture and sell in China."

The transaction was completed for cash; terms were not disclosed. BP

FEBRUARY 5, 2008 PRICE PERFORMANCE	SYMBOL	LAST PRICE	1 MONTH	6 MONTHS	12 MONTHS
Parker-Hannifin	PH	$66.15	-3.2%	2.5%	19.6%
Ingersoll Rand	IR	$38.36	- 8.0%	-21.8%	-10.6%
Gardner Denver	GDI	$32.30	3.9%	-19.1%	-17.0%
United Technologies	UTX	$72.35	-1.3%	0.2%	8.9%
Donaldson	DCI	$41.73	-0.4%	18.0%	21.2%
EnPro Industries	NPO	$30.70	9.1%	-22.4%	-7.2%
SPX Corp	SPW	$100.20	4.4%	23.5%	46.9%

JOB MARKET

Job Openings in the Compressed Air Industry

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McKenzie Equipment Company, a rapidly growing air compressor company headquartered in Houston, is looking to fill the following positions:

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Looking for experienced rotary, portable and recip technicians for the Houston Hobby area. Refrigeration certification a plus.

Mechanics — Industrial Equipment
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Position will be responsible for the following:
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Fax resume to (713) 946-2104 or, call Carolyn at (713) 948-2438
www.mckenzieequipment.com

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Please contact:
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CHICAGO AREA

National air compressor manufacturer looking for service manager and service technicians with qualified experience for the greater Chicago area.

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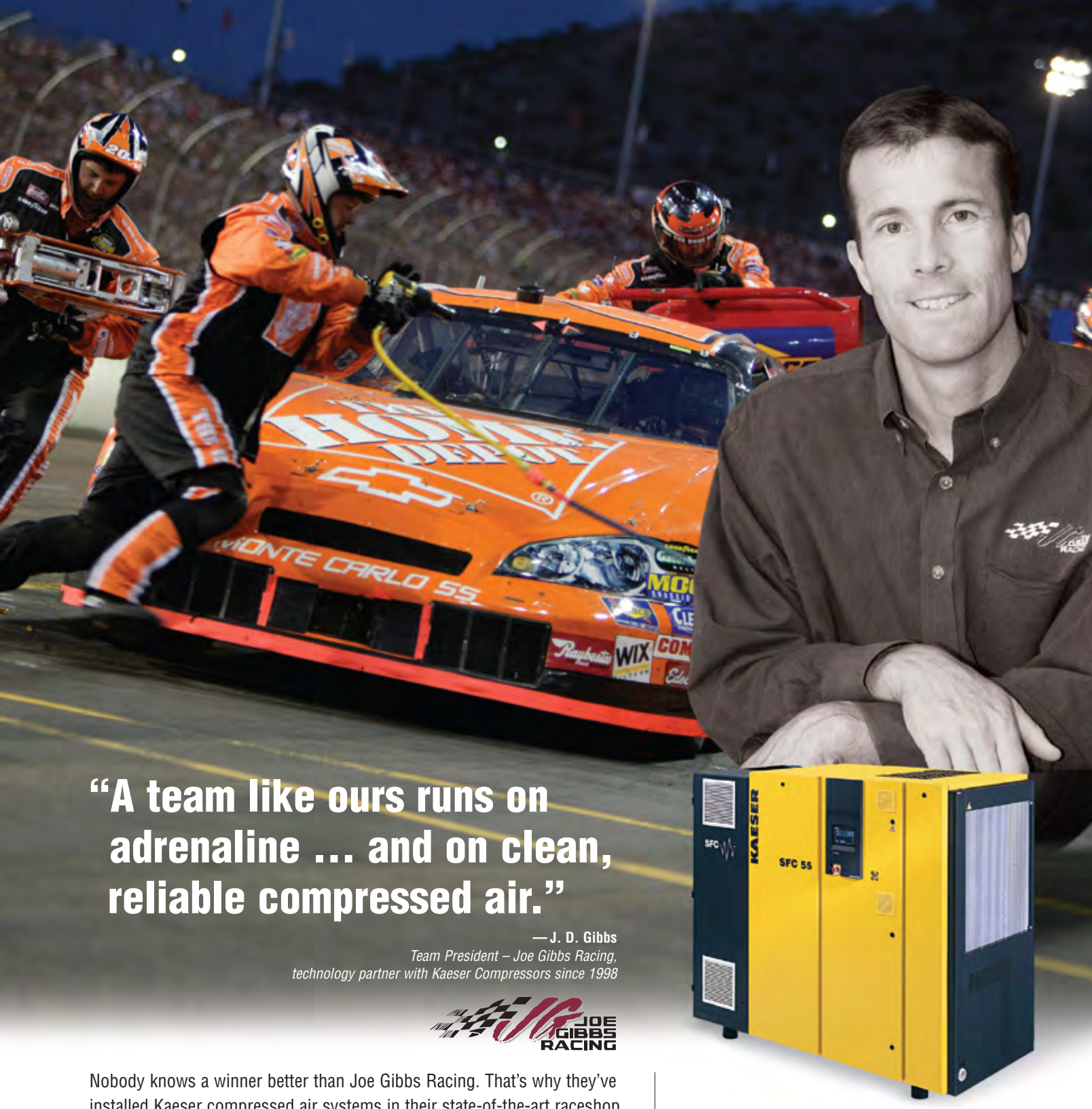

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