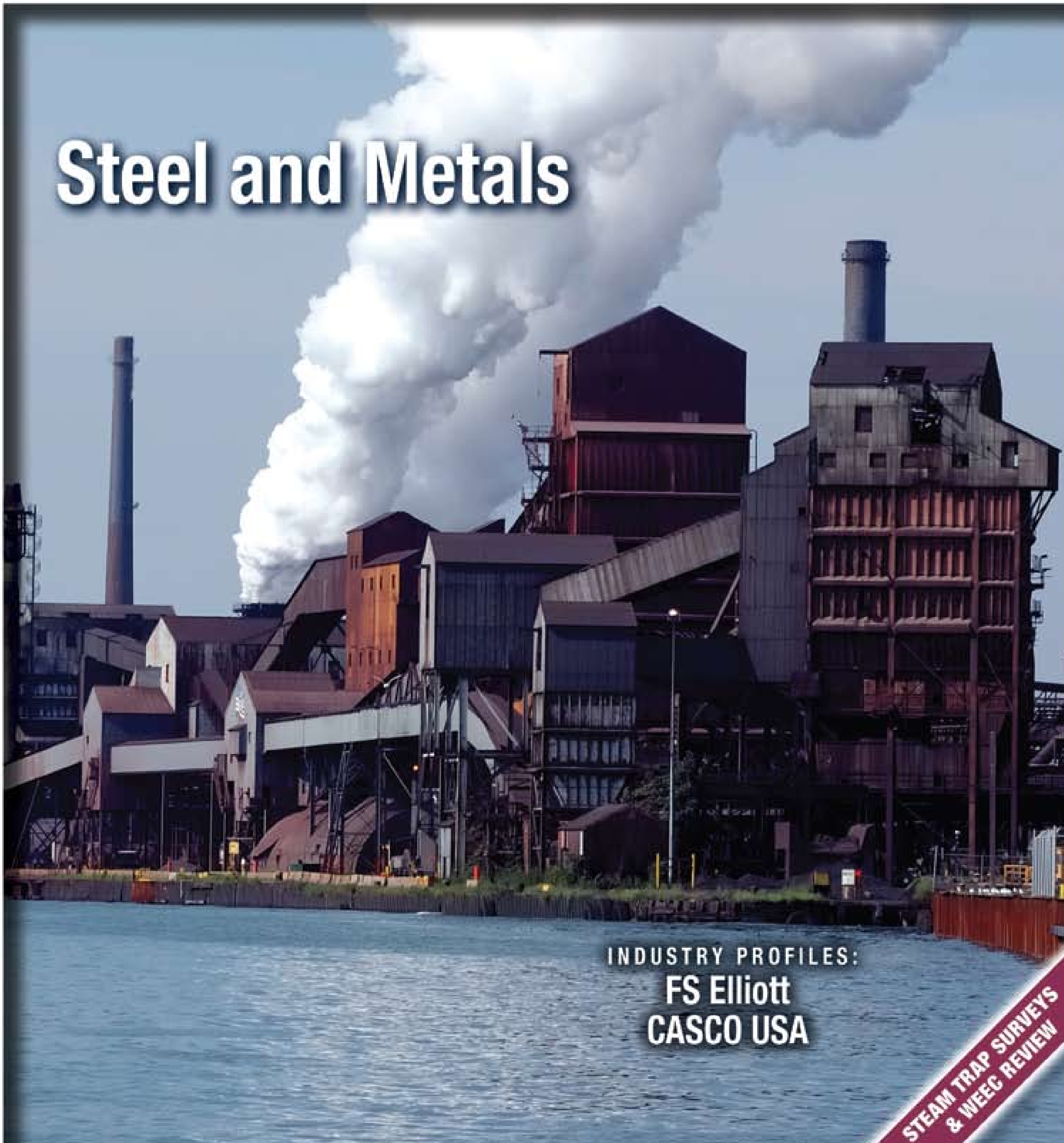
ArcelorMittal Savings   Air Dryers   Compressor Controls

October 2007

COMPRESSED AIR BEST PRACTICES



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FOCUS INDUSTRY FEATURES

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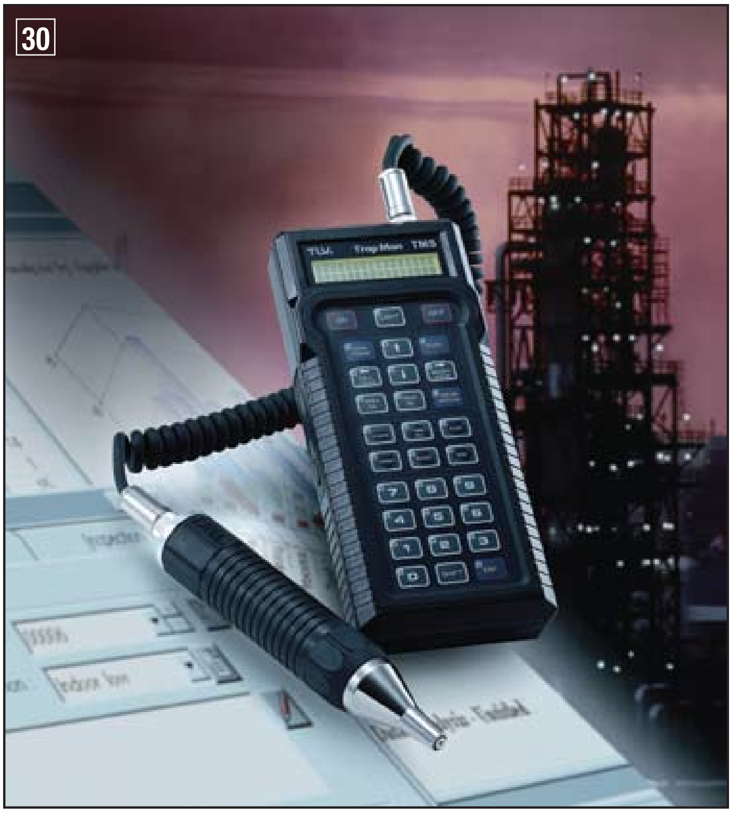

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COMPRESSED AIR BEST PRACTICES MAGAZINE

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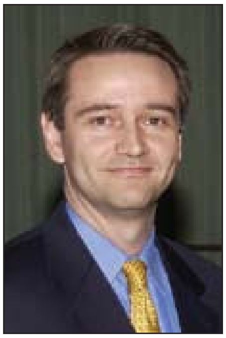
FROM THE EDITOR

Working Together to Save Energy



When industrial facilities, utility companies, and compressed air professionals work together — energy saving projects get done. These three parties work closely together in some areas of North America and this is where we see the majority of projects being implemented.

Industrial corporations (like ArcelorMittal on page 9) are forming "utility engineering" teams with the primary objective being to reduce energy costs across their facilities. Compressed air is high on their radar screen. These teams represent our core readership group.

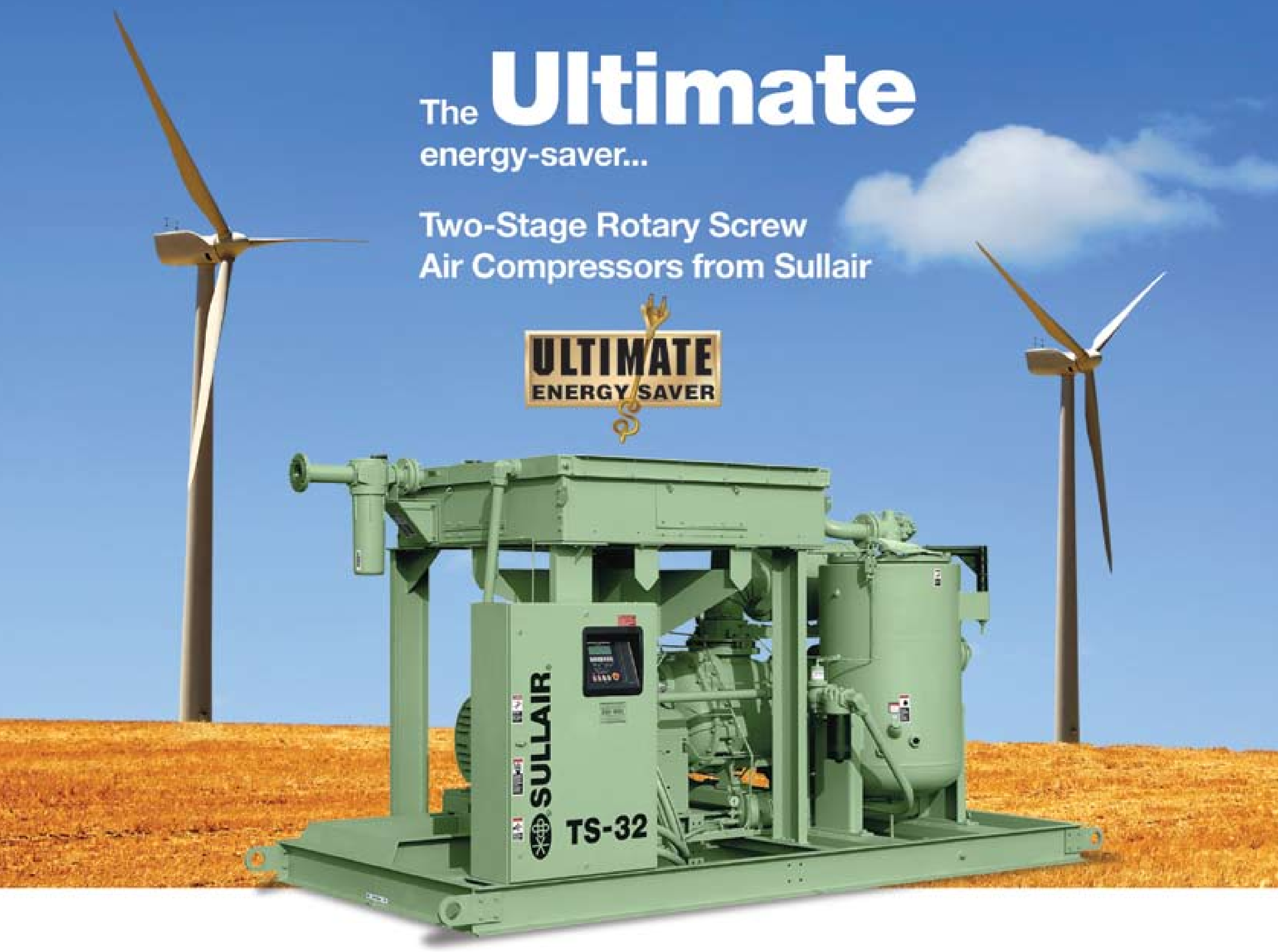
Utility companies can provide financing for audits and capital projects, which will reduce the energy costs associated with compressed air. They can also provide the industrial corporation with a third-party assurance that the proposals and paybacks are sound. As we deepen our relationship with utility companies who are competent in this area, we also hope to encourage more utility companies to get involved.

The compressed air industry brings the auditing know-how and the technology to implement energy-saving projects. From understanding "supply-side" to "demand-side", the compressed air industry can educate end users on how to improve the systems.

The editorial mission of Compressed Air Best Practices Magazine, "to reduce energy costs associated with compressed air", was positively reinforced this past month by our core readership at the Association of Energy Engineers (AEE). Many members of the AEE, visiting our booth at their yearly World Energy Engineering Conference, asked us to expand the scope of Compressed Air Best Practices Magazine to cover more areas where they can save energy (blowers, vacuum, pneumatics).

When all three parties work together, great things happen. We are committed to providing all three with a communication platform to assist in the creation of more energy-saving projects.

ROD SMITH



Electricity constitutes on average 82% of compressed air system operating costs over a ten year period.

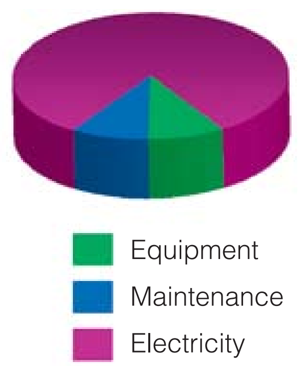
Energy savings are derived from Sullair's two-stage tandem air-end and spiral valve technology. At a power cost of $.08/kW/hr, a tandem two-stage compressor will save $14,373 per 1,000 cfm over a single-stage compressor operating for 8,000 hours at 100 psig.

Energy savings built In.

- Full load – up to 13%
- Part load – up to 30%

Tandem compressors are also available with variable speed drive. The use of a variable speed drive can provide additional part load and unload savings.

Compressor life cycle costs



SULLAIR

For more information on how Sullair's tandem air compressors can reduce your operating cost, please contact your local Sullair distributor. Call Sullair at **(800) SULLAIR** or **(219) 879-5451,** or visit us on the web at **www.sullairinfo.com/ts.**

Compressed Air Savings at ARCELORMITTAL

BY COMPRESSED AIR BEST PRACTICES

ArcelorMittal Weirton's Utilities Area (pictured Mr. Tony Weishner of the Harold G. Jones Company which supports Weirton with compressed air treatment products and steam trap audits).

ArcelorMittal is the worlds largest steel company. The company operates facilities in 16 countries. ArcelorMittal's Engineering and Utilities Division has a goal to reduce energy costs at facilities worldwide by $192 million over the next 3 years. Managers like Jim Taylor, Lawrence Fabina, Bill Berquist and Eugene Arnold work together to identify energy-savings opportunities in the Engineering and Utilities Division. The primary objective of this management team is to reduce electrical and natural gas consumption. ArcelorMittal Weirton's Division Manager Jim Taylor says, "Compressed air has been identified as one of the top opportunities to reduce electrical consumption across the corporation and we have implemented cost-saving actions at ArcelorMittal Weirton."

ArcelorMittal Weirton is a company that has long been the center of life in Weirton, West Virginia. They employ 1,280 people and are a market-leading supplier of tin plate used in canning processes. Boasting an estimated market share of 17% in North America, major customer segments include vegetable canning, pet food containers and soup cans.

The facility appears to fill the length and width of an entire valley and is made up of 3 major sections; the tin mill, the utilities area (including the boiler house) and the strip steel mill (also known as the hot mill and cold mill). ArcelorMittal Weirton's utilities area has taken the lead to reduce the energy costs associated with compressed air. Richard Deveaney, Sr., the Utilities Area Mechanical Engineer, commented, "the process began when the Utilities Division sponsored my attendance at the DOE Compressed Air Challenge training, and that knowledge opened the door to implement energy-saving initiatives." The initiatives have included eliminating waste by conducting air leak audits, reducing air pressure requirements and isolating air systems which permit the use of smaller air compressors in a de-centralizing compressed air system.

COMPRESSED AIR SAVINGS AT ARCELORMITTAL

DOE Compressed Air Challenge (CAC) Training

Education on compressed air systems was identified as an important first step. ArcelorMittal has partnered with the DOE to train employees on where to look for energy saving opportunities. Mr. Deveaney attended a Level 1 Compressed Air Challenge training session in Chicago (visit www.compressedairchallenge.org for more information) and commented, "During the training, it became clear to me that our compressed air system, in the Utilities Area, offered many opportunities to save energy."

Mr. Richard Deveaney with the 350 horsepower air compressor used in the old centralized plant air system

The CAC Level 1 training goes on to provide an introduction to other important topics including how to calculate energy costs of compressed air systems, how to identify inappropriate uses of compressed air, how to improve reliability and how to find, fix and prevent air leaks.

Air Leak Audits

ArcelorMittal Weirton has evolved over the years and the compressed air system reflected an era where much higher volumes of compressed air were used and were supplied by a centralized compressed air system. Mr. Deveaney formed a team to analyze the system, which included Mr. Tom Hendricks (Utilities Shift Manager) and Mr. Wesley Martincic (engineering intern). The centralized system started with a 350 horsepower rotary screw compressor used to supply compressed air through a maze of long-distance pipes, to the garage, boiler house, IMS, power-house, old blowing room and the open hearth oil tank.

This long-distance maze of pipe-work provided a fertile area for the creation of compressed air leaks. Compressed air leaks are prevalent in most compressed air systems and industry experts estimate that most systems waste 20–30% of an air compressor's output through air leaks. Leaks are commonly found in pressure regulators, couplings, hoses, tubes, condensate traps and shut-off valves and pipe joints.

Table 1: The Cost of Compressed Air Leaks

SIZE	COST PER YEAR*
1/16"	$523.00
1/8"	$2,095.00
1/4"	$8,382.00

*Using rate of $0.05 per kWh assuming constant operation
Source: www.compressedairchallenge.org

COMPRESSED AIR SAVINGS AT ARCELORMITTAL

The air-leak audit discovered leaks (painted white) on the Versa-control solenoids used on boilers

Condensate shut-off valves (painted white) were discovered as air leak locations

**Rule of Thumb:
The Cost of Pressure Drop**

A 10 psig pressure drop costs 5% in air compressor brake horsepower.

A compressed air leak audit was then done in the Utilities Area by systematically following all the compressed air piping and examining all joints and air users for leaks. An ultrasonic leak detector with a digital readout was used. Leaks were painted white and then repaired.

Reducing Air Pressure Requirements

Eliminating air leaks has the secondary benefit of allowing compressed air systems to be maintained at lower air pressures. The pressure differential is reduced from the point of compression to the point of use. The cost of pressure drop is significant. A commonly used rule-of-thumb is that every pound of pressure increase (in 100–150 psig air compressors), requires a .5% increase in power. A 10 psig pressure drop on a system supported by a 100 horsepower compressor would therefore cost 5 horsepower in power. Air leaks are not the only source of pressure loss. Compressed air filters, dryers and regulators are also system components, which must be monitored for pressure loss.

ArcelorMittal Steel's "Foster Wheeler" building, across the street from the utilities area, provides control air (instrumentation air). The facility has a 100 horsepower air compressor, which has been delivering air flows between 373–444 scfm at 128 psig over the past 5 years. As a result of the team's initiatives, the air compressor is now set at 90 psig and is providing reliable instrument air. That is a 38 psig lower operating pressure — the equivalent of a 19% more horsepower from an air compressor!

Isolating Air Systems Equals Using Smaller Air Compressors

Within the Utility Area, there are compressed air applications in the garage, boiler house, IMS, power-house, old blowing room and the open hearth oil tank.

Mr. Taylor and Mr. Deveaney saw that gains could be realized by de-centralizing the compressed air system and eliminating the need for compressed air to travel through such long distances of old compressed air piping. Mr. Taylor commented that, "isolating areas became an important objective to eliminate the pressure losses and air leaks realized by having compressed air travel such long distances."

The boiler house originally had a 350 horsepower air compressor feeding into a heated desiccant air dryer. This air is used for instrumentation air in the boiler house and was used as back-up air in all the other buildings.

When the other areas were isolated, the end result was a 50 horsepower air compressor being used with one of the old 350 horsepower units as back-up for the boiler house demand only. The system runs 24-hours a day. The 350 hp unit is having to cycle on occasionally, so the future plan is to install a 100 hp VSD that will take care of all demand peaks in the boiler house. The savings equal 300 horsepower in air compressor energy consumption. Using a rule of thumb calculation, that equals roughly $108,916 in electrical energy savings per year!*

The tool air requirements (primarily impact wrenches) in the boiler house previously used a 125 horsepower air compressor with a similar sized unit used as a back-up. In its place a 50 horsepower air compressor was installed with a 15 horsepower unit in parallel to be used for smaller jobs. The reduction in installed horsepower was the equivalent of 75 horsepower (125 hp–50 hp) and is often 110 horsepower (125 hp–15 hp). Assuming the use of the 50 hp unit and the same rule of thumb calculations, the energy savings are $18,650 per year.

The process of isolating areas continued location after location. In the garage Deveaney's team shut off a 50 horsepower air compressor and replaced it with a 7.5 horsepower unit found in the old paint room. The open-hearth oil tank originally had no air compressors and just drew from the centralized plant air system supported by the 350 horsepower air compressors. The lines running from the boiler house were in bad shape and had many leaks. Two 5 horsepower air compressors were put into service with one acting as a back-up to the other.

Rule of Thumb: Calculating Compressed Air Energy Cost

The variables used are the power to drive the air compressor (HP), the number of hours of operation, the power rate (cents per kW) and the motor efficiency. The simple formula used to calculate the electric energy cost is:

$$\text{Electric Energy Cost (\$'S)} = \frac{\text{HP X .746 X HOURS X RATE}}{\text{MOTOR EFFICIENCY}}$$

Example: A 100 hp air compressor operating 6000 hours a year, with a power rate of $0.05 kWh and a motor efficiency rating of 0.90 equals a cost of:

$$\text{Electric Energy Cost (\$'S)} = \frac{100 \text{ X } .746 \text{ X } 6000 \text{ X } 0.05}{0.90} = \$24{,}867 \text{ per year}$$

COMPRESSED AIR SAVINGS AT ARCELORMITTAL

Mr. Richard Deveaney with the 50 horsepower air compressor used for tool air in the new de-centralized plant air system

Summary

Education was the first step towards saving over $136,000 per year in the Utilities Area of ArcelorMittal Weirton. The decision by the management team to send Mr. Deveaney to the Compressed Air Challenge training course gave him the tools required to begin the initiatives described. Identifying and fixing leaks and reducing pressure losses made it possible to capitalize on isolating the various building of the utility area. This in turn allowed the team to use much smaller air compressors and turn off the larger compressors used in the old centralized plant air system. Duplicating compressed air initiatives like this across ArcelorMittal's facilities will play an important role in their quest to reduce energy costs by $192 million over the next three years.

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

Energy Savings Summary at ArcelorMittal Weirton

1. Boiler House Savings: $\frac{300 \text{ hp} \times .746 \times 8760 \times 0.05}{0.90}$ = $108,916 per year

2. Tool Air Savings: $\frac{75 \text{ hp} \times .746 \times 6000 \times 0.05}{0.90}$ = $18,650 per year

3. Garage Air Savings: $\frac{42.5 \text{ hp} \times .746 \times 6000 \times 0.05}{0.90}$ = $10,568 per year

4. Open Hearth Increase: $\frac{5 \text{ hp} \times .746 \times 6000 \times 0.05}{0.90}$ = $1,243 per year

Total Savings: $136,891 per year in electrical energy costs associated with compressed air.

GETTING MULTIPLE AIR COMPRESSORS UNDER CONTROL

BY PETER RHOTEN

Every large compressed air system operator wishes they could open the valve or throw the switch and get compressed air the same as they do for water and electricity.

Unfortunately, this is not the case. Compressed air is the 4th utility that must be designed, installed, maintained and modified to meet changing air demands in a large facility. The system chosen 6–8 years ago may be totally incorrect for today's requirements due to changes in production equipment or even department shutdowns.

The objective of this article is to outline how to get a large air system under control by understanding the existing situation and evaluating the options available. A major U.S. fastener manufacturer, Stanley Bostich, recently went through the steps outlined in this article and was able to change their air systems as follows:

STANLEY BOSTICH INSTALLATION	PREVIOUS	CURRENT
Number of Compressors in Use	6	3
HP in Use	625	450
System Pressure	110–120	92
System Control	None "Push all the Buttons"	Fully Automated Computer — SAM
Power Cost @ $.12/kW 8,000 hours per year	$433,100	$311,850

GETTING MULTIPLE AIR COMPRESSORS UNDER CONTROL

6 Steps to Get Your Big Air System under Control

What steps do you need to take to determine how to get your large air system (over 500 hp) under control? Here are some relatively easy steps:

1. Inventory your existing equipment including manufacturer's stated CFM/HP/BHP/motor efficiency.

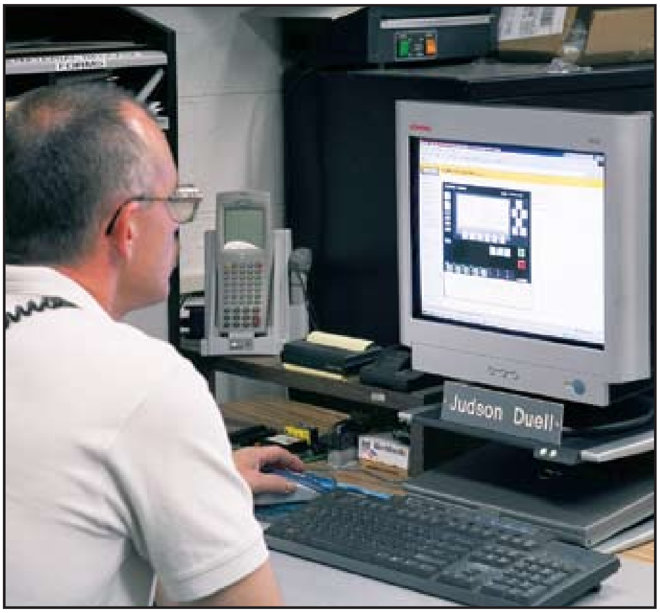
2. Verify each compressor control type and prove that it is operating on this control by dead heading the compressor and running it through the control curve to zero flow. See attached Compressor Control Pros and Cons from the Compressed Air Challenge for complete information on types of controls with pros and cons.

3. Have the operators log which compressors are run in each specific shift. They should log units for r*un hours/ loaded hours/discharge pressure*.

4. The least efficient/smallest compressor should be turned off for a short period on each shift to determine if the pressure can be maintained without this unit in operation. If the required pressure is 100 psi and the pressure decays to 92 psi it is a simple calculation to determine the additional CFM required to bring the system pressure back.

5. Record discharge pressure at each compressor station and at 4 critical points throughout the plant including the area that is the first to let maintenance know on low air pressure.

6. Sit down with the operators and discuss with them their ideas on how they might run the existing system more efficiently on a manual basis. This may not be effective from a savings standpoint but you will get the feedback on their philosophy of operation.



It is not unusual that an operating philosophy is to keep the pressure up and avoid any down time by pushing every button possible. This was acceptable under different business requirements at $.03 kW, **but is not acceptable today**.

Define Your Goals

The key is to define your goals to control the existing air system more appropriately for the current demand. The points would be as follows:

- Reduce operating costs of system need to determine what it cost today and what could be saved by turning off or controlling equipment properly.

- Improve air pressure and quality to the production area to maintain product quality.

- Improve reliability and lower maintenance costs in a system by putting fewer hours on the existing equipment.

Most large systems were designed to meet the highest load condition at the time. This usually leads to a selection of multiple compressors that may be too large for current requirements. Because the compressors were too few and too slow to react, along with being too large, it is possible that none could be shut off. The questions answered above will tell you whether or not the first step in conservation control, shutting off the compressor, can be accomplished.

How To Monitor the Current Air System

What else can you do to monitor your current system to determine what type of controls might be appropriate? Here are some answers:

- Record run hours and loaded hours for each shift to provide a simple overall air usage.
- Install kW meters from a trusted source that will give you actual load characteristics for all the units in the plant. Have the information draft as combined usage and individual usage for each shift.
- Install simple penetration flow meters in each compressor room outlet to determine the actual CFM produced from each location for each shift. Record at the same time the kW recordings are made.
- Overlay kW and flow for each time period and shift to provide actual kW per CFM based on current compressor output and controls.
- Track pressure at the same time that you are measuring kW and flow and you can see how each compressor room is reacting to the system demands. This information will identify the pressure changes that are required to make compressors respond, which could be as much as 10–15 psi.

This evaluation may show that you could be wasting up to 40% of your connected kW running units part loaded, meeting a roller coaster of system demand pressure that needs to be controlled. For example — 40% of a 500 hp compressor system running 8,000 hours a year at $.10 per kW would equal $139,670 in extra power costs.

Power Cost/KWH

HOURS	0.10	0.11	0.12	0.13	0.14	0.15	0.16
2,000 – 1 Shift	159	175	190	206	222	238	253
3,000 – 1.5 Shifts	238	263	285	309	333	257	380
4,000 – 2 Shifts	318	350	380	412	444	476	506
5,000 – 2.5 Shifts	398	438	475	515	555	595	632
6,000 – 3 Shifts	477	525	570	618	666	714	759
7,000 – 3 Shifts/Weekends	557	613	665	721	777	833	886
8,000 – 24/7	636	700	760	824	888	952	1012

GETTING MULTIPLE AIR COMPRESSORS UNDER CONTROL

Addressing Air Leaks and Pressure Drop

Before we address the control of the supply side, we must also look at what is happening in the plant in the terms of leaks. If you do not control your leaks and try to control your compressors you are only kidding yourself. Have a leak audit done and repair the low hanging fruit. For example — a 500 hp air compressor system without previous leak audits would have normally a 20% non-productive air usage rate equaling $69,800 for 8,000 hours at $.10 per kW. This artificial demand needs to be identified and eliminated before controls can be applied.

At 100 psi

Leak Size	CFM Passed	HP Used	$ Cost for 8400 Hours @ .10 K/Hr.
1/32"	1.62	1/2	$336
1/16"	6.49	2	$1,347
3/32"	13.60	4	$2,695
1/8"	26.00	8	$5,390
1/4"	104.00	26	$17,518

Pressure drops are also a critical area to be identified and resolved before controls can be utilized properly. A 5 psi pressure drop within the plant causing the whole system to be increased to meet the demand can cost 2.5% of the connect kW. For example — by reducing the plant system pressure 5 psi in our 500 hp air system, we would save $8,730 per year with perhaps a minimal piping investment.

Once the leak and pressure drop low hanging fruit are taken care of, a control system can now be looked at for a single or multiple compressor room.

Goals for the Air Compressor Control System

1. What do you want a control system to do?
2. Base load the most efficient compressor.
3. Shut off the least efficient compressors leaving on only the best possible trim unit based on its capacity and control function.
4. Change the compressor configurations based on shift load requirements.
5. Provide data on what was happening on the system as far as machine operation/pressure/kW or CFM.

4 Basic Types of Control Systems for Air Compressors

Now that you have an idea of what you're most efficient machines are and the controls on each, we need to select a control system that the budget can afford and you can implement. Here are the 4 basic types of controls that should be considered:

A. Manual Control to pre-determine schedule using the base load machine for each shift that is most appropriate and leaving on the trim machine with the most effective control system — this is least expensive but dangerous because it will not be able to be maintained through the year just through the normal course of running a facility and will not meet changing demands.

B. Time Sequence Selection Panel for up to 6 units selecting the most appropriate base load unit automatically with the 2nd unit with appropriate CFM and best part load controls. This has been done with simple PLC units such as G.E. Fanuc or Alen Bradley to program the on and off times of each compressor — fairly inexpensive, but can not meet changing air demands unless programmed on a regular basis.

C. OEM Sequencer Panel as provided by Atlas Copco, Ingersoll-Rand or equal to sequence compressors with a pre-selected base load machine and a selection of trim compressors based on pressure variation — moderately expensive, in the $4,000–$7,000 range, and may have issues with selecting the correct compressor and keeping within a moderate 5–8 psi pressure band which causes compressors to come on false loads and stay on too long.

D. Fully Automated Computerized System that has less than a 1.5 psi pressure band reaction with built in time delay capabilities and logic to select the correct base load and trim compressors based on control systems and plant air pressure with multiple transducers. Also capable of providing log data showing operation of each compressor and load characteristics converted to CFM such as the Kaeser Sigma Controller — most expensive, in the $15,000–$20,000 range, but with proper installation can provide approximately one year ROI.

The Sigma Air Manager (SAM) provides one comprehensive method for tracking and controlling compressors and monitoring the operation of all air system components, including clean air treatment equipment.

Benefits include:

- Equalizing load hours amount multiple units.
- Tracking system maintenance.
- Remote monitoring and control from any Internet PC.
- Simple, easy-to-read reports and graphs in standard HTML based software.
- Pressure band of +/- 1.5 psi.
- Select the best unit or combination of units for base load, turns off unnecessary units and chooses the most efficient trim unit.

Compressor Control Pros and Cons

CONTROL	PROS	CONS
Dual/Auto Dual	• Combines features of modulating, load/unload and start/stop • Shuts down lubricant injected rotary compressors when unloaded for pre-set duration • Better selects operating mode for small reciprocating compressors	• Adds complexity to control • Over-run timer must be set to limit premature starting and wasted energy
Variable Displacement (Turn/ Spiral or Poppet Valve)	• Energy-efficient control scheme • Matches displacement to demand without reducing inlet pressure or increasing ratios of compression	• Adds complexity to control • Relatively high initial cost • Generally available only for 50 hp or larger compressors
Variable Speed	• Energy-efficient and precise control • Varies rotating speed of compressor, since displacement is directly proportional to speed of rotation	• Adds complexity to control • Relatively high initial cost • Reduced full load efficiency • Efficiency of rotary screw air ends drop at lower speeds • Unsuitable for centrifugals
Multiple Compressor Control	• Saves energy by allowing systems to shut down individual compressors that are not needed • Saves compressor wear by alternating compressors to be shut down • Microprocessor type sequencers limit modulating control to one compressor, optimizing efficiency	• Use is generally limited to compressor type and make produced by manufacturer of controls
Start/Stop	• Simple control using only a pressure switch • Motor and compressor operate only when needed, saving energy • Good for small compressors (10 hp or less)	• Frequent, full load starting wears down motor and compressor • Requires higher than normal compression to build storage, increasing energy use • Relatively "loose" pressure control, ranging as high as 35 psi • Limited to small compressors
Load/ Unload	• Motor and compressor run continuously, reducing wear • Tighter range of pressure control (approximately 10 psi) • Provided adequate storage, offers energy efficient control of both rotary screw and double acting reciprocating compressors	• Improperly applied, "short cycles" cause premature wear and failure, and minimal or no power savings • Proper bleed down time and storage capacity required for lubricant injected rotary compressors to achieve energy savings and prevent lubricant foaming
Modulating	• Motor and compressor run continuously, reducing wear • Tighter range of pressure control (10 psi) • Steadily progressive capacity control to match demand	• Inefficient at lower loads (lubricant injected rotary compressors limited down to 40–60% capacity, centrifugal compressors limited by potential surge and can require discharge blow-off) • Pressure ratios increase as inlet pressure is throttled

Fundamentals of Compressed Air Systems
©1999, The Compressed Air Challenge

Conclusion

What is the correct control system for your single or multiple compressor room applications? It is not a simple answer. To save the money, you must do the work. You can do it internally, which may not be feasible, or find a trusted resource to work with you to collect the data and help make the decisions on the proper control system for your plant. A simple control system with the right parameters will give the best results.

For more information please contact Peter Rhoten, Hope Air Systems, tel: 508-351-1834 email:prhoten@hopeair.com

Evaluating LARGE CAPACITY REFRIGERATION Compressed AIR DRYERS

BY GRAHAM WHITMORE

Large capacity refrigeration dryers can be generally defined as those in the capacity range from 3,000 through 30,000 SCFM. They are installed in the largest of continuous industrial production facilities, including the auto industry, steel and paper mills, textile and food plants. All of these are generally 24x7 operations, which demand special consideration for reliability, redundancy and power consumption.

In these installations, the physical size and cost of the dryers generally restricts the possibility of complete duplication, therefore reliability and redundant components are mandatory. Power cost is a significant factor with large dryers; therefore, it is essential to utilize dryers that are designed to minimize electrical power consumption and pressure drop, which directly affect the air compressor power costs.

The required result of any dryer installation is dry compressed air in the plant, but surprisingly, many large dryers are not able to guarantee dew point. This can be easily verified, however, by using a direct-reading hygrometer or dew point meter and sampling air downstream of the dryer. Only a small percentage of dryer installations actively monitor their dew point independently. All large, central dryers should specify independent verification as a part of the dryer purchase. In this way the customer can be assured of optimum dryer performance and value for their purchase dollars.

Cycling Dryer With Multiple Refrigeration Compressors

There are 3 basic versions of large capacity refrigeration dryers: direct expansion, variable frequency and cycling designs. All have their own following, but a careful evaluation can reveal some significant differences from the end-user perspective. The main evaluation process will likely take the following path, in this order of importance:

Reliability

This is the first and foremost consideration when a large dryer is proposed for a continuous production facility. Many of these facilities have an established and specific demand for dry compressed air. In many cases, wet air will severely impair or even halt production. In these cases the dryer becomes a critical process machine, which cannot stop during production hours. The basic design of the dryer must take account of this requirement; this is the first major step in any evaluation.

Heat Exchangers

Heat exchangers should be shell and tube design, built to TEMA and ASME standards. Two critical requirements are:

1. Unrestricted accessibility of tubes at both ends for repair or re-tubing in-place. Many designs do not allow this access without complete disassembly of the dryer, and sometimes not at all.

2. Hot, saturated, entering air should always be in the tubes of both main heat exchangers. If it is in the shell, long-term internal shell corrosion will occur, which can block the tubes, separator or drains, and shorten the useful life of the dryer. If the wet air is always in the tubes, provided the exposed

header surfaces are coated with durable epoxy or fabricated in stainless steel, the life expectancy of the heat exchangers is almost indefinite. There is no possibility of generating corrosion and rust particles in the dryer. Heat exchangers that are not completely accessible at both ends and repairable on site should be avoided. Sealed plate-type exchangers are typically lower cost with a slightly higher efficiency. The major drawback however is they are totally non-accessible or repairable.

Separation

Separation efficiency is the most misunderstood of critical dryer functions. The currently available technology is impingement, centrifugal, coalescing or a combination of these technologies. By far the most reliable and effective is stainless steel coalescing separation. The others work reasonably well over a limited capacity range (95–98% efficient from 50% to 100% of maximum flow rate. Only efficient coalescing separation guarantees better than 99.9% efficiency from zero to100% flow rate with a much lower pressure drop than impingement or centrifugal separators.

Drain Valves

Drain valves are the final gateway to efficient dryer operation and guaranteed dew point. The most reliable and efficient drain valve is pneumatically operated, with a mechanical lever operating an external ball valve. This valve is extremely reliable in operation for many thousands of cycles and will not waste valuable compressed air. This design eliminates the maintenance and reliability issues of a pneumatically operated valve with a magnet function to operate the ball valve. Ferrous particles will adhere to the magnet and eventually impede reliable operation. All large capacity dryers should feature a redundant drain valve, piped in parallel, with unions, isolation valves and a high condensate alarm. Timer/solenoid drain valves should be avoided. They can stick open or closed, and it is not uncommon for the solenoid to burn out. Consider that if everything in the dryer works flawlessly, except for one small valve, the entire dryer investment is worthless for that period of time.

EVALUATING LARGE CAPACITY REFRIGERATION COMPRESSED AIR DRYERS

Refrigeration Compressors

Refrigeration compressors should *always* be installed in independent refrigeration circuits. Multiple compressors in a common circuit are a disaster waiting to happen. The acid created by a motor burn-out will contaminate the refrigeration system and potentially shorten the motor life of any other compressors in the same circuit. Up to 12 hp fully hermetic piston or scrolls running at 3,400 RPM feature splash lubrication. While impervious to minor liquid slugging and slightly higher in operating efficiency (no valves) scrolls are more sensitive to a larger pressure differential and are also phase-sensitive at initial start-up.

Compressors of 15 hp and larger should be cast iron, semi-hermetic reciprocating design with cylinder unloading. These machines operate at 1,750 RPM and feature a gear-driven oil pump. The very strong forged steel crankshaft and connecting rods, with positive lubrication, insure a long and trouble-free life. Unloading banks of cylinders allow the input power to closely match the imposed load at any time. VFD operation of piston or screw compressors in larger dryers is limited to about 30% of the design load. Gear-driven pumps in reciprocating compressors or pressure differential lubrication in screw compressors both fail to provide adequate lubrication below 30% of their rated speed. Therefore, either inefficient hot-gas valve operation or on/off operation is required, which will degrade the dew point achieved at low loads, especially during nighttime or weekend operation.

Evaporators

Direct expansion evaporators should be single circuit shell and tube design. Dual circuit evaporators should be avoided because if either circuit needs repair, the entire system will be shut down. Glycol evaporators in cycling dryers should always be located where they are easily accessible and not immersed in a tank of glycol. Flooded evaporators are undesirable because they require a very large refrigerant charge — typically 10 times that of a DX or cycling dryer evaporator. Additionally, it is not practical to use multiple flooded evaporators. Therefore this design features a single evaporator and one or multiple compressors in a SINGLE circuit, which completely eliminates real redundancy.

Condensers

Water-cooled condensers should be rod-cleanable shell and design, with removable heads for cleaning in place. It is always advisable to specify a Y-strainer to be installed by the customer in the water supply line to the condensers. This will eliminate or greatly reduce routine inspection or cleaning of the water passages in the condensers. Plate type or coaxial water-cooled condensers are susceptible to plugging and should always be avoided. Air-cooled dryers should have a completely separate condenser for each refrigerant circuit. A multi-circuited air-cooled condenser eliminates real redundancy in the event of a leak or failure.

Redundancy

All major refrigeration components should be redundant, with the dryer capable of continuing without interruption in the event of a component failure.

Specific components which must be totally redundant are:

1. Compressors — installed in independent refrigeration circuits and fitted with service valves on inlet and outlet connections for simple replacement, if required.
2. Automatic compressor and pump rotation for even wear and extended life.
3. Stainless steel evaporators — in independent circuits and fitted with unions and isolation valves to allow removal and replacement without interruption.
4. Thermostatic expansion valves on each independent circuit.
5. Cleanable shell and tube water-cooled condensers with removable heads, unions and isolation valves on each circuit.
6. Water regulating valves with isolation valves and Schrader refrigerant connections for quick and easy replacement.
7. Duplex stainless steel glycol pumps with TEFC motors. Piped and wired in a common circuit feeding all evaporators and air/glycol exchanger. Fitted with unions and isolation valves to allow easy replacement or repair in operation. Loss of flow initiates an immediate change to the standby pump and sets alarm signal.
8. Separate lock-out disconnects for all compressors and pumps to facilitate safety compliance while working on any circuit while the others remain in operation.
9. DIN rail mounted, 24VDC PLC controller with 100% plug-in wiring connections. This allows a complete PLC change out in minutes, without tools and in complete safety.
10. Remote monitoring capability via RS 485 to any Modbus platform or via an Ethernet connection using Back Net or LON.

Power Cost

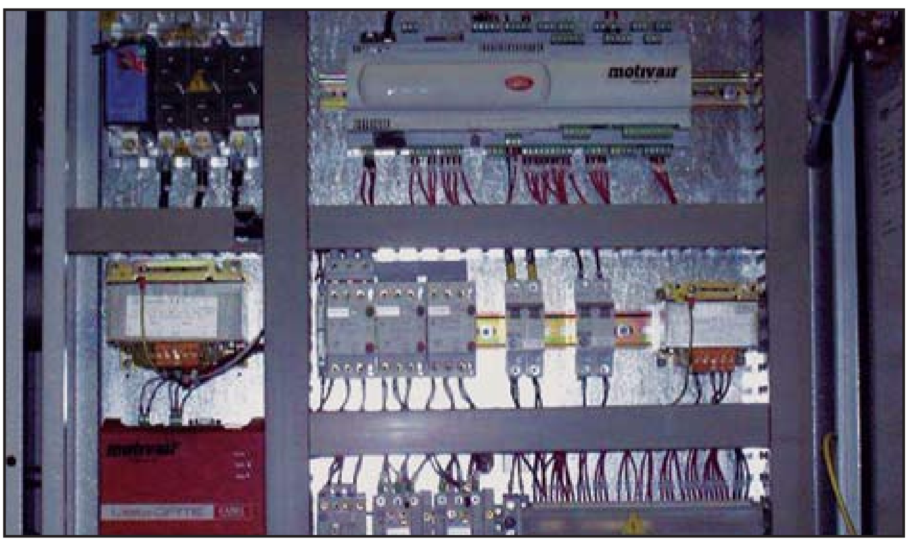
Dryer power cost is comprised of 2 factors: a) direct electrical power cost and b) indirect cost of air compressor motor HP related to dryer pressure drop.

a. Optimum economizer (air/air exchanger) design will reduce the refrigeration plant by about 50% and reheat the leaving air to within 20°F of the entering air temperature. It is critical that plain surface tubes are utilized in the air/air exchanger in order to eliminate plugging in lubricated systems or when particulates are present in the compressed air piping. The small cost savings or thermal efficiency gains of enhanced tubing or plate exchangers is dwarfed by the cost of disassembly and /or complete replacement in the event of plugging.

b. The total air-side pressure drop should be designed for a maximum of 4.0 psi at 100 psig operating pressure. Lower is better, since the additional cost of achieving a reduction in pressure drop will be usually be recovered within the first 2 years of operation.

EVALUATING LARGE CAPACITY REFRIGERATION COMPRESSED AIR DRYERS

Reliable and Efficient Drain Valves Are Critical



PLC Plug-in Board and Ethernet Connection

Air Dryer PLC NEMA 4 Control Panel

By far the lowest direct dryer operating cost can be achieved with a cycling design and multiple compressors. The dryer absorbed power can be closely matched to the load by automatically cycling the compressors off and on, while utilizing the thermal storage mass of glycol in the system. Larger capacity dryers with unloading compressors allow even closer control. Direct expansion dryers with cycling or unloading compressors require hot gas valves in order to maintain a reasonable dew point. Hot gas valves impose an artificial load on the dryer, which consumes more power, unrelated to the load. Variable frequency dryers can only match power to load down to 30% load, below which they must either operate hot gas valves or cycle compressors off and on. This consumes power, while continuous operation, close to the minimum of 30%, can reduce lubrication in screw or piston compressors. Direct power cost is closely tied to the dryer's ability to operate efficiently, with a constant dew point at any load from zero to 100% capacity. Cycling dyers are by far the most efficient design for part-load operation.

Summary

There are critical choices and decisions to be made in the selection of a large capacity dryer for continuous operation. The 3 main considerations of reliability, redundancy and operating cost should be given the same weight as a large and critical piece of production equipment. In most cases, if the dryer is not functioning, production is severely impaired or even stopped. In all but a few installations in recent years, the overwhelming choice for the largest compressed air users has been a multiple-circuit cycling dryer. Other designs are less costly, but sacrifice redundancy, reliability and operating cost, especially in applications with significant variations in compressed air usage.

For more information contact Graham Whitmore, Motivair Corporation, tel: 716-689-0222, email: gwhitmore@motivaircorp.com

Real World Best Practices

by Hank Van Ormer

CONTROL CABINET COOLING

What does control cabinet cooling have to do with compressed air? One of the most effective methods of control cabinet cooling, particularly in very harsh conditions, is with compressed air-driven products, but the single most uneconomical and inefficient type of cabinet cooling is blowing straight compressed air into the cabinet. Between these two choices are several other options that may apply depending on the operating conditions.

Why Do I Need Cabinet Cooling?

Control Cabinet cooling, when needed, will extend the life of critical electronic equipment reducing maintenance and downtime. Improper equipment or improperly applied equipment can greatly increase the operating costs, exceeding the direct savings or cost of the equipment.

When Do I Need Auxiliary Control Cabinet Cooling?

Most equipment designers, when utilizing a control cabinet, select the cabinet size and resultant cooling area with regard to normal internal heat rejection and base their selection using a maximum internal temperature of 90 ˚F target. Most electronic equipment is recommended to run with an internal temperature of 90 ˚F or less to reduce heat stress on the controls and drying of the wafer boards and is designed to operate in 100 ˚F or lower ambient unless otherwise stated.

The designer thus feels that no immediate "short term" damage will occur at ambient temperatures of 100 ˚F or lower and there will be minimum reduction in design life. Therefore, most component selections, including the size of the cabinet, assume 100 ˚F ambient or lower.

To reach this conclusion the designer needs to establish a *maximum allowable peak operating internal temperature and maximum or average operating temperature*. This data should be available to the application team along with the calculated heat load from the internal control equipment

From this we can assume that most applications in ambient areas over 90 ˚F for sustained long time frames may well require auxiliary cabinet cooling particularly on older equipment.

There may be other instances where the design criteria was lower or the implementation poor and a given unit may still require "SOME" auxiliary cooling.

Early Best Practices Thoughts and Actions:

Do you need cabinet cooling?

- Measure the internal temperature when operating under all appropriate conditions.
- Remember the cabinet itself is an effective "heat sink," it will transfer outside generated heat to a cooler surrounding area or it will transfer heat from a hot surrounding area INTO THE CABINET.
  - If the outside heat is migrating in it would be prudent to insulate the walls of the cabinet.
  - If the location of the cabinet is in a very hot area, is it practical to move to a cooler location?
  - If the cabinet is using compressed air to hold inside positive pressure to prevent the intake of outside contaminants. If this is the case, there are cabinet coolers such as the air driven Vortex units that will cool and vent the internal cabinet while it is completely sealed.
  - Is there room and airflow around the cabinet?

Some Cautions:

- Any type of auxiliary cabinet cooling costs additional capital money but more importantly — *increases the true operating energy costs,* regardless of the type of cooler.
- Do not apply auxiliary cooling instead of repairing or replacing old broken down components except under certain circumstances. Generally the operating cost will far exceed the repair cost of the component.

After all these conditions have been considered and you determine you do need cabinet cooling, what type and what size?

Those who want more details, particularly concerning sizing, we have a 14 page technical review of cabinet coolers which can be obtained by contacting the editor of Compressed Air Best Practices magazine.

BEST PRACTICES FOR CONTROL CABINET COOLING

Blowing a fan directly on an open cabinet, as shown here, has many performance drawbacks like blowing hot, humid and dirty air directly into the control cabinet. Not to mention it is a serious safety and OSHA violation. We would never recommend this.

Types of Commercial Cabinet Coolers Available to the Industrial User:

Commercial cabinet cooling comes in 6 basic types: Fan (blowing filtered ambient air), compressed air (probably at ambient temperature), refrigeration (Freon based), refrigeration (Vortex tube cooler, compressed air driven), refrigeration (heat tube) and thermoelectric refrigeration (400–1500 BTU/hr range).

Fan with Ambient Air: Internally Mounted Drawing in Filtered Air:

If the ambient air temperature surrounding the cabinet is more than 90 ˚F, we obviously cannot cool the inside of the cabinet to 90 ˚F. This type of cooling depends on "exchanging the air" and requires a certain amount of cooler air coming in and hotter air going out to handle the BTU/hr load and prevent internal temperature build up. It is limited in application since it will only work with "cooler" ambient air. A properly sized and installed cabinet in a cooler environment may not require any cabinet cooling. If the conditions change seasonally or at different production levels, the fan type cooler has no way to respond. Although these use very low energy, we recommend them when we are sure that the operating conditions are stable and will allow proper performance.

Compressed Air Blowing:

Assuming this compressed air is also at ambient temperature, it will not have any better performance band than the fan driven ambient air cooler except for increased density; overall, it is very expensive to produce compressed air — 200 cuft would require about 35 kW compared to 1 kW or less for the fan. In addition unless this air is dry and filtered, it can carry oil, water and contaminants into the cabinet. We **never** recommend this.

Freon Based Refrigeration Units:

Freon based refrigeration units can lower the ambient air temperature about 15 to 16 ˚F each pass. For more cooling drop the refrigeration action is cumulative as long as there is enough capacity. This limits their usage to ambient temperatures no higher than about 125 ˚F.

The refrigeration units mount on the side of the cabinet and continue to cool the same air in the cabinet over and over until they reach the desired internal temperature. The units usually run constant speed, but when there is enough refrigeration capacity, these may be controlled to shut off with a temperature switch. In practice they usually run most the time because they're being controlled by the hot gas bypass valve. There is no electrical energy savings in the HGBV control model.

- Re-circulating cooling air is not as effective at cooling as replacing hot air with cooler air.
- Frequent starting and stopping leads to extreme short cycling, increasing the maintenance and repairs costs.
- Dust and dirt clog the inlet filters reducing the effective air flow and operation.

Summary:

- Refrigeration units have a practical limitation of 115 ˚F to 125 ˚F ambient without significant over sizing.
- Refrigeration units generally run fulltime.
- The electrical energy operating cost is usually the highest of any type except open blows.
- You can and should apply them to run only when the cabinet is active, if possible.
- Of all the types available, these probably require more general maintenance and shorter overall life, particularly in hotter environments.

These Units Can Have High Maintenance Issues:

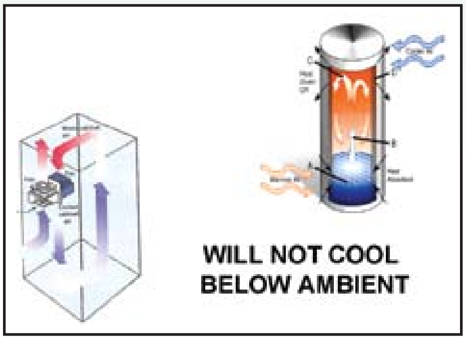
- Often the operating machinery vibration in the area can lead to Freon leaks.
- Escalating ambient temperature will shorten component life.
- Some type of floor drain may be required to remove the condensate when generated.

Heat Pipe or Heat Tube Refrigeration:

A heat pipe consists of a sealed aluminum or copper container whose inner surfaces have a capillary wicking material. Inside the container is a liquid (usually alcohol) under its own pressure that enters the pores of the capillary material, wetting all internal surfaces. Applying heat at any point along the surface of the heat pipe causes the liquid at that point to boil and enter a vapor state. When that happens, the gas picks up the latent heat of vaporization, and the gas — which now has a higher pressure — moves inside the sealed container to a colder location, where it condenses. Thus, the latent heat of vaporization moves heat from the input to the output end of the heat pipe. This process takes place at great speed, reaching over 500 mph.

The core material selected for use in the heat tube cabinet cooler is copper tubing and aluminum fins. This combination of materials is readily available and has been in use for many decades in refrigeration coils, steam heating coils, radiators, etc.

BEST PRACTICES FOR CONTROL CABINET COOLING



The fans are designed to be an easy change replacement part; two axial fans are usually selected as the standard fans for heat pipe cabinet coolers.

The annual maintenance on these units would be to clean or replace the filter elements and the fans.

With these coolers, the cabinet can be completely sealed from the surrounding elements such as dirt, dust, manufacturing debris, etc.

One drawback to these units is if there is a consistent high ambient temperature the heat transfer will be diminished. **The air "heat tubes" will not cool below ambient.** There are water-cooled units that will cool below ambient temperature. These are a great deal more complicated and impose more maintenance issues. We very rarely recommend the heat pipe where there is not enough continuing ambient temperature to internal target temperature differential.

Summary: In the air cooled models heat pipes will not cool below ambient temperature, but use very low electrical energy to operate.

The lowest electrical energy cost ambient cooler, after the fan, is the heat pipe — air cooled units can only cool to **almost ambient temperature.** When the ambient temperature around the box is higher than the desired inside temperature — *it will not work!*

Thermoelectric Refrigeration:

An older technology now emerging into the commercial industrial cabinet cooling market is thermoelectric refrigeration. It was originally developed and applied to internal cooling of computers and other electronic components. The thermoelectric plates utilize an efficient Pelletier cooling design. As current is supplied to the plate, it cools the surface. As current to the plate is reduced, the cooling effect is reduced. The control system modulates the amount of current to maintain the target temperature.

The energy cost to operate a thermoelectric refrigeration cabinet cooler is from 50% to 80% less than Freon refrigeration units. This technology does not always have the capability to develop the higher temperature differential of some others, particularly Vortex tube cooling. In some higher ambient areas (such as furnaces, etc.) with poorly insulated cabinets they may not be usable. We have applied thermoelectric cooling very successfully in manufacturing plants all over the continental Untied States.

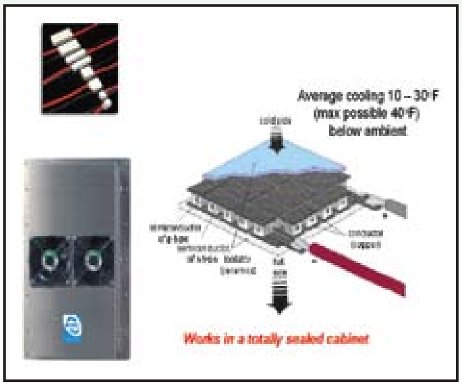
Summary: thermoelectric coolers:

- No refrigerated type cooler has lower electrical energy cost than the thermoelectric air conditioner. Today its practical limit is 1500 BTU/hr cooling in a single unit (or multiples of 1500 BTU/hr). This will handle many of today's cabinet cooling jobs in the industrial environment. It will cool below ambient or the surrounding air temperature. It does have limited cooling temperature differential (10–30 ˚F) from ambient.
- Thermoelectric can cool in a sealed cabinet and do not have to exchange cool air for hot air!

Refrigeration — Vortex Tube Cooling:

Vortex tubes generate chilled air without the use of refrigerant or any moving parts.

Compressed Air Vortex Tube Cabinet Cooler:

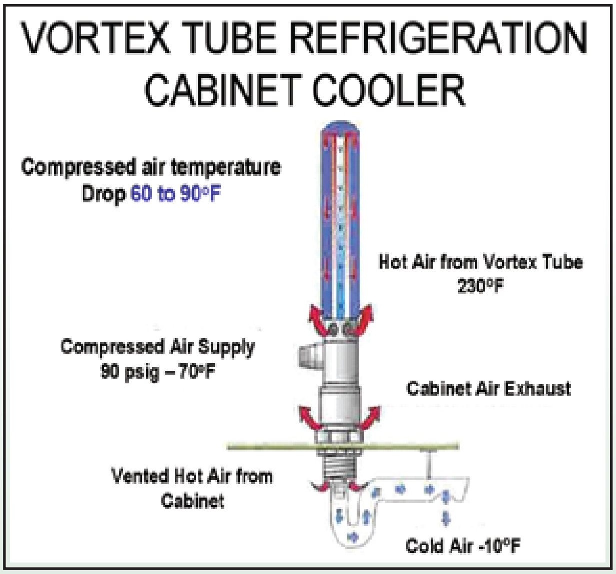


How can you get cold air and hot air from one compressed air stream? Lots of people have tried to explain it, including the French physicist, George Ranque, who invented the Vortex tube in the 1930's. We will not elaborate on this here but in practice:

Vortex tubes behave in a very predictable and controllable way. When compressed air is released into the tube through the Vortex generator, you get hot air out of one end of the tube and cold air out of the other.

The Vortex flow generator — an interchangeable, stationary part — regulates the volume of compressed air, allowing you to alter the air flows and temperature ranges you can produce with the tube on some models.

"Cold fraction" is the percentage of input compressed air that's released through the cold end of the tube. As a rule of thumb, the less cold air you release the colder the air



will be. You adjust the cold fraction with the control knob. Cold fraction is also a function of the type of vortex generator that is in the tube, i.e. a “high cold fraction” or “low cold fraction” generator. Some models use precisely sized plugs to preset the cold fraction percentage.

Most industrial process applications use a high cold fraction (about 50%). A high cold fraction tube can easily give you cold outputs, 50–80 ˚F (28–50 ˚C) *below* the inlet compressed air temperature. The high cold fraction combination of airflow and cold temperature *produces the maximum refrigeration capacity or greatest BTU/hr.*

A low cold fraction (below 50%) means a smaller volume of air coming out that is *very cold* (down to -40 ˚F/-40 ˚C). In short, the less air you release, the colder the air. Often even though the temperature is lower, the low mass of the air limits the total refrigeration capacity or BTU/hr capacity.

Application and Installation Guidelines:

- Everything else equalizes as the inlet pressure rises, the cold air temperature drops (within performance limits). *Conclusion:* Colder air may be delivered if the installation minimizes pressure loss to the inlet of the Vortex tube cooler.
- Back pressure on the cold end will reduce the ratios across the tube and raise the cold end temperature. There is usually a relief valve in the Vortex tube cooler assembly venting the cabinet air, preventing back pressure build up and exchange hot air for cold air.

Since well applied Vortex tubes cool quickly and have no moving parts, they can shut on and off as often as required to save air flow.

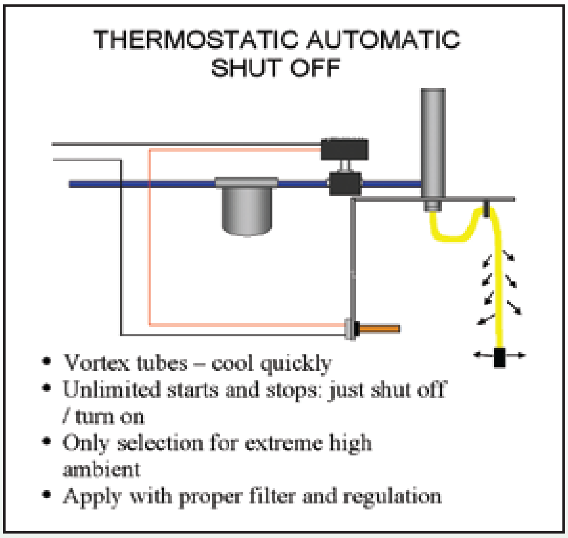
Vortex tube coolers should always be controlled by a thermostat sensing the inside cabinet air and an electric solenoid to shut the air on and off with the signal (see following drawing).

Summary:

Although the Vortex tube cabinet cooler may have similar constant full load electrical operating cost to a Freon refrigeration unit, a few other points are important.

- The operating cost can be reduced by 50% to 80% or more with proper application and thermostatic control.
- Vortex tube is much more controllable than refrigeration and can more easily be shut *OFF* when not needed. This can create significant savings. It has unlimited on and off cycle capability. Controlling pressure also allows control of flow and temperature drop.
- Performance of the Vortex tube is dependent on compressed air inlet temperature and pressure — not ambient air — therefore, it can run with good temperature pull down in almost any environment. As the ambient temperature rises, the performance of the refrigeration unit deteriorates.
- **Cooling by very low air temperatures (up to 80 ˚F ☐T)** and moving out the hot air allows quick cooling of the cabinet after any shutdown with proper controls and installation, active “on time” can be very, very, low.
- Vortex tube coolers can operate in ambient up to 200 ˚F (93 ˚C) when properly selected and prepared. In high ambient they may be the only proper choice.
- Vortex tube coolers are the most popular and the most used coolers due to the fact that they can hardly be misapplied as far as cooling. They can definitely be misapplied as far as inefficiency and wasting compressed air — your most expensive utility.
- There are special continuous purge models that will keep a constant positive pressure in the cabinet when required. However, when vented through the integral bladder valve, a sealed cabinet integrity is still intact.
- Make inspection of the proper operation and control of these Vortex coolers a part of the regular maintenance program. Running improperly or with a leaky seal results in inadequately chilled air.

The Vortex refrigeration cooler is the most flexible type and when used with proper controls and installation, the most economical over varying conditions. Take advantage of the large temperature drop and ability to start and stop an unlimited number of times.



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Data and pictures provided by:

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The Benefits

BY TONY WEISHNER

The high demand for steam trap surveys (due to higher return-on-investments) is for condition monitoring of the steam trap population in industrial facilities. Energy-reduction surveys, pertaining to the insulation of steam line equipment to avoid preventable energy losses, are also in high demand. Driven by escalating energy costs, requests for steam system energy analysis and use-reduction surveys are on the rise.

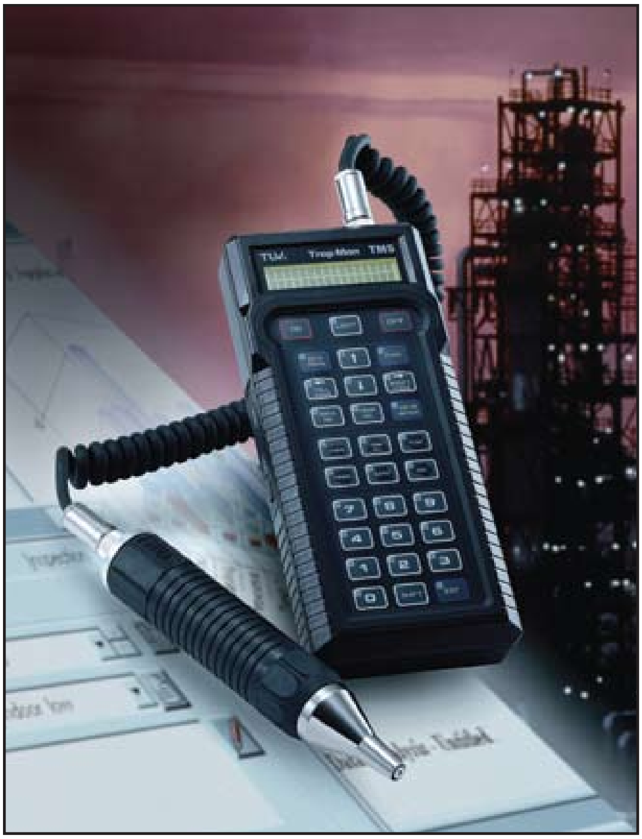
Tony Weishner, President of the H.G. Jones Company

Steam trap surveys help customers save money on energy losses. A leaking steam trap can cost you thousands of dollars a year. If the steam trap leaks 24 hours a day, it can cost between $11.00 and $30.00 per 1,000 pounds of steam, and the losses add up quickly. The objective of a steam audit is to identify defective steam traps in the facilities' steam system and to deliver a failed trap report outlining the costs of the failed steam traps.

Steel mills use large volumes of steam for heating liquids for sprays and other processes including general heating in the winter. Chemical plants and power plants are also major industrial users of steam. Many buildings, such as hospitals, universities and even churches, have central steam plants used for heating. Most people are amazed to find out how many facilities have boilers to make and use steam.

The TLV TrapMan® System

An effective instrument for conducting steam trap surveys is TLV's TrapMan® Computerized Steam Trap Management System for Productive Maintenance. It is a complete measurement and analysis system for effective management of the steam trap population. TrapMan® consists of a precise ultrasonic temperature-testing instrument which stores and accesses diagnosis technology for making consistent performance judgments. The TrapManager® software, a comprehensive Windows-based program, is designed to enable extensive data analysis of the entire trap population. Performance judgments are done by comparing the steam trap test results with stored data from TLV's laboratory analysis of similar traps in a controlled environment. The TrapMan® judgment accuracy has been certified by Lloyd's Register.



The TLV TrapMan® Instrument

# of Steam Trap Surveys

Steam Trap Survey Condition Monitoring Results

TRAP	TRAP TYPE	MANUFACTURER	MODEL	TEST RESULT	EXAMPLE LOCATION	SIZE	TEMP	STEAM COST PRESSURE	LEAK LEVEL	$9.60 MONETARY LOSS
1	THERMO	YARWAY	750	GOOD	Lube Mix Tank	0.5	181	15	0	0
2	THERMO	BESTOBELL	16	BLOCKED	Lube Mix Tank	0.5	98	15	0	$0
3	THERMO	YARWAY	750	LEAK/M	Water Heater	1	177	15	7	$855
4	THERMO	BESTOBELL	16	GOOD	Water Heater	0.5	161	15	0	$0
5	THERMO	YARWAY	750	LOW TEMP.	Water Heater	0.5	123	15	0	$0
6	FLOAT	TLV	J3X-21	GOOD	Main Trace	1	163	15	0	$0
7	THERMO	BESTOBELL	16	BLOWING	Stainless Tracer	0.5	230	10	15	$3,885
8	DISC	NICHOLSON	N-600	GOOD	Treat Line Dryer	0.75	350	150	0	$0
9	THERMO	CLARK-RE	LCT	BLOCKED	Mill Roof	1	87	180	0	$0
10	THERMO	YARWAY	750	GOOD	Mill Roof	0.75	228	180	0	$0
11	FLOAT	TLV	JS7X18	GOOD	Steam to Pump Station	1	292	59	0	$0
12	DISC	NICHOLSON	N-600	LEAK/S	Steam to #6 Fuel Oil	0.75	177	103	1	$383
13	DISC	SPIRAX SARCO	TD52	LEAK/S	Steam to #5 Fuel Oil	0.75	325	103	2	$482
14	THERMO	YARWAY	750	LEAK/S	Steam to #4 Fuel Oil	0.75	156	103	1	$314
15	DISC	NICHOLSON	N-600	GOOD	Steam to #3 Fuel Oil	1	278	43	0	$0
16	DISC	NICHOLSON	N-600	BLOWING	Steam to #2 Fuel Oil	0.75	344	141	15	$2,492
17	THERMO	BESTOBELL	25	BLOWING	Steam to #1 Fuel Oil	0.75	228	9	15	$4,650
								TOTAL LOSS		$13,061

Most facilities have come to understand the expense of steam losses. They want to test as many traps as possible per day, how much steam they are wasting and how much they can save. A sophisticated steam trap test system, like the TLV TrapMan® System, takes less than 30 seconds to determine the accurate steam energy loss. The payback calculation on replacing the traps is then quick and simple. Steam trap testing speed and accuracy capabilities are issues facility engineers must evaluate. There are many devices used to test steam traps that cannot calculate the steam losses or arrive at an accurate energy-loss dollar figure.

THE BENEFITS OF STEAM TRAP SURVEYS

The Steam Trap Survey Process

Steam trap surveys start with reviewing the quantity and location of the steam traps in the system with the plant engineer. A facility map (or drawing) can make it easier to identify the trap locations. The auditor brings stainless steel tags and chains to identify each trap by number or location.

The service tech begins by testing each trap with a probe that is attached to the TrapMan® System to sense the temperature and determine the sonic noise in each trap. After 15 seconds, the system determines the trap condition and rates it as "Good," "Blowing," "Leaking," "Blocked" or "Low Temperature." The leaking traps show a leak rate number on a scale from 1 to 15 (1 is a small leak and 15 is a very large leak) that the TrapMan® System uses to calculate steam losses. Based upon the steam pressure, individual steam trap leaks can cost $300 to $25,000 per year.

The TrapManager® software later computes the lbs/hr steam loss and dollar values of lost steam based on customer steam costs, steam pressure leak rate and time trap is in service over the year. With this method, a survey can generally test 100+ traps per day. The more organized the trap locations are, the more can be tested in a day. In some facilities the location of the steam traps is not available and they must be found by walking the lines.

Conclusion

The finished survey report evaluates the condition of the installed steam trap population. Traps with the highest leak rates are ranked first to last to provide the facility engineer with a priority list to change traps. Steam losses for failed traps, in a facility, can range from $4,000 to $300,000 per year, depending upon the quantity of failed traps and steam pressures of the system. The quickest way to save money is to replace a leaking steam trap. The savings are immediate. Remember, the leak is there until it is eliminated. When you compare the cost of a new steam trap and the labor required to replace it, the potential savings are compelling.

For more information contact Tony Weishner, H.G. Jones Company, tel: 724-873-9088, email: tweishner@hgjones.com

FS Elliott

CENTRIFUGAL AIR COMPRESSORS

Compressed Air Best Practices spoke with Ron Stewart (Chief Executive Officer) of the FS Elliott Company.

Compressed Air Best Practices — Good morning. I have read that around FS Elliott, things are backward-leaning and forward-thinking!

Ron Stewart — Yes, we like to have some fun talking about the energy-efficient design of our backward-leaning impeller blades. Centrifugal (or dynamic) air compressors use impellers to compress ambient air. Backward-leaning impeller blades allow for higher efficiencies compared to other impeller designs.

RS — We foster and encourage a culture, at FS Elliott, of forward-thinking. Stepping "outside the box" has allowed our company to be innovative in product development. We see this with our impeller designs, oil-free technology, control systems and our custom-engineering capabilities, which can meet the rigorous API 672 Standards. The forward-thinking culture has also had a profound impact on our operational and testing capabilities.

Ron Stewart, CEO of FS Elliott, holding a backward-leaning impeller.

FS Elliott Headquarters and Manufacturing Center in Export, Pennsylvania

FS ELLIOTT CENTRIFUGAL AIR COMPRESSORS

CABP — What are the efficiencies offered by the impeller blade designs?

RS — FS Elliott manufactures air compressor sizes ranging from 200 to 3,500 horsepower (150–2,600 kW). They deliver between 600 to 18,000 cfm (1,020–30,600 m3/h) of air flow, at discharge pressures between 45 and 175 psig (3–12 bar). To say that energy efficiency is important to our customers is a big understatement.

RS — Our impeller design produces a higher pressure-rise [to surge] over the entire compressor operating range, when compared to other centrifugal impeller designs. This has 3 primary benefits in a compressed air system:

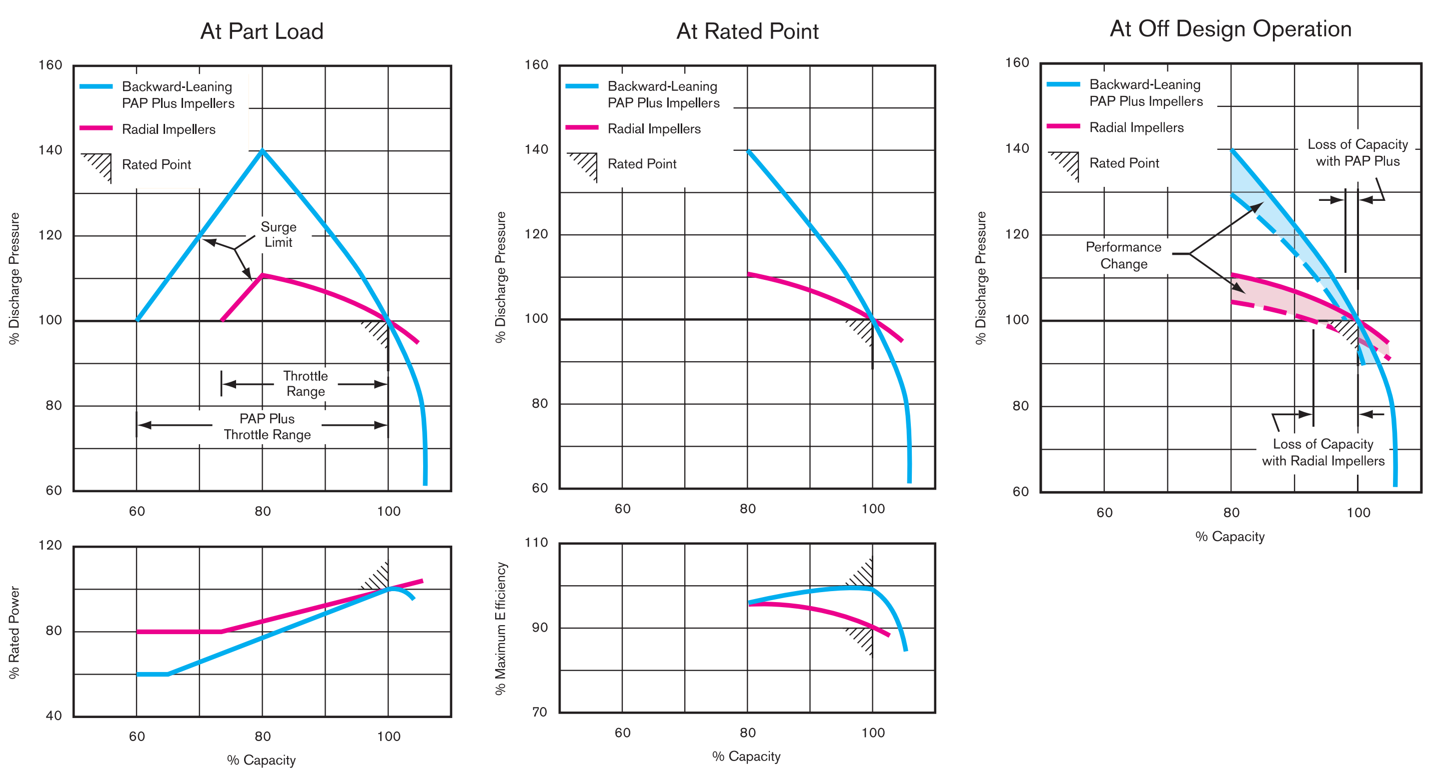
1. Allows for greater discharge air flow capacity as pressures increase.
2. Permits higher efficiencies at partial loads. This design permits a larger throttle-range for reduced power consumption under partial loads.
3. More tolerant to high operating temperatures. When inlet air temperatures or cooling-water temperatures go up, this design compensates and the output reduction is much smaller.

CABP — How do your oil-free centrifugals compare in efficiency to oil-free rotary compressors?

RS — The larger the horsepower size, the greater the advantage in efficiency offered by a centrifugal air compressor. This is why centrifugals have been the technology of choice in process industries and large industrial facilities. Over the years, FS Elliott has innovated and we now have "smaller horsepower" Polaris® oil-free centrifugal compressors. They use our new Regulus® control system, which allows for very efficient over-all operation in the 200 to 1,000 horsepower range. Centrifugals used to be the base-load machine with rotary screws used as trim machines. Now customers can benefit from our centrifugal efficiencies and match their demand.

CABP — Please describe your oil-free technology.

RS — We isolate the pressure lubrication system from the compressed air side of the compressor. The self-contained system operates at 30–35 psig assuring continuous flow to all bearings and gears as well as to the driver when required. The system is designed to ensure appropriate cooling during off-design conditions as well, for example, when ambient air temperatures are high. Popular with service technicians is the fact that the oil reservoir, oil cooler, and oil filter are all located in easy-access areas within the compressor package.



CABP — What is forward-thinking about the new Polaris® Series of air compressors?

RS — The Plant Air Package (PAP® PLUS) compressor was first introduced to the market nearly fifty years ago. It has been very successful in a number of industries including steel-making, electronics, food and beverage processing, snow-making and automotive just to name a few.

The Polaris® Series offers industrial users all of the same core features as the PAP® PLUS compressors (backward-leaning impellers, oil-free air and Regulus® control system), while eliminating the extra packaging costs required to comply with API 672. This has made the efficiencies of the fundamental design attractive and affordable for industrial users. The new value equation is what is driving the strong growth we have seen here over the past 4 years.

Work-in-Progress on a FS Elliott Impeller

CABP — Can you describe the Regulus® control system?

RS — Sure. The processor and touch-screen controller allow the user to monitor and manage the air compressor at the unit or from a remote location. It includes an adaptive control system, which automatically tunes the compressor operation to match operating conditions. Called the Constant Pressure Control feature, it provides control from 0–100% of capacity. This permits energy savings to the maximum turndown point by closing the inlet guide vane or control valve during low demand or low temperature operating conditions.

We can also provide several other modes of operation and optional features to match virtually any facilities' control philosophy requirements.

A FS Elliott 500 hp Polaris® Series Air Compressor

FS ELLIOTT CENTRIFUGAL AIR COMPRESSORS

The Command Center Can Simulate All Operating Conditions

The Transformers Simulate All Power Conditions

Performance is Measured and Verified for all Customers

CABP — Please describe the PAP® PLUS API 672 air compressors.

RS — This package has become the industry standard for oil and gas production, refining and for the petrochemical industry. API 672, API 671, API 614 AND API 541 requirements are met by the PAP® PLUS air compressors, which also include:

- Axial, lateral and vertical alignment blocks and position bolts
- A forged steel, non-lubricated, flexible-element spacer-type coupling
- Custom instrumentation fittings like resistance temperature detectors (RTD's) mounted in the lubricant piping
- Twin full-flow lubricant filters in parallel arrangement with an integral three-port, positive shutoff, zero leakage transfer valve
- Vibration levels meet API standards

FS Elliott has worked with the API (American Petroleum Institute) from their inception and our PAP® PLUS package has always met their standards. This experience has also shaped how we design our manufacturing and testing processes and made all of our equipment extremely rugged and reliable.

CABP — What is the history of FS Elliott?

RS — Elliott has been based in the outskirts of Pittsburgh, Pennsylvania since 1903. The company started by supplying blowers to the steel mills in the region. We began manufacturing centrifugal compressors in the 1950's for refrigeration gas and industrial process gas applications. In the 1960's, and ever since, Elliott centrifugal compressors became a standard for gas compression in the oil refining and petrochemical industries. In the 2003, Fu Sheng Corporation purchased the Plant Air Package (PAP®) Division from Elliott Corporation and FS Elliott was formed.

CABP — Please describe the structure of FS Elliott.

RS — Under Fu Sheng ownership, we purchased a facility here in Export, PA and have created a brand new manufacturing and technology center. We employ 200 people in 2 facilities here, which cover more than 200,000 square feet on 30 acres of land. We also have application engineering and service facilities in Houston, Los Angeles and London.

Internationally we entered China in the early 1990's and operate a 1,000 square foot packaging facility in the Shanghai area employing over 80 people. The operation is located on Fu Sheng's 200 acre manufacturing campus. We also have application engineering and service facilities in southern China, Peking, Singapore and in the Middle East.

CABP — How has business been since the acquisition?

RS — Pretty incredible. The acquisition has brought us the focus on compressed air systems that the technology deserves. Our sales have quadrupled over the past 4 years. Growth has been strong in both the industrial market and the process industry segments.

We have established a strong distributor network, in North America, which is providing more industrial end users with the opportunity to work with our centrifugal air compressors. We have trained them to service the equipment and are working in close partnership with them. The demand has been strong for the training. In fact, we are conducting a sales training seminar in September for more than 100 individuals!

Thank you FS Elliott for your insights.

For more information contact Mr. Ron Stewart, FS Elliott, tel: 724-387-3210, email: rstewart@fs-elliott.com, www.fs-elliott.com

FS ELLIOTT Investments In Quality Testing

FS Elliott has recently completed a state-of-the-art compressor testing facility in its Export, Pennsylvania facility. The test laboratory allows all units to receive performance testing and pass the most vigorous third-party inspections.

CASCO USA

Compressed Air Best Practices interviewed Jim Miller (President) of CASCO USA

Compressed Air Best Practices —Good afternoon. What markets does CASCO USA serve?

Jim Miller — Steel making has been our largest industry in this part of the country for more than 100 years. Although we're not the size we once were, steel, glass and specialty metals manufacturing is still big. Production of high tech specialty metals and materials such as titanium alloys and specialty ballistic glass is increasing significantly. This is somewhat due to the military needs of our country, aerospace and airline industries.

Jim Miller, President of CASCO USA

CABP — Please describe CASCO USA.

JM — We have been a distributor of Kaeser Compressors and accessories since 1990. As our earliest customers will attest, we have always taken a "systems approach" to compressed air system design, with an eye on overall efficiency.

CASCO USA is a major force in the sales, service and installation of compressed air and vacuum systems in our region. Our sales and service staff is Master Certified by Kaeser Compressors and is an experienced service center for centrifugal compressors, oil-free compressors, vacuum systems and liquid pumps. Our service staff is capable of servicing all makes and types of air compressors and compressed air system components.

The company offers all phases of compressed air system auditing, CAD system design, engineered and fabricated package designs and complete installations.

After starting with only a single office covering southwestern Pennsylvania, CASCO USA has grown to 3 sales and service locations covering all of western Pennsylvania, northeast Ohio, northern West Virginia, and southwestern New York. Our main headquarters is located 20 miles south of downtown Pittsburgh in an industrial park in Washington, PA. Our Cleveland Branch is located in Solon, OH. Our Erie Branch is located in the city of Erie, PA.

(Continued on page 42.)

CASCO USA Headquarters in Washington, Pennsylvania

CASCO USA Audits a Metal Processing Firm

In a nutshell, our philosophy has always focused on two points — educating the customer and taking a system approach to solving compressed air problems.

First comes knowing the customers perception of what are the problems with the volume, pressure, and quality of the compressed air. Then our advice is to audit the system over time, normally no less than 1 week to obtain a base line of where the system is now and what the objective is to be.

There are very few compressed air systems where all of the problems can be determined by observation alone. Almost all compressed air systems are dynamic and change is the only constant. Our engineers are trained to observe, verify and recommend solutions that solve problems and the result is not necessarily a complete revamp of a compressor system.

Managing the Supply-Side of the Air System

We have seen in several systems that just by getting operational control of the system on the supply side can make a dramatic difference.

On several applications, for instance, we have utilized Kaeser's Sigma Air Manager master controller. We find that most industrial plants are operating at pressures well above what is required or even recommended. The master control system allows pressure to be maintained in a narrow, stable band while only running the compressors most appropriate to the demand level.

This master controller can significantly reduce energy, flow and system leaks by centrally controlling and lowering the system pressure by several pounds of pressure. With this controller, monitoring and recording the dynamics of the compressed air system over as much as 1 full year is also possible. By constantly monitoring the system dynamics, changes can be made to further get tighter control over the system. The results will be further savings in energy consumption.

Training a Metals Processing Facility and Achieving Savings

One example occurred at a metals processing facility in the Cleveland area. The maintenance manager attended one of our compressed air system seminars, which we periodically provide to maintenance personnel, supervisors and plant engineers, to provide an overview on compressed air systems. He recognized several inefficiencies in the existing system and was intrigued by the possibility of cutting operating costs, so he invited our engineers in for a consultation.

The existing compressor system consisted of two 100 horsepower machines using modulation control, had little air receiver storage volume and had a refrigerated dryer with extensive filtration. There was no coordination of the two machines, except for staggered pressure switch settings. Timed solenoid drains and motorized ball valves were the drains of choice.

The Compressed Air Audit

Our engineers recommended a supply-side audit that included pressure, flow and kilowatt measurements, and the testing was performed over the subsequent few weeks.

The flow data showed an average air demand of 350 cfm, with a base-line flow of 275 cfm. Periodic spikes in demand caused the second compressor to start multiple times daily. Pressure data revealed that the pressure supplied to the plant varied widely, between 95 psig and 120 psig, while compressor discharge pressures varied between 110 and 125 psig. Power data confirmed the expected performance of the modulation-controlled compressors, with large changes in air flow being accompanied by only small variations in power consumption.

CASCO USA

Before a Compressed Air Audit by CASCO USA

Physical examination of the customer's compressed air usages showed no need for the extensive level of filtration currently in use, and no need for pressure above 90 psig. Plant distribution piping was also examined, and found to be sufficient in size and layout, with only a few modifications recommended.

After reviewing this data, our engineers worked with the customer to determine the causes of the high base-load air usage and the demand spikes. It was determined that certain processes ran continuously, requiring a consistent usage of compressed air, but at far lower levels than were measured during week-ends and off shifts. Furthermore, it was determined that the periodic bursts of air usage were caused by compressed air vacuum systems used to periodically empty chemical containers.

The Air Leak Survey

After a leak detection survey, using ultrasonic detection equipment, the base load usage was reduced by nearly 50%. Based on the air demand profile and accounting for the reduction in air leak demand, several options were considered for the customer's new system, including variable speed and constant speed compressor systems. The performance of each of the considered systems was then modeled compared to the customer's demand profile and the most flexible and efficient system was selected.

This system consisted of three 50 horsepower constant speed machines, using auto dual control (load/unload with shutdown after time-delay). Ancillary equipment included 2 receiver tanks, a cycling refrigerated air dryer, an oil removal filter and a master controller to efficiently coordinate the machines.

Results of the Compressed Air Audit

Since the base air usage was significantly reduced, a single 50 horsepower machine efficiently meets the demand on/off shifts, and 2 meet the entire demand during peak load events. The third machine serves as backup and the 3 are automatically rotated for even accumulation of hours by the master control system.

The master controller also maintains air pressure to the plant within a 4 psig band while running only the compressors necessary to meet the demand. This tight pressure band translates to lower average pressure to the plant, lower loss to air leaks and lower power requirement of the compressors. Since the control point is after the air treatment devices, plant pressure remains consistent, even as filters get dirty.

With the revised air treatment equipment, there are fewer filters to become clogged, minimizing pressure drop. Since the high levels of filtration were found to be more than required, 2 filters were eliminated. This will keep pressure at the compressors 5 to 15 psig lower than was previously possible. Additionally, the thermal mass cycling air dryer will match dryer energy consumption to air usage.

The low-pressure drop aluminum piping system also served to reduce pressure drop, and provided a quick, clean installation.

The combined effect was a savings of more than 45% (341,000 kilowatt hours annually), equating to nearly $24,000 savings in energy and demand charges annually.

An added benefit with air-cooled compressors is that the discharge cooling air can be recovered for heating purposes. The old system was not utilizing this valuable utility. The heated discharge cooling air was simply vented to atmosphere all year round. CASCO's engineers pointed out that 94% of the input kW can be recovered for space heating in the winter months. With three (3) 50 hp (37kW) compressors, the potential heat generation was over 355,000 BTU/hr. This amount of heat would be enough to cut heating bills considerably. The ductwork was then designed to take advantage of this heat generation in the winter months and vented to atmosphere when not needed

After the Air Audit Energy Savings of $24,000 per Year Were Realized

CASCO USA

(Continued from page 38.)

Inside Sales and Service Support Staff Provides Knowledgeable Customer Service

Application Engineers Assist Customers With Air Audits and System Design

CABP — Please detail your focus on training customers and employees on air system efficiency.

JM — Training has been our key to success. Having a knowledgeable staff that knows the dynamics of compressed air systems and the capability of the products we offer allows us to better serve and retain our customers now and for the foreseeable future. Our emphasis on hiring and training employees is in engineering and field customer service. Our staff has a considerable number of years in the business and we all share a strong belief in integrity that is conveyed to our customers. We give our customers explanations of their options and recommend solutions that will meet or exceed their expectations.

Our training also extends to our customers. Like the commercial says, an educated customer is your best customer. CASCO USA conducts well-attended customer seminars on the generic best practices to implement for energy conservation and air system management. Our customer feedback on these seminars has been tremendous and we will continue to hold these training seminars for the foreseeable future.

We hold regular training seminars for our current and future customers on compressed air system design to 1,000 psig and for applications involving pressures from near-total vacuum on up to 6,000 psig. We also have the same capabilities for water chillers and various types of fluid pumps.

Our Company staff includes 20 field service technicians who are all factory certified to troubleshoot, repair and maintain our company product lines. Our technicians are certified and licensed in refrigeration repair and refrigerant recovery. Our installation teams install state of the art "Smart Pipe" which is extruded aluminum from Kaeser Compressors. Smart Pipe is highly durable, corrosion resistant, easy to install, attractive in appearance and, best of all, is lowest in overall costs, installed. We also utilize and install copper, stainless steel, and when appropriate, schedule 40 or 80 black iron.

CABP — Please describe your application engineering and inside sales efforts.

JM — We employ application engineers at each facility to assist our sales and service staff as well as our customers with solutions to problems and system design criteria. Our engineers have decades of experience in air system auditing using state of the art equipment such as 3D solid modeling CAD packages, insertion thermal mass and differential type flow meters, power meters, data loggers and air leak detection devices. We provide these auditing and design services in order to provide the customer with the information needed to determine the correct amount of compressed air, at the correct air quality, with the lowest amount of energy consumption and, at the best price.

Our inside sales and service support staff provides knowledgeable customer service on repair and maintenance parts, PM Service Agreements and aftermarket system accessories.

CABP — Thank you CASCO USA for your insights.

For more information please contact Jim Miller, CASCO USA, tel: 724-746-6500, email: j.miller@cascousa.com

Wall Street Watch

BY COMPRESSED AIR BEST PRACTICES

The intent of this column is to provide industry watchers with public 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 gathered, in this column, was on September 3, 2007.

Atlas Copco, August 29, 2007 — Atlas Copco agrees to divest some assets of Prime Industrial Rentals in Australia to Coates Hire Limited, in order to focus the operations on specialty rentals for industrial applications.

The assets divested are predominantly generators and air compressors, as well as 4 branches with 52 employees. As part of the transaction, Atlas Copco will acquire Coates's fleet of oil-free air compressors. "This agreement will allow Prime to focus on the future development of specialty rentals in Australia, where we have seen increasing demand," says Ronnie Leten, President of Atlas Copco's business area Compressor Technique. "It will bring Prime further in its profitable growth strategy to develop applications for industrial and oil and gas customers, with a special focus on oil-free and high-pressure air." Prime Industrial Rentals will continue to operate as part of Atlas Copco's division Specialty Rental.

On August 6, 2007, Atlas Copco announced it will invest about MSEK 160 (MEUR 17) to expand its site in Cologne, Germany, the company's main production facility for turbo compressors and expansion turbines. The initiative is aimed at cutting delivery times to customers and increasing production capacity.

The capacity expansion, which supports the Atlas Copco Gas and Process division in meeting growing demand for large compressors, will be achieved through extending production and test facilities, office and warehouse spaces and improving the production flow of the factory. It adds to ongoing substantial investments in high-tech machinery and will be completed in 2009. "With a market that is currently very strong, this investment will help us meet both the present and future needs of our customers," says Ronnie Leten, President of Atlas Copco's Compressor Technique business area. "By investing into our German hub, we further strengthen our design and manufacturing expertise, leading to a higher degree of flexibility." Atlas Copco's Gas and Process division supplies custom-made compressors and expanders for air separation, gas-fired power stations, liquid natural gas applications and petrochemical companies. It won a record number of orders in 2006, helped by strong demand from Asia and the Middle East. During the second quarter of 2007, the division delivered the biggest compressor ever built by Atlas Copco, weighing 200 tons.

SEPTEMBER 3, 2007 PRICE PERFORMANCE	SYMBOL	LAST PRICE	1 MONTH	6 MONTHS	12 MONTHS
Parker-Hannifin	PH	$107.47	8.9%	30.5%	45.1%
Ingersoll Rand	IR	$51.93	3.2%	19.9%	36.6%
Gardner Denver	GDI	$39.91	- 4.0%	17.9%	11.0%
United Technologies	UTX	$74.63	2.3%	13.7%	19.0%
Donaldson	DCI	$38.18	4.9%	6.5%	14.4%
EnPro Industries	NPO	$41.79	6.1%	10.1%	32.9%
SPX Corp	SPW	$90.05	- 4.1%	28.7%	70.5%

WALL STREET WATCH

CHARLOTTE, NC — August 1, 2007 — SPX Corporation (NYSE:SPW) reported results for the second quarter that ended June 30, 2007:

- Revenues increased 22.4% to $1.28 billion from $1.04 billion in the year-ago quarter.
- Segment income and margins were $150.4 million and 11.8%, compared with $112.1 million and 10.8% in the year-ago quarter. The increase in segment income and margins was driven primarily by increased demand for the company's power and energy infrastructure products.
- Diluted net income per share from continuing operations (the basis of the company's guidance) was $1.26, compared with $1.06 in the year-ago quarter.
- Net income was $63.9 million, or $1.12 per share, compared with $110.3 million, or $1.83 per share in the year-ago quarter. The year-ago quarter included a gain on the sale of discontinued operations of $43.8 million ($0.73 per share) and a benefit from the settlement of certain tax matters of $34.7 million ($0.58 per share).
- Net cash from continuing operations was $88 million, compared with a cash use of $28.2 million in the year-ago quarter. Free cash flow from continuing operations* was $69 million, compared with a negative $41.8 million in the year-ago quarter.

Revenues in the second quarter for the SPX FLOW TECHNOLOGY SEGMENT (including Dehydration) of 2007 were $303.5 million compared to $239 million in the second quarter of 2006, an increase of $64.5 million, or 27%. The increase was due to organic revenue growth of 13.2%, growth from the fourth quarter 2006 Custos acquisition of 11.2% and currency fluctuations of 2.6%. The organic growth was related primarily to continued strong demand in the power, mining, oil and gas and dehydration markets.

Segment income was $45.2 million, or 14.9% of revenues, in the second quarter of 2007 compared to $34.6 million, or 14.5% of revenues, in the second quarter of 2006. The increase in segment income and margins was due primarily to the organic growth noted above and efficiencies achieved from continuous improvement initiatives.

Chris Kearney, Chairman, President and CEO said, "Our second quarter results were strong, as we achieved or exceeded our operating targets for organic growth, margin improvement and earnings, building on the strong trends in the first quarter."

Kearney continued, "We also delivered $69 million in free cash flow, a solid year-over-year improvement and a good indicator of high quality earnings."

Order trends in our primary global infrastructure end markets, particularly power and energy, remain strong, and our operating execution in these markets continues to improve. Based on these factors and our first half performance, we expect to achieve our updated full year earnings guidance range of $4.50 to $4.70 per share," Kearney concluded.

CLEVELAND, August 1, **Parker Hannifin Corporation** (NYSE: PH), reported that for the 2007 fiscal year, the company surpassed $10 billion in sales for the first time in its 89-year history. Sales reached a record $10.7 billion, an increase of 14.2% from $9.4 billion in the previous year. Income from continuing operations increased 30% to $830 million compared to $638.3 million a year ago, and earnings per diluted share from continuing operations increased 32.8% to $7.01 compared to $5.28 a year ago. Cash flow from operating activities reached a record $955 million, or 8.9% of sales.

For the fourth quarter of fiscal 2007, sales increased 9.8% to $2.9 billion, compared to $2.6 billion in the same period last year. Fourth quarter income from continuing operations increased 15.6% to $217.2 million compared to $187.9 million a year ago, and fourth quarter earnings per diluted share from continuing operations increased 18.7% to $1.84 from $1.55 a year ago.

"I want to thank our employees for their continued commitment to premier customer service, profitable growth and financial performance," said Chairman, CEO and President Don Washkewicz. "These three pillars of Parker's Win Strategy enabled us to deliver record quarterly and annual results for our shareholders."

"In surpassing the $10 billion sales milestone, we continue to demonstrate our propensity to grow. Our compound annual growth rate over the last 35 years is in excess of 11%. This year, we grew by more than 14%, or more than three times GDP. This exceeded our Win Strategy goal to grow both organically and through disciplined acquisitions at a 10% compound annual rate. Of the 14% growth, 5% was organic, 6% was from strategic acquisitions, and the remainder was from the effects of foreign currency exchange rates. We're especially pleased with gains we've made in our Industrial International segment, where revenues grew by 34% and operating income grew by 51%. Margins in this segment also reached an all time high and continue to approach those in our North American segment. Overall, our revenues and profits are more balanced regionally than ever before, which speaks to the growing demand around the world for our motion and control technologies. By executing our Win Strategy, we delivered record earnings per share in the quarter and for the year. Total shareholder return for the year was 28%, or 35% higher than the S&P 500, and our return on invested capital remains at the top quartile among our peers."

"We also generated close to $1 billion in annual cash flow from operating activities, which allowed us to both maintain our strong balance sheet and use cash wisely to invest in our company. We continued to invest in strategic acquisitions this year, purchasing eleven companies that added nearly $260 million in annualized revenues. We spent $433 million to repurchase 5.4 million shares, and we made discretionary contributions of $161 million to our pension funds. In fiscal 2007, we increased dividends 13%, paying out approximately $121 million to shareholders, maintaining our dividend increase record that spans 51 years."

Parker Segment Results

In the Industrial North America segment, fourth-quarter sales decreased 1.6% to $1.1 billion, and operating income decreased 0.4% from the prior year to $164.6 million. For the full year, Industrial North America sales increased 1.8% to $4.1 billion, and operating income increased 0.2% from the prior year to $598.4 million.

In the Industrial International segment, fourth-quarter sales increased 30.3% to $1.1 billion, and operating income increased 34.9% from the prior year to $143.4 million. For the full year, Industrial International sales increased 34.4% to $3.9 billion, and operating income increased 50.7% from the prior year to $533.1 million.

WEEC
WORLD ENERGY ENGINEERING CONGRESS

REVIEW OF THE WORLD ENERGY

BY ROD SMITH

30th ANNIVERSARY Established 1977
aee
Three Decades of Achievement

Compressed Air Best Practices Magazine has been fortunate to collaborate with the Association of Energy Engineers (AEE) since we began publishing. We have been mailing our publication to the AEE's 8,500 members since inception and have now had a booth for the past 2 years at the World Energy Engineering Conference (WEEC — held August 15–17 in Atlanta). AEE members have embraced our editorial mission "to reduce energy costs associated with compressed air." We greatly appreciate their support and efforts to make a difference in reducing energy consumption and costs. We consider AEE members to be our core readership.

The WEEC is an annual reunion of professionals working to make a difference in energy costs. This year the WEEC celebrated the 30th anniversary of the AEE. The visitors to the Compressed Air Best Practices booth include the three key parties required to successfully execute energy-saving projects in compressed air systems: managers from industrial facilities using air, utility executives and compressed air industry professionals.

Titles of Difference-Makers

- Manager of Continuous Improvement
- Energy & Utility Manager
- Engineer, Energy & Utility Services Group
- Engineer, Power & Utilities Technology
- Regional Facilities Manager
- Special Projects Engineer
- Energy & Utilities Coordinator
- Global Energy Program Manager
- Papermaking Energy Owner
- Manager – Energy
- Energy Specialist
- Construction Innovation Manager

Industrial Facilities

The knowledge and impact potential of the AEE members representing industry is impressive. Major corporations have established engineering teams with varying creative titles whose objective is to drive down energy costs in the multiple facilities of the corporation. These visitors to our booth appreciate the importance of the compressed air system and are working to optimize them.

I held in-depth conversations about compressed air systems with the gentlemen whose titles are in Table 1 of this article. Some have been working successfully with some nationally recognized compressed air auditors for many years. Many discovered through these audits that they saved $300,000 to $400,000 per year in their large facilities. One gentleman had contracted to have 6 audits performed at 6 of his facilities. He was disappointed, however, with the lack of analysis of his constituents of demand in the audit reports. He felt the report had told him what he already knew about issues on the supply-side and with leaks. "Auditing" continues to varying in quality in our industry.

ENGINEERING CONFERENCE

Another black-belt process engineer was excited about the compressed air leak reduction program he had implemented, netting an estimated $400,000 per year in energy savings. We discussed his next objective to replace a 30-year-old 700 horsepower reciprocating air compressor. The compressor employs a full-time maintenance person and also has no air treatment installed after it. The air system traverses acres of buildings and no analysis has been done on pressure drop. It was interesting to hear how he described the "old-guard establishment" in his company, which he has to battle to get them to consider modernizing this old, inefficient system.

The Utility Companies

One of the big successes of the Compressed Air Challenge, in my opinion, has been the involvment and education of the utility companies on the energy-saving opportunities in compressed air systems. Ken Nathanson from ConEdison Solutions and executives from many other utilities stopped by to discuss compressed air systems. It is impressive how knowledgeable they are about compressed air systems and how excited they are to provide rebate financing aimed at making a difference in the energy costs of the system.

It is clear to me that the utility companies are a major factor in a regions ability to implement and finance energy-saving projects in factories. A knowledgeable utility executive who can discern a valid compressed air energy-saving project from a "wishful-thinking" project can make a huge difference. There is a need for this expertise at the utility company, which administers rebate. I have heard of some utility companies who have abandoned compressed air rebates because, unfortunately, some projects still prioritize selling equipment over saving energy. The utility companies who do have a knowledgeable manager on compressed air systems can identify compressed air auditors who only present projects with real savings opportunities.

ADVERTISER INDEX

REVIEW OF THE WORLD ENERGY ENGINEERING CONFERENCE

The Compressed Air Industry

The third party required to implement compressed air efficiency projects is of course the compressed air industry. Our industry can (and does) deliver the capability to audit a compressed air system, manufacture efficient equipment and install/service the compressed air system for optimal performance. Aside from Compressed Air Best Practices Magazine, the WEEC featured exhibits by Kaeser Compressor and Motivair Corporation. Kaeser's booth focused on energy management and Kaeser's own Mr. Wayne Perry taught people how to manage multiple air compressors using their SAM (Sigma Air Manager) technology, which was at the booth. Mr. Graham Whitmore, of Motivair, presented both large-volume air dryers and cooling units. Motivair embraces customized projects for large-scale applications where energy efficiency opportunities exist.

The opportunity exists for more involvement from our industry. The visitors to our booth have requested that we expand the scope of the magazine to include vacuum, blowers and pneumatics. While we currently provide occasional articles, we are considering going deeper into this in 2008. The visitors were also looking for companies who can assist with demand-side analysis. I would invite manufacturers to contact the AEE (Ted Kurklis — www.aeecenter.org) for more information on ways to work with AEE members.

Conclusion

Speaking with managers at Kraft, General Motors, Ford, Toyota, Honda, Chrysler, CITGO, Sunoco, P&G, Coca Cola, ArcelorMittal, Merck, Robins AFB, Kimberly-Clark, Millipore, Michelin and Cooper Tire (to name a few) was very fulfilling for me. Compressed air is an area of which they are very aware and all feel that tremendous opportunities exist. The WEEC provides them with a venue to share and explore ideas on how to meet their energy management goals. I commend the AEE for their educational efforts and leadership. When the three parties work together, industrial facilities, utility companies and the compressed air industry, rewarding energy-saving projects are realized.

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

INDUSTRY NEWS

Press Releases

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JOB MARKET

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Compressed Air Best Practices

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