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May 2007

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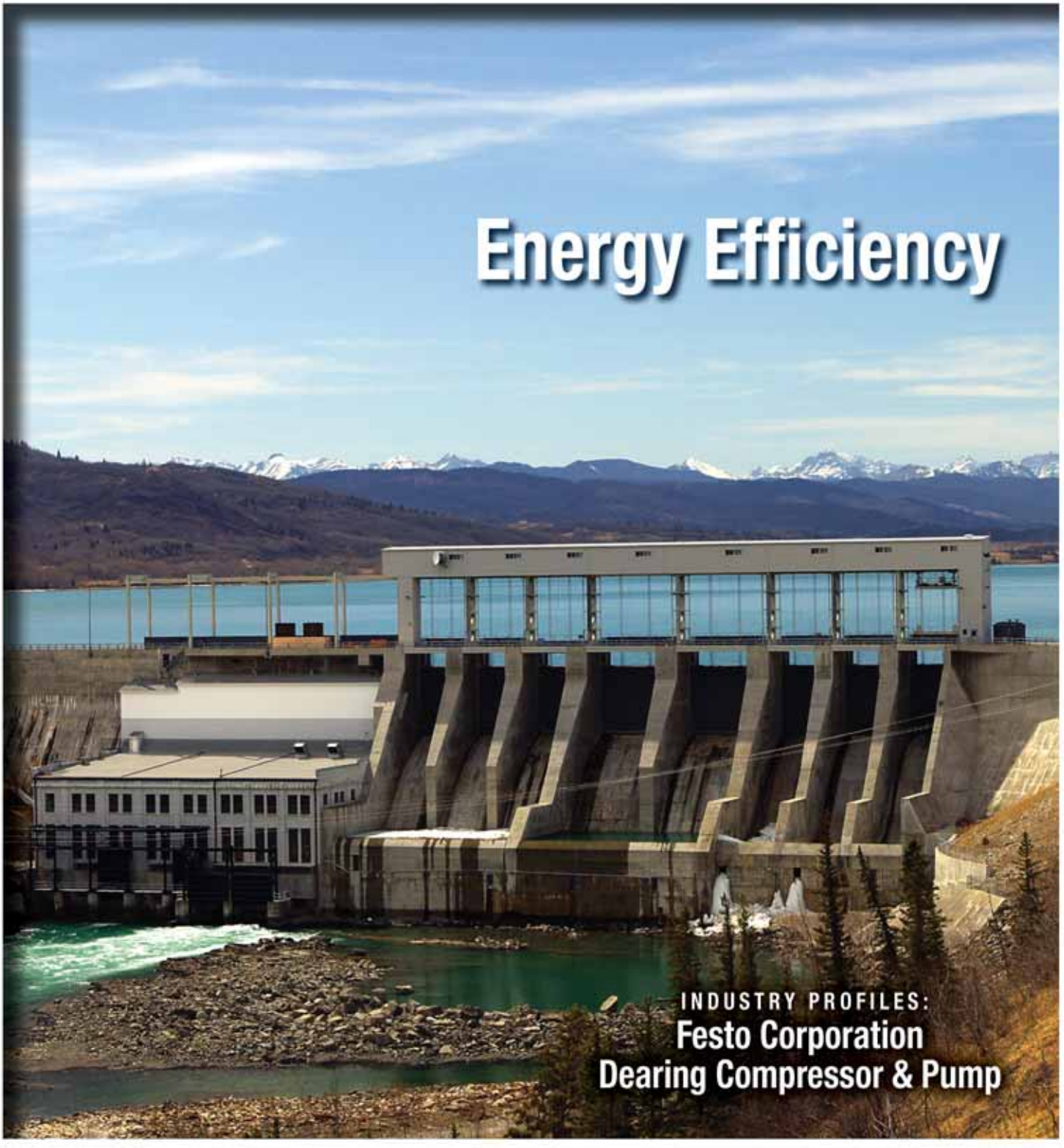

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FROM THE EDITOR

Building a Virtual Dam

Rob Armstrong, of **Manitoba Hydro,** said it quite simply when I asked him why a utility company invests so many resources in encouraging industrial customers to save energy. "Investing in building a virtual dam is more cost-effective than building a real one." Not to mention helping customers "entrench" themselves in markets by being cost-effective manufacturers. Not to mention being environmentally friendly. This truly embodies the Win/Win scenarios for businesses investing in reducing energy costs. We share in this edition Manitoba Hydro's ground-breaking efforts to reduce industrial energy costs related to compressed air.

It sometimes takes an amazing amount of coordination to make energy-saving projects a reality. **Tom Osborn** of the **Bonneville Power Administration** walks us through how the Boise Building Solutions Studmill in Oregon was able to implement a energy-saving project. The article describes how BPA initiated scoping studies, worked with the local utility company (**Oregon Trail Electric Consumers Co-op**) to secure project financing, and engaged a DOE Compressed Air Challenge consultant (**Jeff Yarnall** of **Rogers Machinery**) to perform a detailed energy efficiency analysis of the system.

Variable Speed Drive (VSD) air compressors are now having a very positive impact on energy savings in compressed air systems in North America. In this edition, **Frank Moskowitz** reviews the benefits of VSD and also provides guidance on how to apply (and on how not to apply) VSD air compressors. We also provide a profile of **Dearing Compressor & Pump,** which has been working with VSD gas engine drives since the early 1990s. They share some of their expertise on VSD air compressors with us in the article.

What we here at Compressed Air Best Practices consider a significant event is written about in our interview of **Festo Corporation.** Festo has taken the unprecedented step of offering end users and OEMs an Air Service Program that focuses on **reducing air consumption at the point of use** where the pneumatic components are located. As a global leader in manufacturing pneumatic components, Festo is uniquely capable of advising customers on what the optimal air requirements are for the pneumatic systems. This new strategy from Festo represents a significant first step in unifying demand-side and supply-side experts in compressed air systems.

ROD SMITH

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www.airbestpractices.com

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

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

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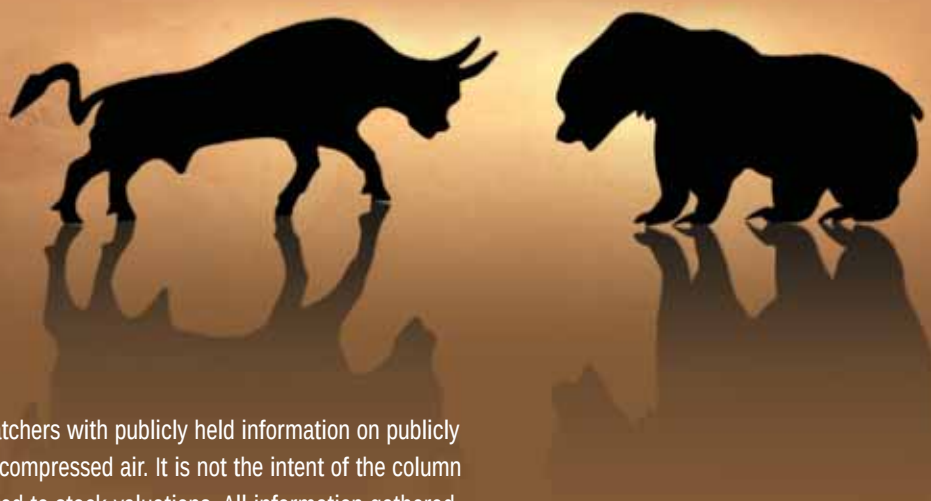
Wall Street Watch

BY COMPRESSED AIR BEST PRACTICES



The intent of this column is to provide industry watchers with publicly held information on publicly held companies involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information gathered in this column was during the trading day of April 17, 2007.

Donaldson Company (NYSE:DCI) announced on Feb. 22, 2007, record second quarter diluted earnings per share ("EPS") of $.38, up from $.32 last year. Net income was $31.3 million, versus $26.9 million last year. Sales were a record $463.7 million, up from $392.9 million in fiscal 2006. For the six month period, EPS was another record at $.81, up from $.69 last year. Net income increased 14 percent to $67.3 million compared to $59.1 million last year.

WALL STREET WATCH

Sales were a record $910.2 million, up 14 percent from $796.3 million in fiscal 2006. "Sales growth was very strong during the quarter, supporting our outlook for another record year," said **Bill Cook, Chairman, President, and CEO**. "Our sales were especially good in Europe and Asia, where solid economic conditions and our well-developed market presence combined to deliver growth in excess of 25 percent in both regions. Our year-to-date operating margin of 10.6 percent compares favorably to 10.2 percent a year ago. Global economic conditions remain healthy for most of our businesses, giving us confidence in delivering our 18th consecutive year of record earnings."

Donaldson Income Statement Discussion

Translated at constant exchange rates, sales increased $56.9 million, or 14.5 percent, during the quarter and $95.7 million, or 12.0 percent, year-to-date. The impact of currency translation increased the reported sales growth to $70.8 million, or 18.0 percent, for the quarter and to $113.8, or 14.3 percent, for the year. The impact of foreign currency translation increased reported net earnings by $1.7 million in the quarter and $2.5 million year-to-date. Gross margins of 30.5 percent for the quarter and 31.3 percent year-to-date compare to prior year margins of 31.8 percent and 32.2 percent for the same periods. During the first half of the fiscal year, we have brought on new distribution capacity while customer demand ramped up beyond our expectations, leading to higher than expected distribution costs. Over the next few quarters, we will be making investments in people, processes, and technology to further optimize our distribution capabilities. Gross margin was also impacted by a higher mix of system sales versus replacement parts during the quarter. Operating expenses for the quarter were 21.2 percent of sales, down from 22.1 percent in the prior year. Our second quarter included $2.5 million for the majority of our annual stock option expense, compared to $2.2 million last year. Operating expenses for the year were 20.7 percent of sales, down from 22.0 percent last year. The effective tax rates of 25.6 percent for the quarter and 28.7 percent year-to-date compare to 28.4 percent and 27.5 percent for the same periods of the prior year. The lower tax rate in the quarter is primarily due to the impact of the reinstatement of the Research and Experimentation Tax Credit retroactive to January 1, 2006. As a part of our ongoing share repurchase program, we repurchased 1,660,100 shares during the quarter for $58.2 million. Year-to-date, we have repurchased 1,759,800 shares for $61.9 million.

Donaldson Outlook

Engine Products: We continue to expect mid-single digit percent full year sales growth in fiscal 2007, including the impact of the projected NAFTA new truck production decline.

- NAFTA heavy-duty truck build rates are expected to decrease significantly with the implementation of the new EPA diesel emission standards. We expect our NAFTA truck product related sales to decrease $30 to $35 million during the second half of fiscal 2007, compared to the second half of fiscal 2006.
- Strong international conditions are expected to continue in the production of new construction and mining equipment by our OEM customers. NAFTA non-residential and public construction markets are expected to remain healthy.
- Both our NAFTA and international aftermarket sales are expected to continue growing with strong equipment utilization, the ongoing growth by our OEM customers of their replacement parts business, and the increasing amount of equipment in the field with our PowerCore™ filtration systems.

Industrial Products: We expect low- to mid-teens percent sales growth in fiscal 2007.

- Our industrial filtration sales are expected to continue growing as a result of the healthy global manufacturing investment and production utilization conditions.
- Our full year gas turbine sales should continue rebounding with our full year sales increasing approximately 20 to 25 percent over last year. Strength is seen in both the international power generation and the global oil and gas segments we serve.
- Conditions for our special applications products are expected to remain good due to continued strength in our global end markets.

Other:

- Our tax rate is expected to be 28 to 30 percent for the full year although our rate will vary by quarter due to country earnings mix and discrete events.
- We expect our full year fiscal 2007 EPS to be between $1.72 and $1.82 per share.

WALL STREET WATCH

APRIL 17, 2007 PRICE PERFORMANCE	SYMBOL	LAST PRICE	PRICE CHANGE YTD	52-WEEK HIGH	52-WEEK LOW	BETA
Parker-Hannifin	PH	$90.00	16.5%	$89.59	$69.70	1.25
Ingersoll Rand	IR	$44.81	14.9%	$49.00	$34.95	1.47
Gardner Denver	GDI	$36.52	-1.6%	$40.73	$29.77	1.06
United Technologies	UTX	$65.90	5.2%	$69.49	$56.87	0.69
Donaldson	DCI	$35.20	0.8%	$38.97	$30.16	0.97
EnPro Industries	NPO	$37.44	14.3%	$40.70	$29.28	1.88
SPX Corp.	SPW	$70.53	15.8%	$72.18	$50.47	1.09

Parker-Hannifin Corporation (NYSE: PH), reported on April 4, 2007, an increase of 3 percent in total orders for the month of March compared to the same month a year ago. Orders are calculated as a percentage increase over the prior year using a daily average. The company derives orders from a wide variety of global end that which the company serves directly and through a network of thousands of distributor locations.

In addition, Parker reported the following orders by operating segment:

- Orders in the Industrial North America segment decreased 2 percent versus March a year ago.
- Orders in the Industrial International segment increased 15 percent versus March a year ago.
- Orders in the Aerospace segment increased 2 percent on a rolling 12-month average basis.
- Orders in the Climate and Industrial Controls segment decreased 15 percent versus March a year ago.

EnPro Industries (NYSE:NPO) reported on April 13, 2007, Garlock Klozure®, a Division of Garlock Sealing Technologies, announced that it has acquired the Syntron RP Mechanical Seal line from FMC Technologies, Inc. "The Syntron acquisition extends Garlock Klozure's dynamic sealing portfolio for today's industrial process market," says Tim Magill, Product Manager. "While growing the breadth of our dynamic sealing products, this mechanical seal fits well with our strategic direction." The Syntron RP seal is a small, cartridge-type, double seal used to seal fluids and gases on various rotating equipment such as pumps, compressors and mixers. The seal itself is constructed of brass or stainless steel, with flexible drive rings and lapped seal faces. "Garlock Klozure provides critically important fluid sealing solutions to core industrial markets. Our engineered solutions are key in a broad range of services in the chemical processing, power generation and primary metals industries," explains Magill. "Syntron RP seals add to the solutions our customers can expect from Garlock Klozure." The Syntron mechanical seal line and associated assets have relocated to Garlock Klozure's new, multi-million dollar facility in Palmyra, New York.

Donaldson Company (NYSE:DCI) announced on March 1, 2007, it has acquired 100 percent of the shares of Aerospace Filtration Systems, Inc. ("AFS") from Westar Aerospace and Defense Group, Inc. Terms of the acquisition were not disclosed.

AFS, based in St. Charles, Mo., is the industry leader in designing, developing and manufacturing high-performance air filters for commercial and military aircraft. AFS had annual sales of approximately $18 million in calendar year 2006.

"The acquisition of AFS complements our existing aerospace filtration business well," said **Lowell Schwab, Senior Vice President, Engine Systems and Parts.** "Donaldson and AFS have already worked jointly over the last year to apply our media technology to AFS's military and commercial aircraft systems. The acquisition of AFS allows us to further combine our filtration and manufacturing capabilities with AFS's strong market position."

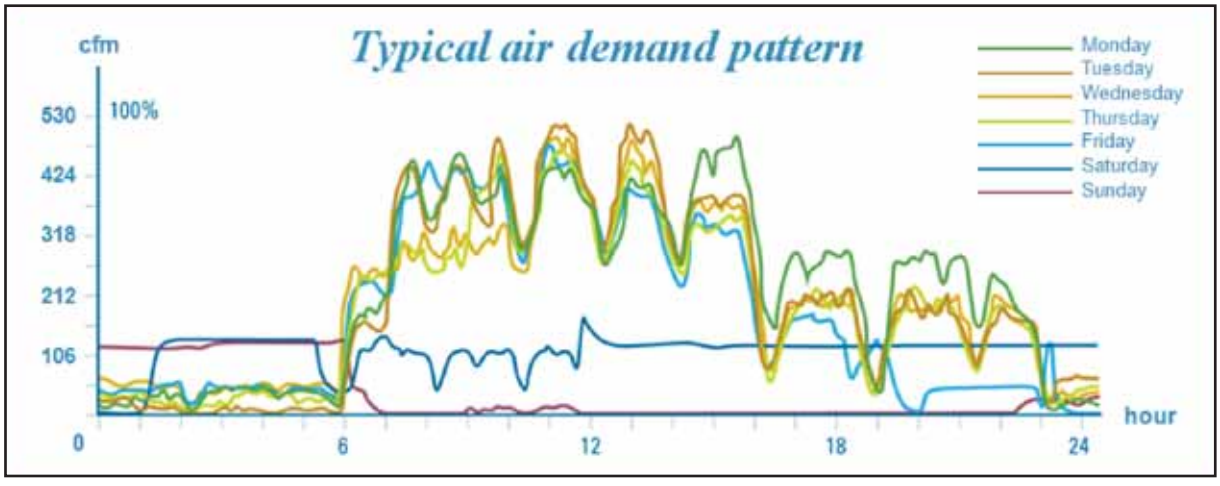
Headquartered in St. Louis, Mo., Westar Aerospace and Defense Group, Inc. is a systems engineering contractor with more than 1,200 professionals around the world, dedicated to providing high-value engineering, software solutions, logistics and IT support services to the U.S. Department of Defense, allied governments and select commercial customers. Westar was a wholly owned subsidiary of UK-based QinetiQ (LSE:QQ), an international defense and security technology company with approximately 2,500 employees in the U.S.

SAVING energy WITH A VSD Compressor

BY FRANK MOSKOWITZ

Compressor controls are designed to "*match the compressed air supply with system demand*" and are one of the most important influences on overall system energy efficiency. Proper control is essential to efficient system operation and high performance. The objective of any control strategy is also to shut off unneeded compressors or delay bringing on additional compressors until needed. All units that are operating should be run at full-load, except one unit for trimming. Key word in this last sentence is "one unit for trimming." End users have the choice to pick any type of compressor for trimming. Sometimes their decision is energy efficient and sometimes not. This article will discuss the more popular VSD compressor and hopefully shed some more light on how it fits into the mix with other types of compressors and controls.

Compressor systems are typically comprised of multiple compressors delivering air to a common plant air header. The combined capacity of these machines is generally sized to meet the maximum plant air demand. System controls are almost always needed to orchestrate a reduction in the output of the individual compressor(s) during times of lower demand. Compressed air systems are usually designed to operate within a fixed pressure range and to deliver a volume of air that varies with system demand. System pressure is monitored and the control system decreases compressor output when the pressure reaches a predetermined level. Compressor output is then increased again when the pressure drops to a lower predetermined level.



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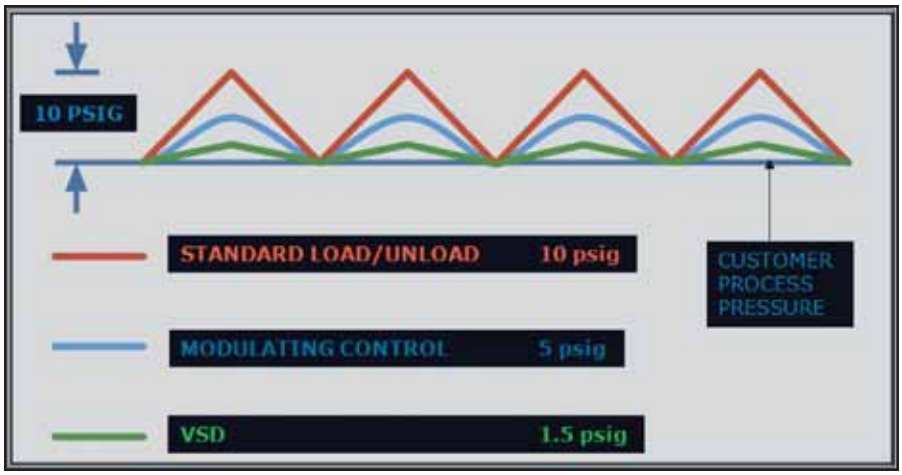
SAVING ENERGY WITH A VSD COMPRESSOR

In most applications, the consumption of compressed air is characterized by significant fluctuations as pictured in the chart at right. Conventional controls will either load and unload a compressor or throttle the intake to keep pace with the demand patterns. This wastes energy.

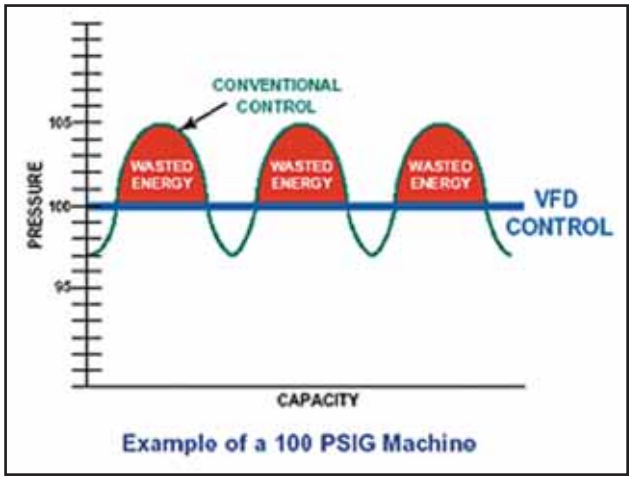


A VSD control on the other hand varies the speed of the compressor motor and closely follows the changes in the load patterns. This control is the most efficient and saves energy for the users.

The difference between these two pressure levels is called the control range. Depending on air system demand, the control range can be anywhere from 2 to 20 psi. Pictured above is a 10 psig control range. Most compressor pressure control set points maintain pressures higher than needed to ensure that the compressor discharge pressure, after cleanup, will not go below the minimum requirements for the system. A variable speed compressor, as shown above will maintain:

- Stable compressed-air delivery pressure
- No energy waste
- No pressure overshoots

A rule of thumb for systems in the 100 psig range is for every 2 psi increase in discharge pressure, energy consumption will increase by approximately 1 percent at full output flow. So we can see why holding a single setpoint pressure is more economical than riding up and down the control range. There is also another penalty for higher-than-needed pressure. Raising the compressor discharge pressure increases the demand of every unregulated usage, including leaks, open blowing, etc. Although it varies by plant, unregulated usage is commonly as high as 30 to 50 percent of air demand. For systems in the 100 psig range with 30 to 50 percent unregulated usage, a 2 psi increase in header pressure will increase energy consumption by about another 0.6 to 1.0 percent because of the additional unregulated air being consumed. The combined effect results in a total increase in energy consumption of about 1.6 to 2 percent for every 2 psi increase in discharge pressure for a system in the 100 psig range with 30 to 50 percent unregulated usage.



Example of a 100 PSIG Machine

Controls and System Performance

Few air systems operate at full-load all of the time. Part-load performance is therefore critical, and is primarily influenced by compressor type and control strategy. The type of control specified for a given system is largely determined by the type of compressor being used and the facility's demand profile. If a system has a single compressor with a very steady demand, a simple control system may be appropriate. On the other hand, a complex system with multiple compressors, varying demand and many types of end uses will require a more sophisticated strategy. In any case, careful consideration should be given to both compressor and system control selection because they can be the most important factors affecting system performance and efficiency.

> "End users have the choice to pick any type of compressor for trimming."

Individual Compressor Control Strategies

Over the years, compressor manufacturers have developed a number of different types of control strategies. Controls, such as start/stop and load/unload, respond to reductions in air demand, increasing compressor discharge pressure by turning the compressor off or unloading it so that it does not deliver air for periods of time. Modulating inlet and multi-step controls enable the compressor to operate at part-load and deliver a reduced amount of air during periods of reduced demand.

Start/Stop — Start/stop is the simplest control available and can be applied to either reciprocating or rotary screw compressors. The motor driving the compressor is turned on or off in response to the discharge pressure of the machine. Typically, a simple pressure switch provides the motor start/stop signal. This type of control should not be used in an application that has frequent cycling, because repeated starts will cause the motor to overheat and other compressor components to require more frequent maintenance. This control scheme is typically only used for applications with very low-duty cycles for compressors in the 30 horsepower (hp) and under range. Its advantage is that power is used only while the compressor is running, but this is offset by having to compress to a higher receiver pressure to enable air to be drawn from the receiver while the compressor is stopped.

SAVING ENERGY WITH A VSD COMPRESSOR

Load/Unload — Load/unload control, also known as constant-speed control, enables the motor to run continuously, but unloads the compressor when the discharge pressure is adequate. Compressor manufacturers use different strategies for unloading a compressor, but in most cases, an unloaded rotary screw compressor will consume 15 to 35 percent of full-load horsepower while delivering no useful work. As a result, some load/unload control schemes can be inefficient.

Modulating Controls — Modulating (throttling) inlet control enables the output of a compressor to be varied to meet flow requirements. Throttling is usually accomplished by closing the inlet valve, thereby restricting inlet air to the compressor. This control scheme is applied to centrifugal and lubricant-injected rotary screw compressors. This control method cannot be used on reciprocating or lubricant-free rotary screw compressors and when applied to lubricant-injected rotary screw compressors, is an *inefficient* means of varying compressor output. When used on centrifugal compressors, more efficient results are obtained, particularly with the use of inlet guide vanes, which direct the air in the same direction as the impeller inlet. However, the amount of capacity reduction is limited by the potential for surge and minimum throttling capacity.

Inlet-valve modulation used on lubricant-injected rotary air compressors enables compressor capacity to be adjusted to match demand. A regulating valve senses system or discharge pressure over a prescribed range (usually about 10 psi) and sends a proportional pressure to operate the inlet valve. Closing (or throttling) the inlet valve causes a pressure drop across it, reducing the inlet pressure at the compressor and, hence, the mass flow of air. Since the pressure at the compressor inlet is reduced while discharge pressure is rising slightly, the compression ratios are increased so that energy savings are somewhat limited.

Inlet valve modulation is normally limited to a range of from 100 percent to about 40 percent of rated capacity. When operating at 40 percent rated capacity and when discharge pressure reaches full load pressure plus 10 psi, it is assumed demand is insufficient to require continued air discharge to the system. At this point the compressor will operate fully unloaded, like a compressor using load/unload controls.

Dual-Control/Auto-Dual — For lubricant-injected rotary screw compressors, auto-dual control provides modulation to a preset reduced capacity followed by unloading with the addition of an overrun timer to stop the compressor after running unloaded for a pre-set time.

Variable Displacement — Some compressors are designed to operate in two or more partially loaded conditions. With such a control scheme, output pressure can be closely controlled without requiring the compressor to start/stop or load/unload.

Reciprocating compressors are designed as two-step (start/stop or load/unload), three-step (0, 50, 100 percent) or five-step (0, 25, 50, 75, 100 percent) control. These control schemes generally exhibit an almost direct relationship between motor power consumption and loaded capacity.

Some lubricant-injected rotary screw compressors can vary their compression volumes (ratio) using sliding or turn valves. These are generally applied in conjunction with modulating inlet valves to provide more accurate pressure control with improved part-load efficiency.

Variable Speed Drives — Variable speed is accepted as an efficient means of rotary compressor capacity control, using integrated variable frequency AC or switched reluctance DC drives. Compressor discharge pressure can be held to within +/- 1 psi over a wide range of capacity, enabling additional system energy savings.

It should be noted that the terms VSD (Variable Speed Drive) and VFD (Variable Frequency Drive) are used interchangeably in our industry. However, VFD is only one of the VSD technologies available. VFD devices are available from numerous manufacturers. Other VSD drive technologies are magnetically coupled. The workings of each of these technologies are discussed later in this article. This mention is to make the reader aware of other types of VSD technologies besides the vastly popular VFD.

Rotary screw compressors with fixed-speed drives can only be stopped and started a certain number of times within a given time frame. Depending on the control scheme used, instead of stopping the compressor, it will be unloaded, throttled or the compressor

displacement will be varied in applications where the demand for air changes over time. Compressors equipped with variable speed drive controls continuously adjust the drive motor speed to match variable demand requirements. In a positive-displacement rotary compressor, the displacement is directly proportional to the rotational speed of the input shaft of the air end. However, it is important to note that with constant discharge pressure, if efficiency remained constant over the speed range, the input torque requirement would remain constant, unlike the requirement of dynamic compressors, fans or pumps. The actual efficiency also may fall at lower speeds, requiring an increase in torque.

A Variable Speed Drive (VSD) compressor perfectly matches air supply to air demand by varying the speed of the drive motor, for optimum efficiency, offering increased stability in production processes and proven energy savings of up to 35%.

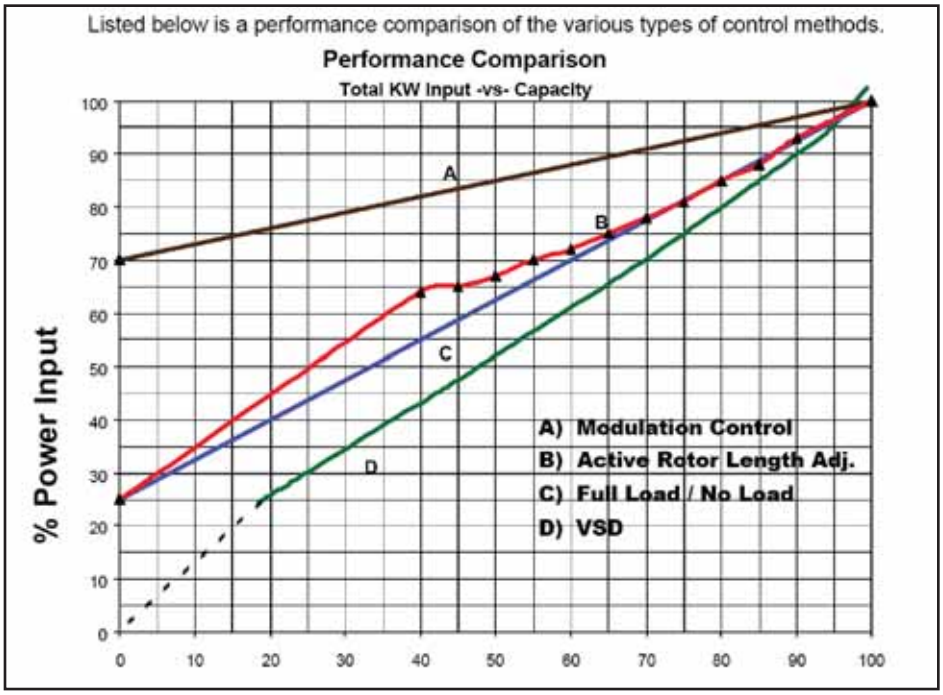
The majority of production facilities experience fluctuating air demand profiles and compressors with a traditional regulation system are unable to follow these varying air demand patterns.

The integrated frequency converter of the VSD compressor range varies the speed of the compressor to closely match the fluctuating air demand profile characteristic of production facilities. The frequency converter also provides a soft-start, and therefore a reduction of the size of the transformer, supply cables, switch gears and fuses.

VSD compressors lower the delivered flow as air demand is reduced and power consumption is consequently lowered. Motor speed regulation is the most efficient compressor control method where air demand varies with cost saving benefits of up to 35% energy saving and up to 22% on a 5-year life cycle. The total cost structure is significantly reduced when considering the fact that energy consumption in the total life cycle cost of a standard compressor is over 70%.

- Low starting torque
- Low starting current
- High power factor
- Constant pressure for increased efficiency on equipment
- Lower average operating speeds for low operational costs

Listed below is a performance comparison of the various types of control methods.



PART LOAD PERFORMANCE OF DIFFERENT REGULATION TYPES
(ESTIMATED)

%Capacity	MODULATION CONTROL % BHP	ROTOR LENGTH ADJUSTMENT % BHP	FULL LOAD / NO LOAD % BHP	VSD % Input kW
100	100	100	100	100+(3-5)%
90	97	93	92	90
80	94	85	85	80
70	91	78	77	70
60	88	72	70	61
50	85	67	62	53
40	82	64	55	43
30	79	55	47	35
20	76	45	40	26
10	73	35	32	--
0	70	25	25	--

SAVING ENERGY WITH A VSD COMPRESSOR

VSD Explained

The most common VSD is the Variable Frequency Drive, which converts 60 Hz alternating current to direct current and then reconverts it to the proper frequency required to turn the drive motor at the desired speed. The variable frequency drive is less efficient at full load compared to other types of modulation controls because the electrical conversions usually require an additional two to four percent more energy.

Another type of variable speed drive used is the switched reluctance drive system. This drive converts a standard three-phase AC power supply into a high-voltage DC power supply. High-current diodes rectify the AC power supply to produce a large DC voltage. The DC supply is connected to a bank of capacitors, which stores the electrical power required by each motor phase pulse to eliminate main power supply surge currents. The final drive is a DC motor.

Motor Background

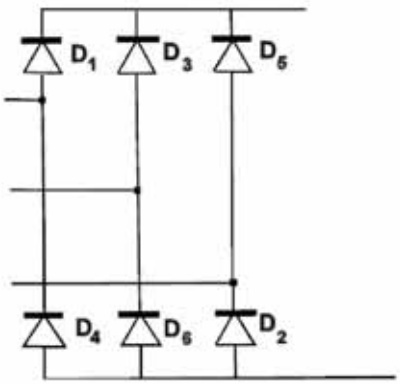
The speed of a motor is the number of revolutions in a given time frame, typically revolutions per minute (RPM). The speed of an AC motor depends on the frequency of the input power and the number of poles for which the motor is wound. The synchronous speed in RPM is given by the following equation, where the frequency is in hertz:

$$RPM = \frac{120 \times \text{Frequency (Hz)}}{\text{\# of Poles}}$$

As shown from the formula above, the speed of an AC motor is determined by the number of motor poles and by the input frequency. It can also be shown that the speed of an AC motor can be varied infinitely by changing the frequency. Notice that with the addition of a Variable Frequency Drive, the speed of the motor can be decreased as well as increased.

Drive Properties

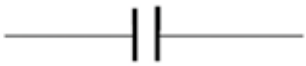
A Variable Frequency Drive changes fixed AC Voltage and Frequency and changes them into Variable voltage and Variable frequency. This transition is performed in three primary blocks.



1. Diode Bridge Rectifier

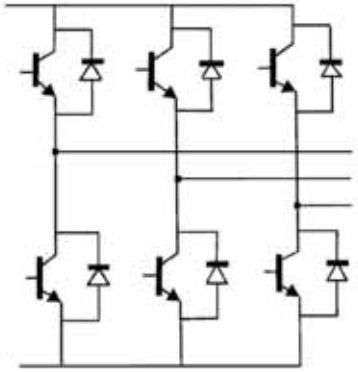
The first section of a VFD is a full wave diode bridge rectifier. The function of this section of the VFD is to convert AC power into DC power. A 460 VAC VFD will have 650 VDC on the bus using the following formula.

2. Capacitors



The second section of the VFD utilizes capacitors to filter DC bus ripple. After the diode section, the waveform is DC; however, there is a high ripple content in the waveform. Capacitors are added to smooth out this DC ripple.

3. Inverter

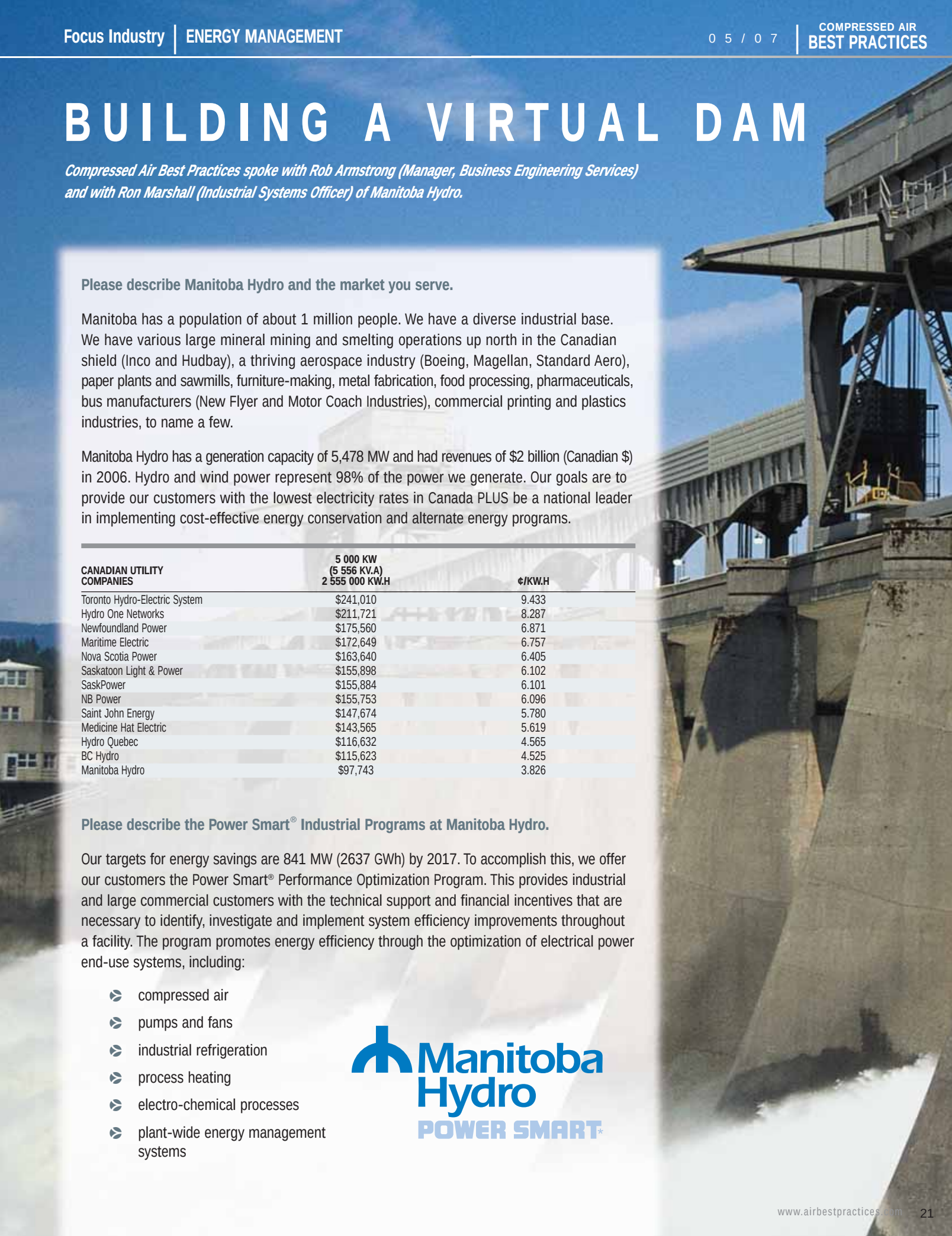


As the name implies, this section inverts the DC voltage back to AC. But, it does so in a variable voltage and frequency output. This third section of the VFD utilizes transistors to change the DC waveform back into AC. By utilizing six or more transistors, the drive is able to recreate a sine wave to the motor. This method of power conversion is called pulse width modulation (PWM).

(Continued on page 40)

BUILDING A VIRTUAL DAM

Compressed Air Best Practices spoke with Rob Armstrong (Manager, Business Engineering Services) and with Ron Marshall (Industrial Systems Officer) of Manitoba Hydro.



Please describe Manitoba Hydro and the market you serve.

Manitoba has a population of about 1 million people. We have a diverse industrial base. We have various large mineral mining and smelting operations up north in the Canadian shield (Inco and Hudbay), a thriving aerospace industry (Boeing, Magellan, Standard Aero), paper plants and sawmills, furniture-making, metal fabrication, food processing, pharmaceuticals, bus manufacturers (New Flyer and Motor Coach Industries), commercial printing and plastics industries, to name a few.

Manitoba Hydro has a generation capacity of 5,478 MW and had revenues of $2 billion (Canadian $) in 2006. Hydro and wind power represent 98% of the power we generate. Our goals are to provide our customers with the lowest electricity rates in Canada PLUS be a national leader in implementing cost-effective energy conservation and alternate energy programs.

CANADIAN UTILITY COMPANIES	5 000 KW (5 556 KV.A) 2 555 000 KW.H	¢/KW.H
Toronto Hydro-Electric System	$241,010	9.433
Hydro One Networks	$211,721	8.287
Newfoundland Power	$175,560	6.871
Maritime Electric	$172,649	6.757
Nova Scotia Power	$163,640	6.405
Saskatoon Light & Power	$155,898	6.102
SaskPower	$155,884	6.101
NB Power	$155,753	6.096
Saint John Energy	$147,674	5.780
Medicine Hat Electric	$143,565	5.619
Hydro Quebec	$116,632	4.565
BC Hydro	$115,623	4.525
Manitoba Hydro	$97,743	3.826

Please describe the Power Smart® Industrial Programs at Manitoba Hydro.

Our targets for energy savings are 841 MW (2637 GWh) by 2017. To accomplish this, we offer our customers the Power Smart® Performance Optimization Program. This provides industrial and large commercial customers with the technical support and financial incentives that are necessary to identify, investigate and implement system efficiency improvements throughout a facility. The program promotes energy efficiency through the optimization of electrical power end-use systems, including:

- compressed air
- pumps and fans
- industrial refrigeration
- process heating
- electro-chemical processes
- plant-wide energy management systems

Manitoba Hydro
POWER SMART®

BUILDING A VIRTUAL DAM

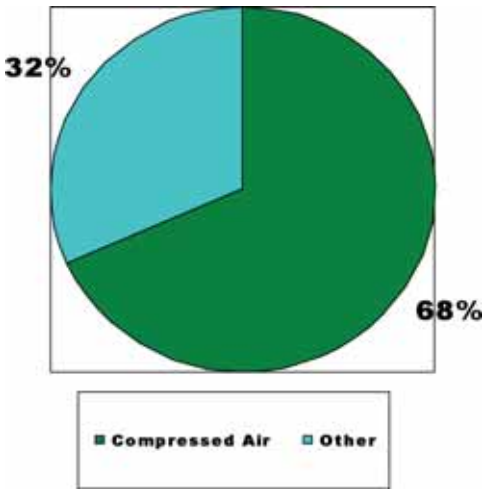
What role do compressed air systems play in the Power Smart® Program?

Compressed air systems can consume significant amounts of energy in industrial facilities. On average, about 10% of the total electric bill will be compressed air related. Average savings of 30% and sometimes up to 70% can be gained by applying energy efficiency measures. So far, 68% of our projects have been for compressed air systems. We have provided incentives to our customers totaling $2.9 million for compressed air related energy-saving projects.

Can you describe how the process works for a customer using the Power Smart® Performance Optimization Program to optimize their compressed air systems?

The Program aims to support customers at each phase in the development of an energy efficiency improvement project. Access to the technical and financial resources that are required is provided in order to identify, investigate and implement the projects.

Manitoba Hydro provides financial incentives to support the identification phase, the analysis of a customer's compressed air systems through scoping studies. Scoping studies are part of Hydro's basic customer service and are provided at no cost to the customer. A study completed by Manitoba Hydro or an approved external vendor measures the pressure and power consumption of the plant's air system over a 7-day period to develop a benchmark profile that identifies opportunities for improvement. The resulting data is analyzed and combined with other site observations of end uses. This enables a base-line energy consumption and operating cost estimate to be calculated and presented in report form. A projected potential savings estimate for various efficiency measures is then developed.



STANDARD AERO CUTS COMPRESSED AIR COSTS BY 86%

Standard Aero's 50,000 square foot facility near Winnipeg International Airport.

Standard Aero has installed two compressed air systems at its new turbine engine maintenance and repair facility in Winnipeg, following Power Smart® design options recommended by Manitoba Hydro.

By acting on Hydro's recommendations, the company has virtually eliminated the high operating costs typical of compressed air systems during facility start-up, and is now saving an estimated $46,000 a year in operating costs.

Standard Aero needed two systems, one to supply plant air and the other to supply much larger amounts of air in short bursts to test General Electric CF-34 turbine engines. In planning both systems, Standard Aero's facility engineers faced a classic dilemma: how to design them to supply only small amounts of compressed air in the beginning, yet be able to ramp up as the facility grew.

The next part of the process is the investigation phase where a full comprehensive audit (fee for service) is done. For an additional fee, a full audit can be completed by Manitoba Hydro or any other approved service provider at the customer's request and is supported by a Feasibility Study Incentive at a level of 50% for the first $10,000 cost and 25% of the remainder. This is a detailed analysis of the facilities compressed air system from the end uses all the way through to the air compressors. Data is taken over a number of weeks to create a more accurate base case and to capture any system problems. Research is then done to determine savings and benefits of various energy efficiency options. A business case for these options is created and presented in report form that can then be used to apply for Power Smart® Performance Optimization Project incentives, rounding out the process at the implementation phase.

How do the financial incentives work?

They are structured so that the more a customer saves, the greater the incentive. We also, however, ensure a customer's commitment to the project by placing a 1-year cap on the payback period and limit what we will contribute to the projects' cost to 50%. This structure has worked quite well for all parties. Our rebate programs make it interesting to our end users. In 2006, the incentive was 3.5 cents per kWh. We went to 10 cents, this year, to drive more projects. We also offer special rebates for reductions in energy consumption during peak usage periods in winter and summer.

The Power Smart® Program was put in place in 1993 and our goal then was to create savings of 6.5 MW during the first decade. What we accomplished was savings of 60 MW!

They knew that installing two oversized systems from the start would significantly increase initial operating costs, but at least the two systems would have enough reserve capacity to meet growing demand. With the help of research and advice from Manitoba Hydro, they made refinements that have resulted in systems that have plenty of reserve capacity as well as operating costs directly proportional to the loads they serve.

Old Ways Were Costly

Standard Aero's traditional approach was to run their compressors in modulating mode and dry the air using fixed cycle desiccant dryers.

There are two penalties for taking this approach. In modulating mode, a typical compressor consumes at least 70 percent of its full load power even though it may be running well under capacity. Fixed-cycle desiccant dryers need to divert roughly 15 percent of the air they dry to regenerate the dessicant beads that strip moisture from the compressed air.

"We frequently see modulating mode compressors and desiccant dryers in industrial facilities," says Ron Marshall, Manitoba Hydro's compressed air systems expert. "For Standard Aero, the combination would have minimized initial capital costs while meeting future compressed air needs. But we were able to show how optimizing both systems would lower operating costs by 70 percent, even at predicted future loads, and save even more during facility start-up."

BUILDING A VIRTUAL DAM

> "We are building a virtual dam by saving power."

Why does a power company want its customers to use less power?

Our mission statement has wording about promoting economy and efficiency in the use of our power. We are therefore committed to energy efficiency. We want our product to be used wisely. Our primary goal is to help our customers grow, survive and entrench themselves as healthy Manitoba-based businesses.

We also have business models that show it is more cost effective to save energy than to build more generating capacity. We are primarily a hydro-power utility and for us to generate more power it costs billions of dollars to build water-power dam generating systems. We are building a virtual dam by saving power.

Lastly, we can get a higher price for our energy when we export. Today, we export more than 30% of the energy we generate.

What air compressors do you see as part of your projects?

We see lots of VSDs installed here. Because of our energy rebates and our awareness promotion efforts, we have been told that Manitoba is one of the hottest markets for VSD compressors. We have had a lot of experience with these types of compressors, mostly good. Most of our projects use a VSD; about 98% of our projects involving new compressors will have at least one VSD compressor included in them. However, if a customer just buys a VSD, it will run adequately. But, if you couple it with adequate flow control and storage, the system runs even better.

MANITOBA HYDRO COMPRESSED AIR SYSTEM RECOMMENDATIONS

VSD Compressors
Flow Controllers
Storage Receivers
Low Differential Filters
Airless Drains
Heat Recovery
Leak Reductions
End Use Reductions
Cycling Dryers
Dewpoint Control

Properly applied in multiple compressor systems VSDs work very well. We see many installations where there is a high load during the day, medium load in the evening and very

Steven Spry, P.Eng., at Standard Aero with the new VSD Compressor

Timely Assistance

Steven Spry, P.Eng., the Project Engineer in charge of designing the main plant system, says they were under severe time constraints to buy both compressed air systems. "Even so, Hydro quickly showed us projected operating costs for our traditional system, savings and paybacks with Power Smart®, and the financial incentives available."

Power Smart® measures included installing a variable speed drive compressor (VSD) rather than a modulating compressor to supply plant air. VSD compressors have excellent turn-down characteristics. That means facilities can install a larger compressor to handle larger loads in the future — without suffering steep operating costs during start-up. Standard Aero selected a 100 hp Ingersoll Rand Nirvana VSD compressor for the job.

New Desiccant Dryer Delivers a -40 ˚C Dewpoint with Purge Control

Since specialized processes required plant air with a — 40 ˚C dewpoint, a desiccant dryer was installed. Hydro recommended an energy management control system that constantly monitors the dewpoint of the dryer's output. It keeps purge air off until the dryer's desiccant beads are fully saturated with moisture. The strategy reduces the amount of air consumed by the dryer itself, particularly when the plant does not need much air or when air entering the dryer is already low in moisture content.

light load at night and on weekends. In these situations, the average compressor loading may only be 40%. A VSD, with an almost linear turndown profile, can provide tremendous savings at these lighter loads compared to typical methods of compressor control, often adding 20–30% to the savings over load/unload controls.

For base load machines, we encourage the use of two-stage rotary screw designs, where applicable. Using these more efficient machines, you get more air per kWh, and because there is an energy savings, our incentives can pay part of the extra cost.

Where are the opportunities for end users?

Everyone says you should fix leaks first. While leaks are very important to identify and fix, people don't talk enough about the controls. The fact is that if you fix 10% of the leaks in a system with uncontrolled modulating compressors, you might get 3% savings. With a well controlled system, which may include a VSD, or other efficient methods of compressor control, if you fix 10% of the leaks, you can get 10% savings.

The biggest opportunity in compressed air is not necessarily always with leaks. It is often with compressor controls. Control settings are often forgotten about or ignored. Set points are established "willy-nilly" with no regard or understanding of the consequences. Big systems often have all compressors in modulation with the same set points — with operators not realizing that one or two could be turned off. Good control strategies required careful attention to setpoints and also require significant storage. People don't realize that you need a substantial amount of storage to enable the air compressors to work properly.

How did Manitoba Hydro get started working on compressed air systems and how has it built the program?

Some time ago we attended a compressed air seminar sponsored by BC Hydro and presented by Mr. Scot Foss. We could see a real potential in raising the awareness about compressed air efficiency and decided to put on our own seminars. We had an excellent response with a good number of attendees from Manitoba. With Mr. Foss as a mentor, we did a lot of walkthrough audits and started to get ourselves and our customers more comfortable with the ideas. After a few big successes, it really began to grow.

We have constantly promoted awareness of compressed air costs to our customers. We find that often the best compressed air savings potential lies "between the ears" of our customers. We do about one seminar every two years. This awareness is very effective because almost every industrial site has air compressors. It is a very common utility. We find there is great interest in compressed air efficiency right from our biggest mining customers with thousands of horsepower all the way down to our smallest systems in small car dealerships and body shops.

We believe strongly enough in the compressed air efficiency movement that we have committed to become a sponsor of the Compressed Air Challenge® and our Mr. Armstrong has also joined the Board of Directors. We are one of only two Canadian members of the CAC.

A Flow Controller Reduces Artificial Demand for Air

Dual dryer inlet filters were installed, reducing the pressure drop across the filters by 75 percent, compared with the standard coalescing filters originally planned. Standard Aero also installed a 3,800-gallon storage receiver to stabilize plant air pressure and minimize the number of compressor starts.

A ConservAir flow controller downstream of the receiver regulates air pressure in the plant. The controller protects critical processes and reduces artificial demand caused by higher-than-necessary air pressures. The VSD compressor is equipped with a heat recovery system that helps heat the plant over the winter, reducing consumption of natural gas for lower greenhouse gas emissions.

Large Storage

Standard Aero needed a second compressed air system to test the CF-34 engines it overhauls at the facility. Testing turbine engines demands very large volumes of air, but only for a few minutes at a time throughout the day. One way to supply this air would have been to use a 350 hp compressor. Instead, with the help of Scot Foss, an internationally renowned compressed air expert, Standard Aero, selected a modified 75 hp compressor that feeds two 10,000 gallon storage receivers at 160 psi.

The system was sized to supply engine test needs in a worst-case scenario that would draw supplementary air from the plant air compressor, without turning on the test air compressor during the day. As a result, the test air compressor runs only at night when most equipment is off, thereby avoiding steep electrical demand charges.

The system uses a thermal mass, cycling refrigerant dryer rather than a fixed-cycle desiccant dryer, because drying specs for engine tests are not as stringent as they are for plant air. The refrigerant dryer has cut drying costs by 98 percent because, unlike fixed-cycle desiccant dryers, it does not constantly need the compressor to keep coming on to feed it.

BUILDING A VIRTUAL DAM

What kind of a relationship does Manitoba Hydro have with compressor vendors?

We feel our local compressor vendors are very important to the success of our programs. They are part of our action plan to reduce energy costs in Manitoba. They communicate with customers at multiple levels which is key. About 95% of our customer contacts come from compressor vendors who find it is good business for them and for their customers to save energy. For the vendors, energy-saving projects encourage the use of additional system accessories, which reduces energy that often pays for any extra cost in the system purchase price. The vendors are also interested in helping their customers use the energy rebates we make available that further reduces the initial cost.

We have recently encouraged compressor vendors to do data logging. Data logging is essential to understand what is happening with the system. We had a bus manufacturer who could not maintain air pressure and couldn't understand why. They swore that their compressed air system had been thoroughly reviewed many times. Data logging showed that timers, installed on the compressors in a failed attempt at a simple compressor control, were shutting them down at odd times and causing low pressure. The maintenance guys would go to one room and find everything was ok—and as soon as they left, the compressors were turning off! They had three separate compressor rooms and couldn't watch them simultaneously. The data loggers showed the real story.

We offer free data logging to our customers as part of our Scoping Studies either though Hydro or using our external vendors. We find this helps customers understand their system a bit better and helps to capture the "before" picture or baseline. Often a customer will not immediately act on a project right away, but will be forced later to upgrade their system by an unanticipated compressor failure. This baseline data can then be used immediately to lead into an efficiency project that can help pay for a newer more efficient compressor rather than a rebuilt old unit.

All the compressor vendors say they have the best machines. How can a user distinguish?

The compressor companies all offer product with various bells and whistles. On the whole most modern manufacturers offer well-designed products supported by excellent warranties. We find that, rather than product quality, the local service capabilities are the most important things our customers look for in a vendor. Customers need to have a good feeling about the services provided by the vendor — do they trust their service capabilities and feel comfortable with the company. We are committed to being vendor neutral and will work to assist all our local vendors as long as they provide systems with good energy efficiency to our customers.

Thank you Manitoba Hydro for your insights.

For more information contact Mr. Ron Marshall at tel: 204-474-3658, email: rcmarshall@hydro.mb.ca

Power Smart™ from the "Get-Go"

Ron Marshall says that, "As with all Power Smart® projects, we verified the proper operation of the new system using data loggers when the facility was in its first few months of operation. We expected to see a system loading an average of 33 kW over the full operating cycle of the facility. But because of lower than expected air loading and the extremely efficient operation of the VSD plant compressor, we measured an average loading of only 2 kW. If Standard Aero had stuck to a more traditional design, energy consumption would have been 30 times higher!"

Steven Spry is pleased with the way refinements to both compressed air systems were planned and implemented. "Going Power Smart® from the get-go was the easiest way we could implement these measures," he says. "It would have been more difficult to justify a major retrofit later on, with all the problems of installation downtime, selling the old equipment and finding replacements."

Randy Zulkoski, P.Eng., Project Manager for the engine test system says, "The Power Smart® approach is paying off even faster than we expected because of our unusually low start-up costs. The systems are also working perfectly. According to our maintenance people, there hasn't been a single hiccup."

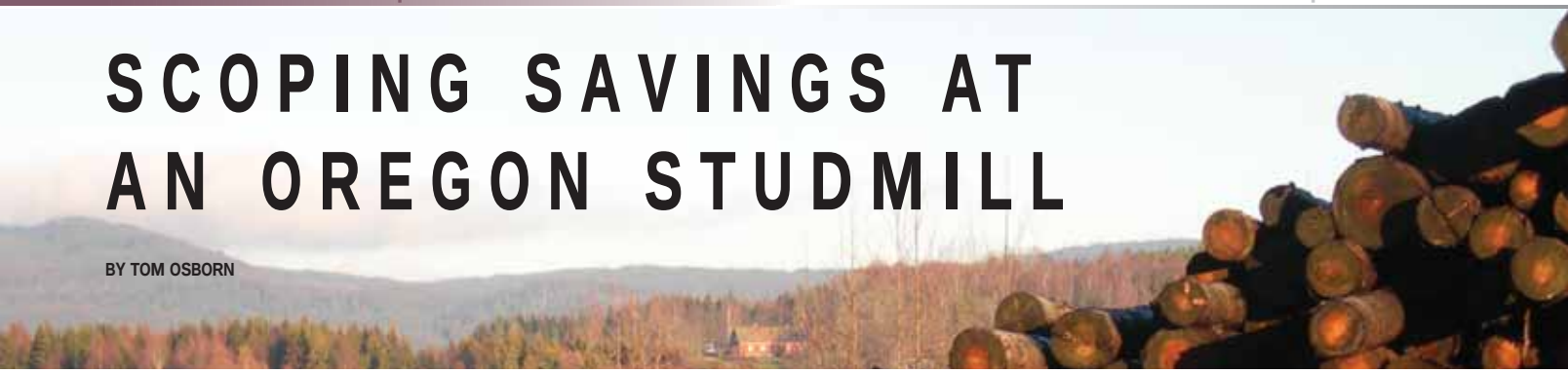
When the system was re-checked six months after initial monitoring, production levels were higher, with only a slight increase in energy consumption. Higher than expected savings of $45,880 a year represent an 86 percent savings in compressed air operating costs over the base case.

Incremental costs of the energy efficient system, over the base case, were $120,600. A Power Smart® Performance Optimization incentive reduced the simple project payback to 1.7 years.

The project won one of Canada's Energy Efficiency Awards, earning recognition from Natural Resources Canada as "an excellent example of Canadian innovation and achievement in the field of energy efficiency."

Manitoba Hydro
POWER SMART®

SCOPING SAVINGS AT AN OREGON STUDMILL



BY TOM OSBORN

The intent of this article is to provide the industrial user of compressed air with an idea of the kinds of resources available to examine systems for energy-savings opportunities. The Bonneville Power Administration (BPA) Industrial Focus works together with the industrial customers of local utility companies to identify savings opportunities.

The Boise Building Solutions Studmill, located in Elgin, Oregon, is a customer of the Oregon Trail Electric Consumers Co-op (OTEC). OTEC sources their wholesale power from BPA. BPA partners with the local utility companies it supplies, like OTEC, to purchase energy saved through investments in efficiency. Investing in efficiency is less expensive than purchasing power on the wholesale market or building more power plants. For this reason, the BPA will send a specialist, like myself, to visit an industrial facility, like Boise, to scope out energy savings opportunities.

I scoped potential energy-saving opportunities at the plant. This included T-5 or T-8HO lighting, boiler fan VFDs, dry kilns VFDs, pump VFDs and compressed air. Subsequently, BPA and Boise hired a Compressed Air Challenge (CAC) consultant to perform a detailed energy analysis of the compressed air system. The CAC consultant was Mr. Jeff Yarnall from the Rogers Machinery Company.

The results of the energy analysis were used by Boise to develop a long-term plan for their compressed air system. The Boise Building Solutions, Elgin, Oregon Studmill facility, in partnership with the Oregon Trail Electric Consumers Co-op (OTEC) and the Bonneville Power Administration (BPA) then completed an energy efficiency project that will result in $40,472 a year savings in power costs. The project saves approximately 883,000 kilowatt-hours a year by reducing the amount of horsepower needed to provide compressed air to the mill. The project improves the mill's efficiency, reduces costs and helps the mill stay competitive. Based on the verified energy savings, OTEC paid Boise $106,000 toward the total project cost of $291,000.

Excerpts from The Energy Analysis Presented to Boise Building Solutions, Elgin Studmill

The Pre-Project System

The original compressed air system consisted of a two (2), lubricant injected, single stage, rotary screw air compressors in two (2) compressor rooms each operating with inlet modulation controls. Each compressor discharged through a dual tower desiccant air dryer directly into the distribution system and responded to individual controls sensing at the discharge of the compressor package.

Typically, both compressors operated continuously in modulation. On occasion, one compressor would be manually shut down during non-production hours. There were no system-wide controls. Energy consumption was high primarily because both compressors operated with modulation controls. The part load efficiency of the system was low, averaging less than 3.9 cfm/kW.

BPA has a long history of supporting and advancing the role of industrial energy efficiency in the Northwest. In recent years, Conservation Augmentation (ConAug) and the Conservation & Renewables Discount (C&RD) have been major mechanisms to acquire industrial savings. The Industrial Focus is an aggressive effort to gain energy efficiency in the industrial sector through traditional methods, and through Technical Service Providers that enable experts in the field of industrial energy technology to propose energy-saving projects at industrial facilities in the Region.

BONNEVILLE POWER ADMINISTRATION

Oregon Trail Electric Consumers Co-op (OTEC) is Oregon's largest distribution cooperative. Headquartered in Baker City, Oregon with district offices in La Grande, Baker City, John Day and Burns, OTEC serves some 28,800 consumers in Baker, Union, Grant and Harney counties with a network of overhead and underground lines more than 2,870 miles long.

SCOPING SAVINGS AT AN OREGON STUDMILL

The Baseline Study

Compressed air system data was collected for a two-week period. A baseline demand profile was established for power, energy and flow to establish an existing baseline for compressed air demands and energy consumed. Plant personnel noted that during the baseline period, demands were unusually low because of a temporary slow-down in business going through the plant. Monitoring and logging (15-second averages) of the system occurred for 14 days from October 26 through November 8, 2006 inclusive. The power and pressure measurements yield an estimated demand profile of the system and illustrate the lower power consumption by the air compressor and dryer.

Energy Efficiency Measure (EEM) Actions

1. In order to keep the radiators clean, recover waste heat and assist in control wiring, a new compressor room was built to house two compressors, two air dryers and filters.
2. Two 1,060 gallon receivers were installed just outside the compressor room.
3. A new QNW V300, variable speed controlled air compressor with a temperature-controlled VFD cooling fan was installed to improve part load efficiency of the compressed air system.
4. The QNW 1011 was modified with load unload controls and moved to the new compressor room.
5. A new 1,000 scfm dual tower, deliquescent, heat reactivated, air dryer with dew point demand and filters was installed.
6. The QNW 1000 and related air dryer were shut down and will only be used for backup.
7. A system sequencer was incorporated in the control panel of the new QNW V300 air compressor.

Compressor Pressure Settings

The compressor settings are detailed in a document titled, "Commissioning Set Points," located in the appendix. Please note that the VFD control panel senses pressure at the two dry 1060-gallon air receiver located approximately 25 feet from the new compressor. Thus, the compressor responds to plant pressure not compressor discharge pressure. Pressure measurements were also recorded at the planer mill and sawmill receivers. These match the same pressure locations used in the original report.

The data shows that there is little pressure drop between the 1060-gallon dryer receiver at the compressor room and the demand side receivers located in the planer mill and sawmill. The QNW V300 P1 (full output) and integration control pressure settings are as follows:

OCTOBER 9	SET POINT		
P1	90	90 psig	fast speed
Delta P	+4	94 psig	slow speed
Reload QNW V300	+10	100 psig	@ slow speed
Unload QNW V300	+20	110 psig	@ slow speed
PS1 Open	98	98 psig	Unload QNW 1011
PS2 Close	88	88 psig	Reload QNW 1011
QNW 1011 Timer	10	10 minutes	Stops QNW 1011

The QNW 1011 will shut down after running approximately 10 minutes unloaded.

Rogers Machinery QNW Variable Speed Compressor

Dryer Performance

The compressed air system uses dual tower, regenerative desiccant dryers to remove moisture and prevent air line freezing. The energy efficiency recommendations replaced the existing 1,000 acfm heatless dryer with a heated dryer with purge saving controls. This reduced the volume of air required to dry the air. Purge flows and heater on times are controlled and match moisture loading.

During data collection, it became obvious that the existing EE1800 dryer, which dries the air from the QNW V300, was in "normal" or timed mode. Purge flows and heater on time were high and constant because the purge-saving controls were not performing properly. The project did not have a budget line item to repair the EE1800 dryer controls however, Boise personnel were repairing the dryer during the M&V monitoring period as a maintenance item. Additional dryer savings will appear once the dryer controls are repaired.

Dewpoint was measured in the studmill at the original location of the QNW 1011. The system was "wet" when data logging began. After a few days, the dewpoint dropped to the correct level and remained there.

Verification of Equipment Installation

All of the equipment detailed in the analysis was installed and is operating per manufacturers' specifications. Post monitoring was performed and the data analyzed to determine energy savings.

Purge-Saving Heated Desiccant Air Dryer

SCOPING SAVINGS AT AN OREGON STUDMILL

Results

	FLOW ACFM	COMPRESSOR POWER KW`	ANNUAL ENERGY KWH
Measured Baseline Analysis EEM 3	1115.3	288.45	2,526,861
Post Project Projection	1115.3	196.37	1,720,214
Projected Savings EEM 3 (1)		82.87	725,982(1)
EEM 4 Savings		4.62	40,470
Total Projected Savings		87.49	766,452
Post Project Monitoring	1134.2	187.56	1,642,983
Savings		100.89	883,878
Savings Difference		13.39	(15.3%)
		117,426	(15.3%)

Notes (1): Savings were reduced by 10% as a safety factor

Conclusions

This post monitoring commissioning report confirms the following:

- The equipment detailed in EEM 3 and 4 has been installed and is operating properly.
- The average air demands have increased slightly from 1115.3 to 1134.2 ACFM.
- Compressor controls will enable reduced pressure settings, saving additional power and reducing the leak load.
- The estimated savings created by EEM 3 and 4 is 15.3% higher than predicted.
- Part load efficiency of the system has been greatly enhanced. Total system efficiency increased from 3.89 to 6.05 ACFM/kW.
- Because the system is now "proportional" through a wide range of flows, each cubic foot of air costs the same as the next. Additional savings will be significant if total air consumption is reduced, i.e., leaks and open blowing.

Additional Recommendations

- Reduce pressure settings one (1) psig per week until performance is affected in production areas.
- The existing EE1800 air dryer purge saving controls should be repaired.
- The purge air supply plumbing (1") for the new EE1000 dryer should be connected to the dry receiver instead of the dryer outlet.
- Replace open blowing applications with engineered nozzles to decrease air consumption. Install shut-off valves and automatic solenoids to shut off air when work stations are not being used.
- Refresher operator training should occur once per year.
- Production personnel should receive "shop floor" training to better understand the cost of compressed air as a utility.
- Proper equipment maintenance should be performed at manufacturers' recommended intervals.
- Ultrasonic leak detection should be performed twice yearly. BPA loans its detectors.

The above case study is an illustration of the energy efficiency analysis that local and regional power companies, working together with local compressed air system experts, can bring to industry. In this case, we had the BPA (Bonneville Power Administration), the Oregon Trail Electric Consumers Co-op (OTEC) and the Rogers Machinery Company all working together to reduce energy costs related to compressed air at the Boise Building Solutions Studmill located in Elgin, Oregon.

For more information, please contact Mr. Tom Osborn, Mechanical Engineer — Renewables and Energy Efficiency, Bonneville Power Administration, 1520 Kelly Place, Suite 100 Walla Walla, WA 99362, tel: 509-527-6211, email: trosborn@bpa.gov

Expertise AT THE POINT of Air Consumption

Compressed Air Best Practices interviewed Dr. Christian Boehm, Ph.D. (Manager Technical Engineering Center) and Philipp Klaschka (Special Applications Engineer) of Festo Corporation.

Good morning! How is Festo structured internationally?

Festo is a leading global manufacturer of pneumatic and electromechanical systems, components and controls for industrial automation. We were founded in Germany in 1925, and today employ about 12,000 employees who work in more than 180 countries around the world. The revenues of the Company are approximately 1,500 million Euros.

Festo global headquarters is located in Esslingen, Germany. Our Technology Center is located there. Festo continues to be a privately held company. Dr. Wilfried Stoll and Dr. h.c. Kurt Stoll are the two brothers who founded the Company and who remain the primary shareholders in the firm.

How is Festo Corporation structured in the U.S.?

We were incorporated in 1972 in Hauppauge, New York. Happauge remains our headquarters for the U.S. and also serves as our eastern manufacturing center. We also have design and manufacturing operations in Livermore, California and in Chicago, Illinois. These facilities offer customers custom pneumatic solutions to their manufacturing needs.

Festo operates a Customer Resource Center out of St. Louis where we handle customer service and order processing. Our sales organization is split into four distinct geographic sales districts. In total, we have approximately 400 employees in the U.S.

Please describe the objectives of Festo Air Services.

As you know, the purpose of Festo Air Services is to optimize the efficiency of existing pneumatic systems. Customer benefits include, but are not limited to:

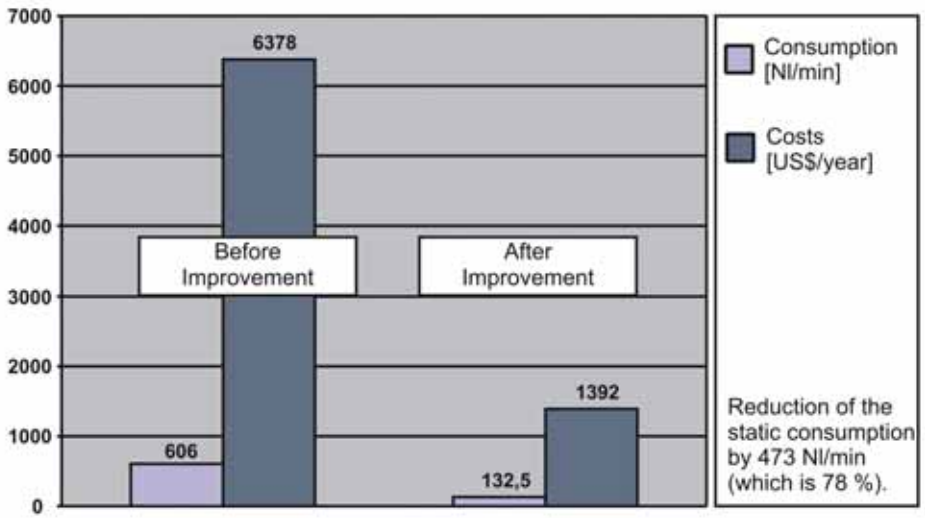
- Essential information about the pneumatic system performance (required air consumption and pressure of the overall system, subsystems or single components).
- Suggestions for improvements if applicable.
- Knowledge of existing pressure requirements, air consumption and air losses and their effects on product cost and machine performance.

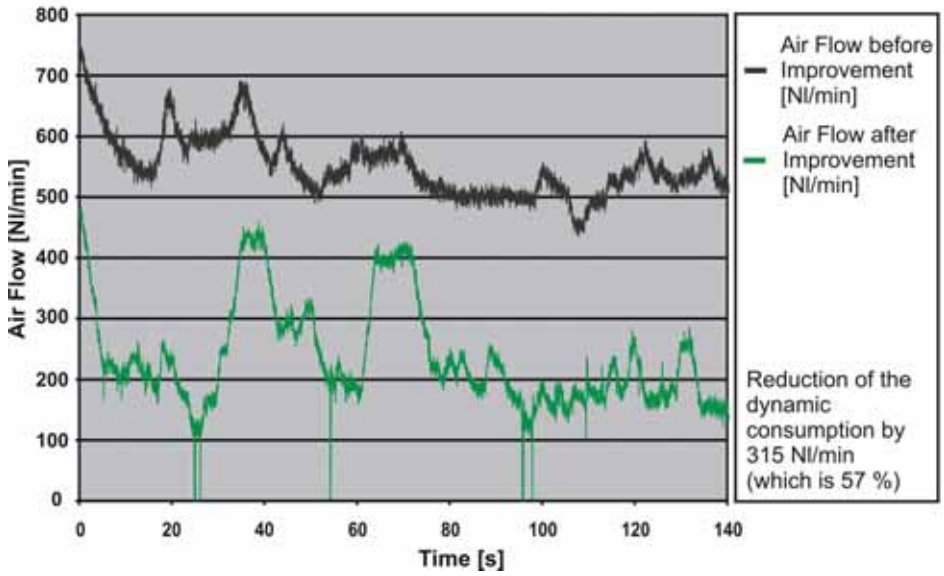
EXPERTISE AT THE POINT OF AIR CONSUMPTION

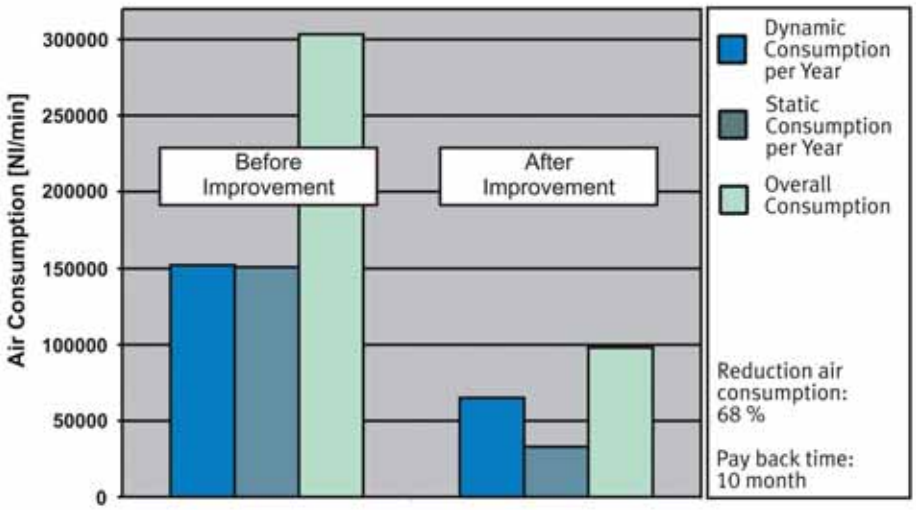
The tables at right describe the effect Festo Air Services can have on the air consumption and costs of one pneumatic system of one of our customers.

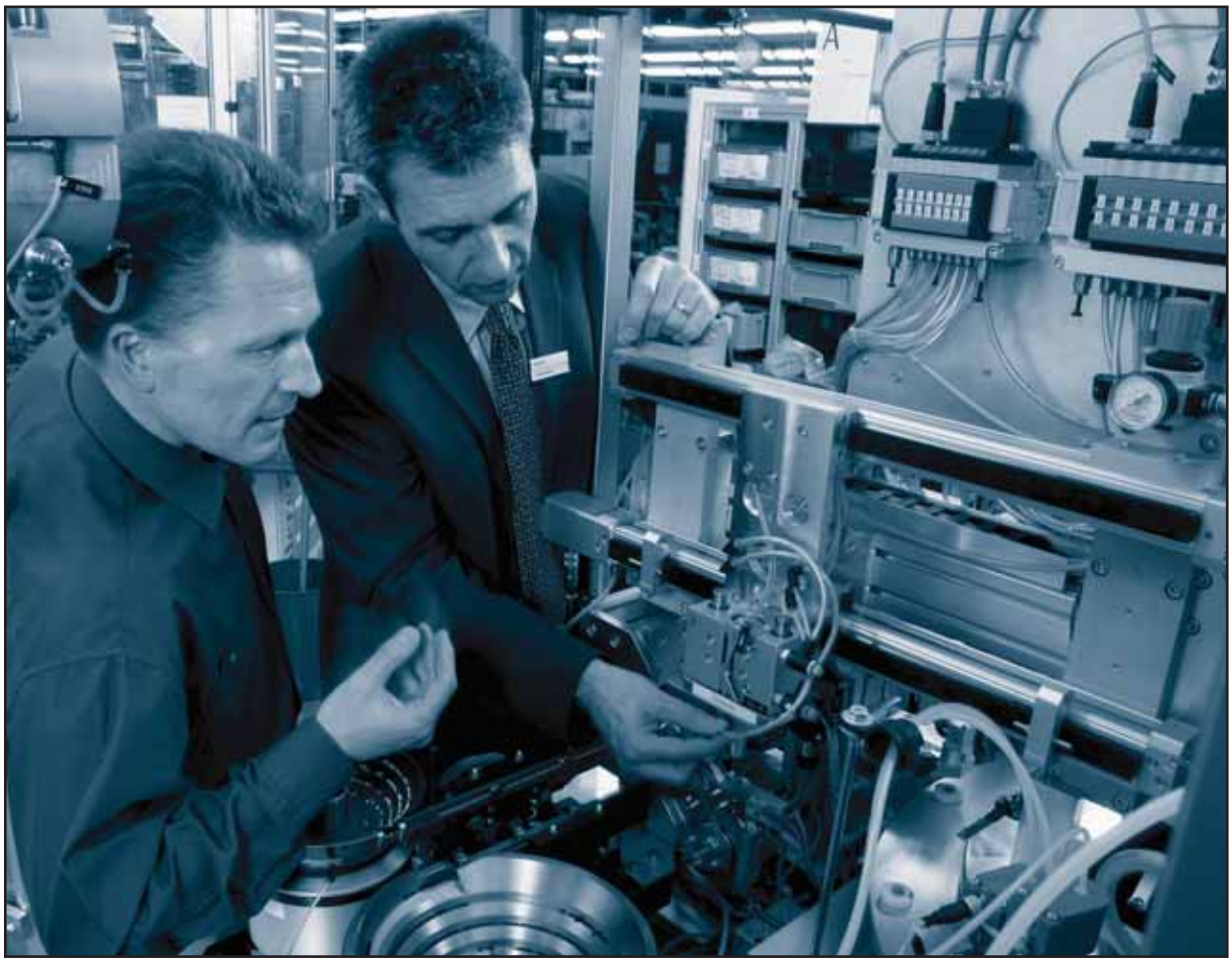
How do your analyze the existing situation of the pneumatic system?

During the performance of our Air Service, we use different measuring devices to measure and investigate the pneumatic system. We measure the temperature, air consumption, flow and pressure. We measure these variables during several operating conditions in the main supply line of the pneumatic system and at key nodes in the pneumatic system. These measurements give us a very good understanding of the condition of the system and its demand. These results are also a benchmark for us to estimate and calculate the potential savings.









Working with Machinery OEMs to Reduce Air Consumption of Pneumatic Components

What pneumatic components do you look at?

Every pneumatic component (actuator, muffler, tube, valve, throttle, etc.) of the target application is investigated. It is checked to see if it is necessary and how much its air consumption can be reduced. If deemed necessary, we can even simulate with a very powerful software program, not commercially available, the air consumption, actuator movements and required pressure patterns of pneumatic components. We sometimes use this simulation to identify potential improvements and to verify the potential improvement in front of the customer.

> "Zero-leak plants have great opportunities."

We can give you an example. One of our customers used pieces of pipes in different machines with drilled holes. He used these pipes to build up cushions of compressed air to turn a foil around 130 degree. We identified that this piece of pipe was responsible for more than $50,000 in operating costs in his plant. We provided a simple pneumatic solution to the process and this money was added to the customer's profit. This customer was simply not aware of how much money he could save by using another component.

EXPERTISE AT THE POINT OF AIR CONSUMPTION

Working with End Users to Reduce Compressed Air Consumption of Pneumatic Systems

Festo Air Services at the Point of Air Consumption

1. Air Consumption Analysis
2. Energy-Saving Service
3. Air Quality Service

How did Festo Air Services get started?

It originated in Germany, where the need for optimizing a plant floor is very high due to the high energy and space costs. It was launched six years ago in 2001. It was accepted, in Germany, in a gradual manner as our customers became educated on the opportunities to save energy and improve the efficiencies in their pneumatic systems.

We introduced Air Services in the U.S. earlier this year. We have trained our sales force who have been busy introducing Festo Air Services to our customers. We work as a partner with our customers to provide them with the knowledge to understand the opportunity. There are three main components to the program: air consumption analysis, energy saving service and air quality service.

Please describe the Air Consumption Analysis program.

Plant engineers and production managers are providing a growing demand to validate the air consumption figures of the pneumatic equipment in their plant. With the growing awareness of the costs of compressed air, they have major incentives to improve the performance of these systems. What may hamper many firms is the lack of skills and appropriate technologies for accurate air consumption measurements — of these specific pneumatic components.

This is the area of expertise of Festo. The new Air Consumption Analysis Service from Festo gives machinery OEMs the ability to document air usage figures for new or existing equipment. The detailed analysis provided by Festo enables manufacturers to reduce compressed air costs and optimize distribution networks. From flow measurement on the machine level to the analysis and documentation of the values calculated, tailor-made solutions help the machine builder to calculate and document the vital characteristic values for the end user.

How does the Energy Saving Service work?

This service takes place at the factory where the end user operates pneumatic equipment. There are countless opportunities to reduce the air consumption of pneumatic systems. We use our expertise to help the customer do machine inspections. We will pinpoint and measure air leaks and

analyze weak points in the machine. Please understand that we don't just run around with a leak detector. Zero-leak plants have great opportunities. The machines commonly are functioning, but not optimally due to an issue with a pneumatic component. By repairing the leaks and/or the defective pneumatic components, the output of the machine will increase and therefore its energy efficiency increases as well. The exciting part of the Energy Saving Service is to see the increased productivity and process reliability of the machine using pneumatic systems.

The Air Quality Service focuses on the point of air consumption, correct?

Correct. The Air Quality Service offers end users the opportunity to receive an analysis of the quality of the compressed air, at the points of air consumption. We measure residual oil content and pressure dew point. Remote air preparation devices and pneumatic components at the point of consumption are also inspected and analyzed. We then develop measures to improve the air quality.

Air quality doesn't affect a single pneumatic device. It affects them all. In a production facility, you are talking about banks of valves and actuators. A flood of oil, caused by a failed oil separator on an air compressor, will flood hundreds of valves and actuators, potentially affecting them all.

Moisture is the carrier of contaminants. If you have moisture in the compressed air, you probably have particulates and oil. That is when damage occurs. When this contaminated air reaches pneumatic systems with rubber parts, they can swell, harden or crack. This can cause a pneumatic valve to slow down, leak or stop working completely.

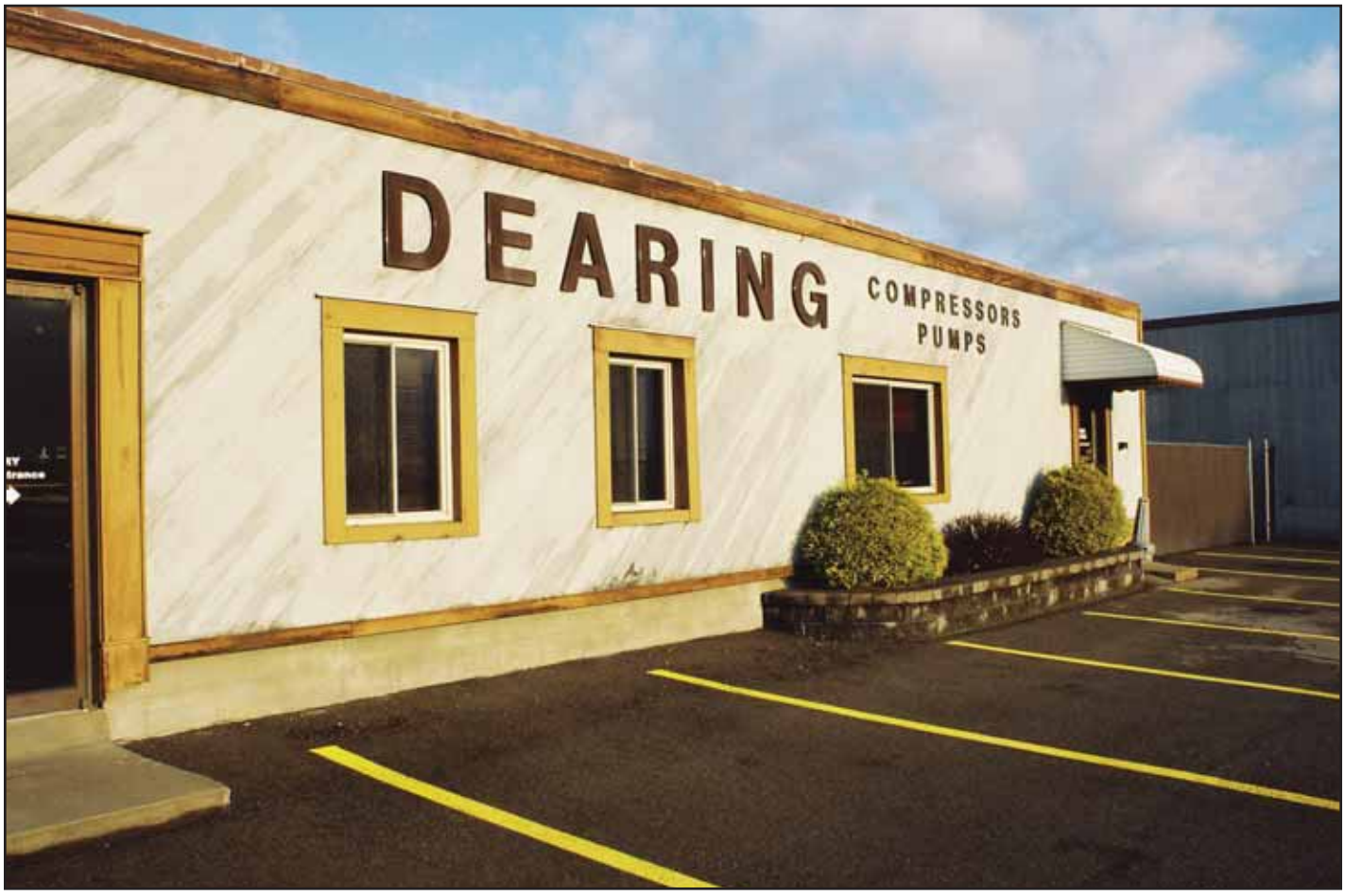
Solid particles in compressed air can cause increased friction, which in turn can cause pneumatic valves to malfunction. After the valve, the particles can get to the actuator. An actuator has seals in the piston (rod seals). Moisture, oil and particles can cause leaks. If a piston seal goes, this affects the extension and retraction of the piston rod. Particles can then score the barrel of the rod and damage it due to its abrasiveness. Cintered metal or rust introduced into the barrel of the cylinder affects its smoothness and scratches it. A component, which stops working, does so normally as a result of a gradual failure — a decrease in performance over time — this might produce bad parts only to be detected after a big batch has been made.

Thank you Festo for your insights.

For more information, please contact Mr. Philipp Klaschka, Festo Corporation, tel: 847-759-2678, email: saveair@us.festo.com

DEARING COMPRESSOR

Compressed Air Best Practices spoke with Mr. Robin Wall (Vice President of Sales) of the Dearing Compressor & Pump Company.



Dearing Compressor & Pump in Youngstown, Ohio

How was Dearing Compressor founded?

Dearing Compressor & Pump was founded in 1945. For more than 50 years, we have based our reputation on service, reliability, integrity and innovation and have responsibly served our industrial and energy customers with dependable equipment and systems for compressed air, gas, process gas and hydraulic applications. The Company continues to be owned and operated by the Dearing family.

What is the structure of the Company?

We operate two distinct divisions: the Industrial and the Energy divisions. Our Industrial Division focuses on selling and servicing systems for industrial air compressors and pumps in Ohio and Pennsylvania. We cover the Akron, Canton, Cleveland and Erie markets. We have a full-service shop in Cleveland as well as our headquarters here in Youngstown, Ohio. The Industrial division has grown significantly over the past five years. We are adding products like blowers for low pressure applications. This has helped us get into new applications like wastewater aeration, blow-offs and conveying.

& PUMP COMPANY

What product lines are sold by the Industrial Division?

Dearing is Gardner Denver's second oldest distributor in the U.S. We began selling and servicing GD compressors from the very beginning in 1945. To this day, we continue to provide Gardner Denver industrial air compressors to plants in Ohio and Pennsylvania. Gardner Denver's acquisitions of other technologies has been positive for Dearing as we are now engaged with blowers as we mentioned before.

Two Gardner Denver VS135 single-stage, air-cooled, variable speed drive compressors rated at 802 CFM @ 125 PSIG. These units are being operated in a three-shift plant, 7 days per week. Estimated annual energy savings are more than $50,000.

Please describe your Energy Division.

The Energy Division has been working, since 1960 with customers in 10 to 12 states. We build customized packaged systems up through 3,000 horsepower with both electric and natural gas engine drives. Our primary application is for oil and gas pipelines. This has been a strong market as energy prices have gone up. Natural gas prices, for example, have tripled over the past few years. The systems we design and package can be very large systems and there is never any margin for error. We work closely with the design firms and the utility companies on the jobs.

For this reason, Dearing Compressor & Pump has invested significant resources into this Division. The Company has recently finished a 12,000 square foot addition to the fabrication area, with cranes for the heavy lifting. We have a full-time engineering staff working on auto-cad drawings and 25–30 fabricators in our shop working full-time on these packages.

Our main product lines in the Energy Division are Gardner Denver rotary screws up to 600–700 horsepower and reciprocating gas compressors built by Ariel. Ariel is the premier gas compressor manufacturer in the world and is based not far from us here in Ohio. We work extensively with motor manufacturers as well as Caterpillar, Reliance and Toshiba.

DEARING COMPRESSOR & PUMP COMPANY

Ariel 300 horsepower water-cooled air booster compressor packaged by Dearing Compressor. This package boosts 100 psi air at suction to 700 psi at discharge.

What markets does your Industrial Division serve?

Steel mills use a lot of compressed air. Their financial health, however, is a roller coaster. The steel industry is in good shape right now and we have a lot of experience working with it. Who knows how it will be in a year? We do a lot of projects with steel mills with rotary screw compressors and desiccant air dryers.

We also work with some power plants. The majority use centrifugal compressors and desiccant air dryers. We do a lot of controls work on their centrifugal compressors. We will usually upgrade the control systems. We normally partner with CASE Controls on these projects. The controllers have remote monitoring and control capabilities. This permits Dearing to offer the power plant 24-7 remote monitoring, troubleshooting and service capabilities. If they have a problem, they call us and we tap into the lines to see what is going on. This enables the power plant to focus on what their strength is. We have done these remote monitoring contracts with steel mills as well.

Although we do work with Tier 1 suppliers, the automotive industry has been downsized in northeast Ohio and is not in a growth mode. We are now looking more at the plastics and rubber industries, which are growing pretty well. Plastics materials are sometimes replacing steel and continue to find more and more applications. Akron, of course, is the "rubber capital" with Goodyear headquartered there. This has spawned some offshoot businesses, which are also rubber-related.

What's your take on compressed air auditing?

We are strong believers in helping customers understand their compressed air systems. From our standpoint, there are a lot of auditors out there and every one has their own way of doing things. We feel that to audit properly you need a thermal mass flow meter to measure flow, pressure and power. We use Sierra flow meters. It is critical to truly measure air flow.

Too many auditors estimate air flow by using an amperage clamp on the motor and then extract those readings to estimate air flow. This doesn't work well with many air compressor controllers like with modulating machines. The difference in amperage measured between full load and 60% load is insignificant. This can, therefore, provide a flawed understanding of flow. For this reason we use flow meters.

It is obviously in the best interest of compressed air users to reduce their energy consumption. In Ohio, power rates are expected to go up 30–50% in 2008. Rates have been stable, for the past 10 years, and that is about to change. The energy prices depend upon the type of operation. Single shift operations are at 12 cents, two-shift operations are at 8–9 cents, and three-shift operations can be at 5½ cents (the big steel mills). The parent company of our utility supplier, First Energy, does not offer energy rebate programs in our region. A lot of customers are still quite unsure of how to evaluate their electric bill and we work to help them with that.

A Gardner Denver VST-90 two-stage, air-cooled, variable speed drive compressor rated at 677 CFM @ 100 psig. This unit is installed at a manufacturer of building supplies and operates a two-shift plant, 5 days per week. Estimated annual energy savings are more than $25,000.

What areas should end users look at to improve their systems?

They should look for opportunities to improve their piping systems and understand the points of use of compressed air. They should try to uncover inappropriate uses — for example, using compressed air instead of blowers. They should use energy-efficient air nozzles instead of smashed pipe. Variable speed drive motors also present opportunities.

What is your experience with Variable Speed Drive (VSD) Compressors?

Dearing Compressor & Pumps' Energy Division started working with VSD gas engine drives in the early 1990s. Now with the growing awareness of energy costs related to compressed air, manufacturers like Gardner Denver have brought to market good VSD air compressors. We are a strong supporter of the technology and have years of positive experience with VSD.

As with any technology, VSDs need to be matched up with the right situation. All situations are different. Probably the best application is between 400 and 1,200 scfm. You want to use the VSD air compressor to trim the peaks of air demand and use another air compressor for your base-load flow. These are the best applications. Audit work and VSD technology have created a lot of demand and some customers will specify VSD no matter what. Some compressor vendors will quote a thermal mass dryer, a VSD and a mist eliminator no matter what. This is not a good idea. We try to really keep an open mind and do what is best for the customer by gathering data, evaluating it and listening to the customer.

What are the "next technologies" for compressed air systems?

We believe we will see advancements on the controls side of the business. We think that remote monitoring and remote control will become more commonplace as these technologies become more affordable for smaller installations. Advancements in wireless technologies should also make data points easier to access and therefore manage.

Why has there been a consolidation of the compressor sales and service distribution channel?

A lot of companies don't treat service as important as selling. You have to support the customers well. The difference is in the people at Dearing Compressor & Pump and in how we take care of our customers. We focus hard on maintaining the customers we have — first and foremost. Many firms are so busy looking for the next new account that they don't realize that they have an unstable foundation. Some distributors have also not kept up with the ever-changing advancements in technology and expertise. If your firm hasn't learned how to do compressed air audits, with expertise, your company is in trouble.

Thank you Dearing Compressor & Pump for your insights.

For more information please contact
Mr. Robin Wall, Dearing Compressor,
tel: 330-783-2258,
email: robin_wall@dearingcomp.com

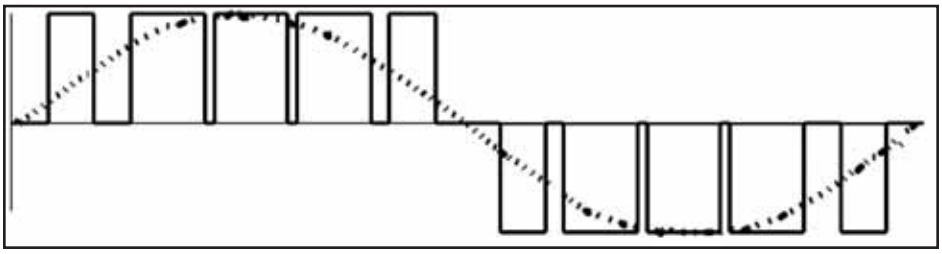
Dearing Compressor & Pump Co.

SAVING ENERGY WITH A VSD COMPRESSOR

(Continued from page 20)

Pulse Width Modulation

Notice, by firing the transistors on the output of a variable frequency drive, a sinusoidal waveform can be created. By varying the time the pulses are on and which transistors are firing, the frequency can be increased or decreased. Also, by changing the width and duration of the pulses, the average voltage to the motor can also be increased or decreased.



PWM Is a technique used by the drive that controls the amplitude and frequency of the AC voltage supplied to the drive motor.

This is accomplished by varying the time that the **IGBTs** are switched on and off. This results in an approximated sine wave of AC voltage. The faster the switching, the more uniform the resulting sine wave. The "sawtooth" image of the wave actually produced contains high-frequency harmonics. The better the sine wave, the fewer harmonics are generated. PWM is the best method of producing a near perfect sine wave for the supplied voltage to the drive motor.

IGBT

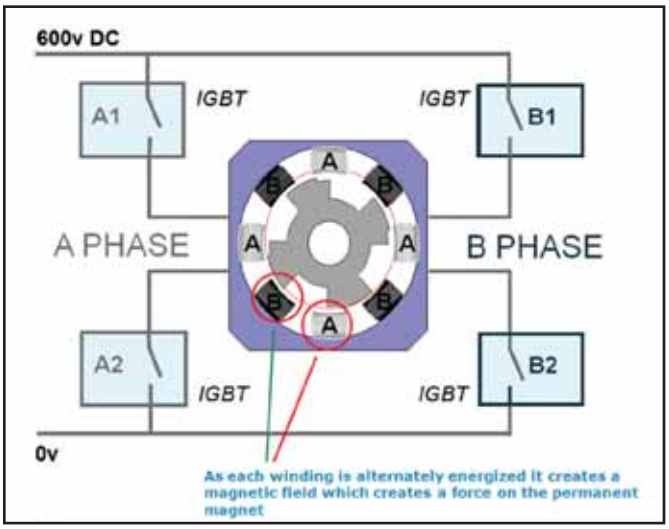
The most recent advances in AC drive technology have been improvements in the size and performance of IGBTs. IGBTs or insulated gate bipolar transistors have displaced other types of power switching devices. Losses of the new devices are lower than earlier types of switching devices. The advantages of IGBTs are as follows:

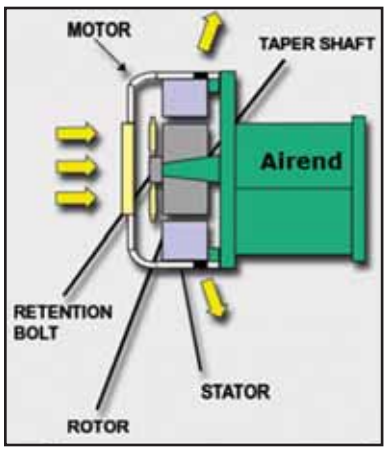
- Fast switching capability
- Quieter motor operation
- Closer approximation of a sine wave
- More efficient motor operation
- Small packages
- Increased reliability and better performance

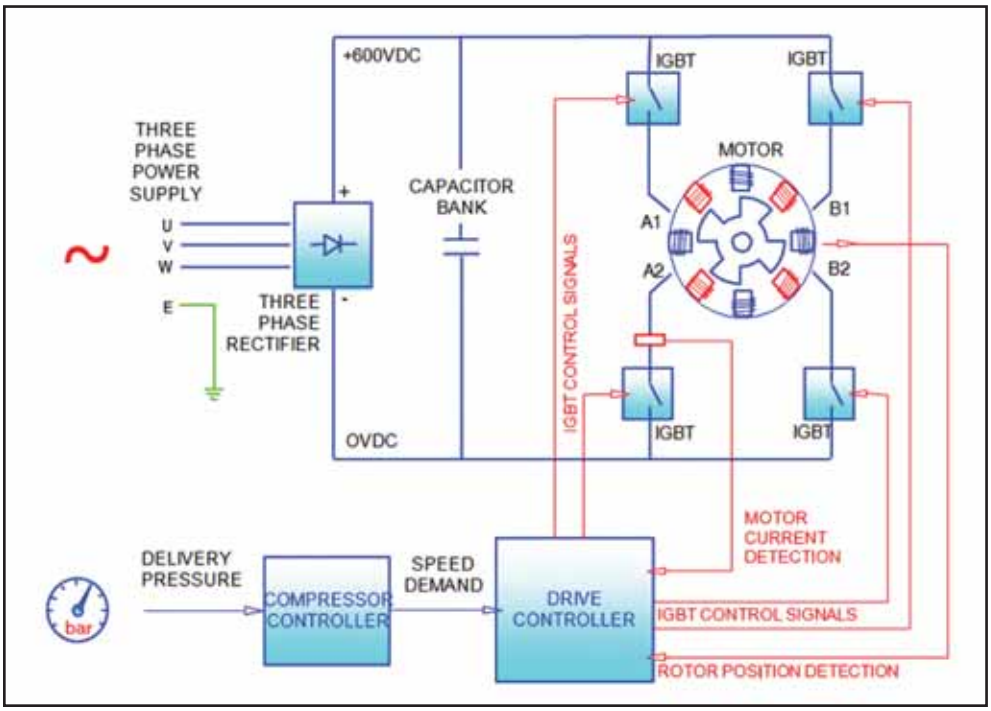
Switched Reluctance Drives

The name switched reluctance has now become the popular term for this class of VSD. The drives are alternatively known as variable reluctance drive motors, reflecting the origins of the technology being derived from VR stepper motors. Even so the first recognizable reluctance machines were built over 150 years ago, most famously by Davidson as a traction drive for an electric locomotive in 1838.

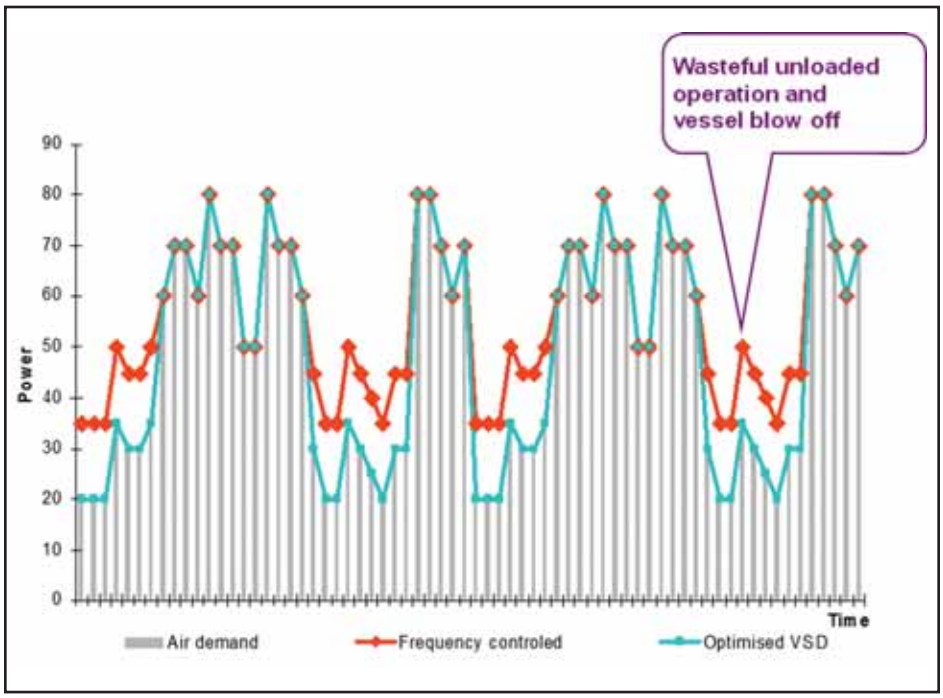
SRD compressors can be up to 2% more efficient than AC frequency convertors. However, this is only a positive statement when the units are running at constant speed at full load, not really why you would purchase a variable speed compressor in the first place. One problem associated with SRD technology is that the efficiency of the drive is based on the strength of the magnetic field within the motor. As the magnets age, they may lose their magnetic properties. Pictured at right is what's known as an HPM drive or Hybrid Permian Magnet drive. It is essentially a DC brushless motor using Hall Effect[1] sensors for commutation or rotor position feedback to the drive.







SAVING ENERGY WITH A VSD COMPRESSOR



Why Would I need a VSD?

There are differences in the various types of VSD's available. The chart at left shows a plant with variable loads and two different VSD compressors power usage in comparison to flow. Some VSD compressors do not blow down their sump when they stop. They simply ramp up and down as needed to maintain setpoint pressure. Some VSD compressors do unload and blow down their sump each time. The two power curves at left, although not that different, will add up to a considerable energy difference during the course of one year.

On the next page is a real data tracing of one compressor using load/unload controls. It operates at about 50% output all year long, feeding a rather constant

THE 9 MOST COMMON VSD

1 It is common to find VSDs without an external local disconnect.

a. The switch that is located on the door of some VSDs with a Siemens drive is not an isolation disconnect but an E-Stop switch.

b. This switch only isolates power from the Converter or Drive, not the control circuit.

c. A VSD requires a local disconnect switch to be installed.

2 A VSD has hazardous voltage and pressure present for six minutes after removing power and closing the discharge valve.

a. A VSD has a capacitor bank that filters and stores voltage at about 670 VDC.

b. This capacitor bank takes six minutes to discharge itself to 0 VDC after opening the local disconnect.

c. Some VSDs keep the separator pressurized to system pressure after a stop.

d. This pressure takes several minutes to blow down after the local disconnect is opened.

3 The placement of a VSD compressor is very important to its reliability.

a. The compressor should be installed in a clean, dry location with adequate clean cooling air flow.

b. Remember that a VSD compressor contains sensitive electronic components that are not protected from the environment.

c. Some dusts are conductive and can cause problems.

d. Dust of any kind acts as an insulator and can lead to overheating of the converter.

e. The cooling air should also be free of airborne chemicals.

f. Some chemicals can attack the circuit board coatings or the plastic vent fan found in most converters.

4 If a VSD is oversized:

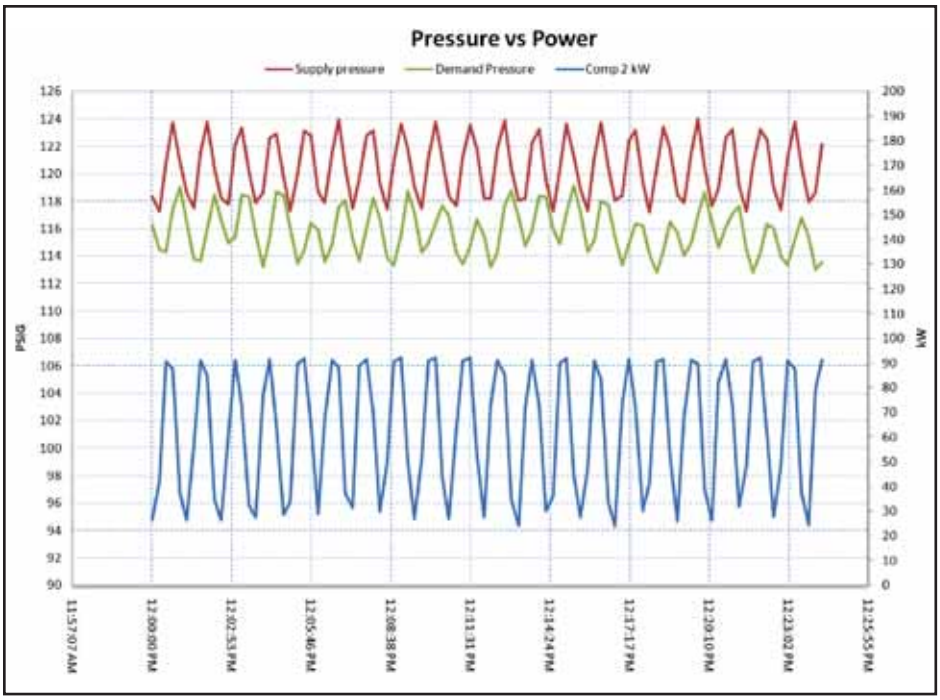
a. The compressor will run at low speeds and stop frequently.

b. This will cause low separator oil temperatures

c. Low separator temperature will cause the condensation in the compressed air to condense into the oil and stay there.

type load. Using Airmaster+ software[2] a 75hp VSD compressor was substituted in place of the 100 hp load/noload.

The chart at right shows the load/unload patterns in blue for the 100 hp compressor operating at a facility. Discharge pressure goes from 115 psig to 125 psig while the demand side pressure is about 7 psig lower. This is due to the pressure drop through the existing filter and dryer. The patterns produce a load profile showing 50% output, no matter what day of the week it is. Two day types were identified during the 7-day data collection period. Monday through Saturday seemed to repeat exactly the same each day with an increase in compressed air flow and power from the hours of 4P.M. to midnight. Sunday had no increase for the full 24 hours.



INSTALLATION ISSUES:

d. The oil level will rise as water begins to fill the bottom of the separator vessel and displace the oil.

e. Once the oil level hits the separator element, the oil will carry over downstream.

f. Once the water level in the separator vessel hits the oil supply line, the compressor element and bearings will be supplied water rather than oil for lubrication.

g. The result, if not caught in time, is a locked-up element

5 If a VSD is undersized or set up to run base load, it will run at its maximum RPM.

a. The compressor is not as efficient at max RPM.

b. The installation is better suited for a standard full load — no load compressor.

6 Multiple VSDs in a common system should be avoided unless:

a. Automation is installed

b. Only one unit runs at a time (redundant installation)

7 If multiple VSDs are running at the same time in a common air net:

a. One unit will have to run base load

b. Base load unit will run at Max RPM

c. Low efficiency

d. Better suited for a Full Load/No Load Unit

8 There are a couple ways of handling multiple VSDs in a system without automation; each has drawbacks.

a. Staggered pressure setpoints

b. Staggered running times

9 When staggering the pressure setpoint on two VSDs, the base load unit should have the Maximum RPM limited so that it does not run at Max RPM constantly.

a. This does, however, limit the capacity of the compressor.

b. You should also ensure that the top load unit does not run at minimum RPM and stop frequently (see over sizing). This cannot always be controlled.

SAVING ENERGY WITH A VSD COMPRESSOR

This data at right is a baseline of the existing 100 hp compressor loading and unloading all day long to feed the present demand load. Demand load, consists of production machines and leakage. All data is based on $ 0.15 kWh.

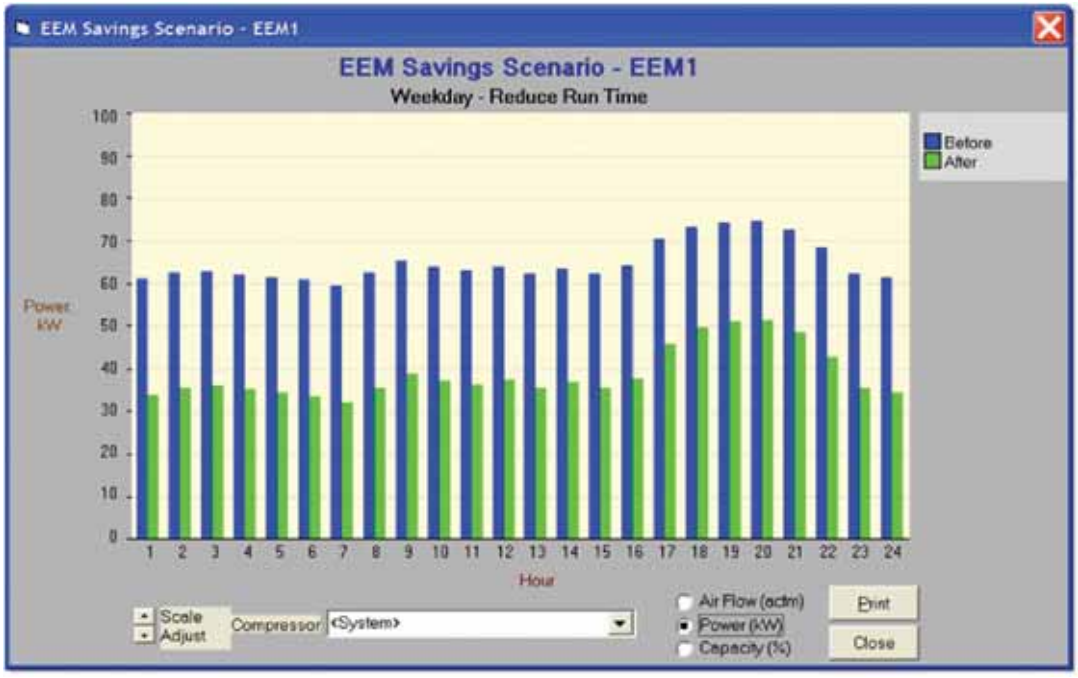
Using AirMaster+ software, a typical 75 hp variable speed compressor has substituted in lieu of the 100 hp to see the power savings available. This new baseline has dropped the annual cost by 229,108 kWh or $ 34,366 annually.

The chart at right is another representation of the difference in power or kW that would be required to maintain the present production rate with a 75 hp VSD. The present 100 hp has an output of 446 acfm at 125 psig. The facility only needs slightly less than 200 acfm, and with leak repair, even less.

For more information, please contact Mr. Frank Moskowitz, Draw Professional Services, tel: 480-563-0107, email: fmoskowitz@drawproservices.com

[1] The Hall Effect refers to the potential difference (Hall voltage) on the opposite sides of an electrical conductor through which an electric current is flowing, created by a magnetic field applied perpendicular to the current. Edwin Hall discovered this effect in 1879. When electrons flow through a conductor, a magnetic field is produced. Thus, it is possible to create a non-contacting current sensor. The device has three terminals. A sensor voltage is applied across two terminals and the third provides a voltage proportional to the current being sensed. This has several advantages; no additional resistance (a shunt, required for the most common current sensing method) need be inserted in the primary circuit. Also, the voltage present on the line to be sensed is not transmitted to the sensor, which enhances the safety of measuring equipment.

[2] (AIRMaster+ Version 1.1.2 Release Date: March 8), 2007AIRMaster+ provides comprehensive information on assessing compressed air systems, including modeling, existing and future system upgrades, and evaluating savings and effectiveness of energy efficiency measures



Daytype	Total OpHrs	Avg Airflow, acfm	Avg Airflow, %Cs.	Peak Demand, kW	Load Factor, %	Annual Energy, kWh	Annual Energy Cost, $
Weekday	7,512	225	29.1	74.4	44.5	486,590	72,988
Sunday	1,248	202	26.2	64.5	42.4	77,043	11,556
System Totals	8,760	213	27.6	74.4	43.4	563,633	84,545

Daytype	Total OpHrs	Avg Airflow, acfm	Avg Airflow, %Cs.	Peak Demand, kW	Load Factor, %	Annual Energy, kWh	Annual Energy Cost, $
Weekday	7,512	225	29.1	51.3	26.6	290,974	43,646
Sunday	1,248	202	26.2	38.2	24	43,551	6,533
System Totals	8,760	213	27.6	51.3	25.3	334,525	50,179

INDUSTRY NEWS

Press Releases

SULLAIR EARNS ENERGY STAR SPP PARTNER STATUS

SULLAIR®
Always air. Always there.

Michigan City, IN, March 1, 2007 — Sullair Corporation, a business unit of Hamilton Sundstrand, a United Technologies Company, is pleased to announce that it is now an ENERGY STAR Service and Product Provider (SPP) Partner. ENERGY STAR is a collaborative program of the U. S. Environmental Protection Agency (EPA) and the U. S. Department of Energy (DOE), which is helping to save money and protect the environment through energy efficient products and practices.

ENERGY STAR has come to symbolize an ongoing effort to improve the energy and financial performance of businesses, to manufacture products that comply with its standards, and to offer more environmentally friendly product choices. In 2006 alone, ENERGY STAR helped to save enough energy to power 15 million homes, reduced air pollution the equivalent of removing 14 million cars from the road while, and at the same time, saving nearly $7 billion on energy bills.

Sullair Corporation has made significant contributions to help maximize energy efficiency and productivity of compressed air systems. Among these contributions is AirMetrix℠, a total system management program designed to help users reduce energy consumption and maximize productivity by analyzing, managing and controlling the complete compressed air system.

Sullair is one of the world's leading compressor manufacturers, and has been an industry leader and innovator since 1965. With subsidiaries in France, China and Australia, Sullair is also a globally recognized manufacturer of compressed air contaminant removal equipment, vacuum systems and contractors' air tools.

energy
An ENERGY STAR Partner

INDUSTRY NEWS

VARIABLE SPEED DRIVE TECHNOLOGY FOR LESS!

SFC 18S Offers Less Noise, Uses Less Space

KAESER COMPRESSORS
Built for a lifetime.™

Kaeser Compressors, Inc. has expanded its line of Sigma Frequency Control compressors. The new price-competitive SFC 18S rotary screw compressor combines our proprietary Sigma Profile airend, Sigma Control Basic system and state-of-the-art drive technology to offer 21 to 114 scfm in pressures to 217 psig.

The SFC 18S features a space-saving cabinet and split-cooling air flow design for easier ducting and extremely low noise levels. Wide-opening access doors enable frontal access to all major components and significantly reduce access clearance and footprint. The SFC 18S is also available with tank mounting, and many SFC models are available with optional, integral refrigerated dryers.

Kaeser's variable speed drive, rotary screw compressors are specifically designed to achieve maximum efficiency over a wide flow range. Our advanced drive technology offers precise pressure control to +/- 2 psig with superior operation from 100% down to approximately 28% load.

There's never been a better time — or more affordable offer in variable speed drive technology. For more information, please call 800-777-7873 or visit us at www.kaeser.com/sfc.

NEW BALSTON® IT SERIES MEMBRANE AIR DRYERS PROVIDE PURE, DRY COMPRESSED AIR AT A GUARANTEED DEWPOINT OF 35°F AND FLOW RATES FROM 1 TO 50 SCFM.

Parker anything possible

Haverhill, MA — New, compact, point-of-use Balston IT-Series Membrane Air Dryers for applications requiring 35 °F dewpoints and flow rates up to 50 SCFM are now available from Parker Hannifin Corporation.

Proven to be the best performing dryers for the most sensitive point-of-use applications, the Balston IT-Series Membrane Air Dryers offer lower operating costs and better performance than both non-cycling and cycling refrigerant air dryers and eliminate downtime and costly repairs resulting from dirty, wet compressed air supplies.

The Balston drying system produces a guaranteed dewpoint of 35 °F and removes all other compressed air contaminants down to 0.01 micron in size. The system requires no electricity, has no moving parts and offers quiet operation. Unsurpassed in performance and durability to dehydrate and purify compressed air, the Balston IT-Series Membrane Dryer significantly outperforms refrigerant air dryers in dewpoint reduction and is far less expensive to operate.The Balston IT-Series Air Dryers are shipped complete with prefilters, auto drains and membrane modules all pre-assembled for easy installation.

For additional information, contact Parker Hannifin Corporation, Filtration and Separation Division, call toll-free at 1-800-343-4048 or 978-858-0505. Fax: 978-858-0625. Parker Hannifin Corporation, 242 Neck, P.O. Box 8223, Haverhill, MA 01835-0723.

With annual sales exceeding $9 billion, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of commercial, mobile, industrial and aerospace markets. The company employs more than 57,000 people in 46 countries around the world. Parker has increased its annual dividends paid to shareholders for 50 consecutive years, among the top five longest-running dividend-increase records in the S&P 500 index. For more information, visit the company's web site at http://www.parker.com, or its investor information site at http://www.phstock.com.

INDUSTRY NEWS

SETRA SYSTEMS TO INTRODUCE MODEL 260 "ONE SIZE FITS ALL" LOW DIFFERENTIAL PRESSURE TRANSDUCER

Model 260 Is Ideal for HVAC Control, Static Room Pressure, Oven Pressurization, Furnace Draft Controls, HVAC Service and Retrofit and Environmental Pollution Control

Setra Systems, Inc., a leading designer and manufacturer of pressure measurement devices, introduces its new Model 260, "One Size Fits All" low differential pressure transducer. The Model 260 offers user-selectable pressure ranges and analog outputs, a standard LCD, and AC/DC excitation on voltage output operation. At a standard accuracy of 1% FS, the Model 260 is the only multi-range transducer to provide fixed range performance for all selectable ranges. The Model 260 is Ideal for HVAC Control, Static Room Pressure, Oven Pressurization, Furnace Draft Controls, HVAC Service and Retrofit and Environmental Pollution Control.

Ideal for customers who are unsure of their exact requirements, this product gives the installer the ability "to configure on the fly." The Model 260 offers various pressure ranges from 0.1 in. W.C. full-scale up through 10" W.C. full-scale (comparable Pascal ranges available as well). All units may be field-configured as unidirectional or bidirectional ranges, which helps reduce inventory and gives users the flexibility of covering a wide range of typical HVAC applications with a single unit.

The Model 260 Series' capacitance-sensor provides better than 0.5% FS long-term stability. Combined with its microprocessor-based electronics, Setra guarantees the user uniform range-to-range accuracy — which equates to savings at start-up and eliminates the need for future service calls. Its standard LCD feature provides the installer and end user with a quick and accurate assessment to confirm proper operation functionality — no tools required!

Re-configuring the unit requires no more than a fingertip: there are separate slide switches for the range selection as well as analog output and unidirectional or bidirectional ranging of the span. User does not have to be concerned with jumpers or dip switches. Additionally, the model features an external push button for field zeroing to provide fast, accurate zero, without compromising the full-scale performance.

Additional benefits include immediate feedback of range and output status after reconfiguring. Its hinged spring-loaded cover, with no screws, enables quick access to all electrical connections and switches.

For more information on the Model 260, contact: Setra Systems, Inc., 159 Swanson Road, Boxborough, MA 01719; call 1-800-257-3872; fax: 978-264-0292 or e-mail: sales@setra.com. Visit Setra on the World Wide Web at http://www.setra.com.

NEW BREED OF AIR CONTROL VALVE PROVIDES PEAK PERFORMANCE IN EXTREME ENVIRONMENTS

RICHLAND, MICHIGAN, APRIL 02, 2007 — The Pneumatic Division of Parker Hannifin Corporation (NYSE:PH) introduces a heavy-duty industrial in-line valve series specifically designed for use in extreme operating conditions. The new Viking Xtreme® incorporates innovative spool technology for effective use in applications where pneumatic systems have to operate at extreme temperatures. Viking Xtreme has an operating temperature range of -40 ˚C to +70 ˚C, with a maximum pressure of 16 bar.

Traditional solenoid valves typically use either an O-ring or lip seals between the valve spool and body. The Viking Xtreme aluminum spool, with a specially engineered over-molded rubber, eliminates the problems of seals deforming or extruding under conditions of high pressure or flow.

The precision ground-molded spool construction lessens unit complexity, increases flow rates, ensures stable seal performance in high flow/pressure drop situations and offers robust performance in a wide range of operating temperatures.

Viking Xtreme provides enhanced performance for a variety of mobile applications such as truck/trailer, bus/coach and rail, as well as non-mobile uses, including mining, wood cutting, pulp/paper processing and sawmill operations.

The new Viking Xtreme is available in three versions — solenoid operated, remote air pilot, and manually actuated. With a choice of ⅛", ¼", ⅜" and ½" port sizes, the series offers peak performance in the most rugged environments. Viking Xtreme is a robust IP65-rated valve, constructed with an anodized aluminum body, and a bore polished to high surface finish for maximum flow capacity and extended life. Thermo set plastic coils, stainless steel fasteners and anodized aluminum end caps complete the product package and provide durability and resilience. A porous sintered bronze vent plug is built-in to prevent contamination ingression.

For more information regarding the Viking Xtreme pneumatic valve, contact Parker Hannifin Corporation, Pneumatic Division. Phone (269) 629-5000 or visit us online at www.parker.com/automation/transportation.

INDUSTRY NEWS

PENTAIR ACQUIRES POROUS MEDIA, FURTHERS ITS WATER STRATEGY

MINNEAPOLIS — March 6, 2007 — Pentair, Inc. (NYSE:PNR) announced today it has entered into a definitive agreement to acquire Porous Media, a privately held Minnesota company with manufacturing operations in both Minnesota and Texas. The acquisition accelerates the Company's water strategy by strengthening its filtration and separation technology portfolio and extending its reach into attractive new markets.

"Porous Media is a compelling strategic fit with our existing water business," said Randall J. Hogan, chairman and chief executive officer. "We will leverage Porous Media's filtration and separation technologies across Pentair's existing Water customers, especially in markets outside of North America. For example, we believe Porous Media's oil separation technologies, developed for the petrochemical market, will effectively address unmet needs for our existing wastewater reuse and recovery customers globally," he said. "In addition, we will capture synergies from the acquisition by applying Pentair's Integrated Management System, especially our supply management and lean disciplines," Hogan said.

The Company noted that the acquisition also brings strong technical talent to its Water Group, including engineering, material science, media development and application capabilities. These strengths are reflected in Porous Media's current product offerings and robust new product development pipeline.

Porous Media's well-protected product portfolio includes high-performance filter media, membranes and related filtration products and purification systems for liquids, gases and solids for the general industrial, petrochemical, refining and healthcare market segments, among others. Within its offering, consumable products represent more than 80 percent of Porous Media's sales and provide an established base of recurring revenue, according to Pentair.

Pentair said the transaction is expected to close in the second quarter of 2007, and that the purchase price is approximately $225 million or, adjusted for tax benefits, 9.7 times 2007 expected EBITDA. Pentair expects the acquisition to be approximately $0.03 to $0.04 dilutive in fiscal year 2007, with a significant portion of the dilution attributable to the fair market step-up in inventory. Pentair also announced it is reducing the top end of its previously announced 2007 earning guidance range of $2.00 to $2.15 to reflect the dilutive impact of the acquisition.

About Pentair, Inc.

Pentair (www.pentair.com) is a diversified operating company headquartered in Minnesota. Its Water Group is a global leader in providing innovative products and systems used worldwide in the movement, treatment, storage and enjoyment of water. Pentair's Technical Products Group is a leader in the global enclosures and thermal management markets, designing and manufacturing thermal management products and standard, modified and custom enclosures that house and protect sensitive electronics and electrical components. With 2006 revenues of $3.15 billion, Pentair employs approximately 15,000 people worldwide.

ADVANCED SOLUTIONS FOR YOUR COMPRESSED AIR CHALLENGES

The BEKO range of reliable performance products includes all aspects of economical, safe and ecologically responsible compressed air use. With their unique and diverse capabilities, all of the product families meet the demands of tomorrow's advancements today, from individual components right up to those of complete large-scale systems.

Being that every system, no matter how large or small, is made up of individual components, only components that are designed to work with each other, and are suited to rigorous applications and conditions can fulfill their performance expectations in a reliable and environmentally friendly way.

BEKO does more than manufacture phenomenal products, we are a complete solutions provider. Ranging from analysis of the problem, to specification, installation support, maintenance resolutions and comprehensive customer service, the BEKO know-how for compressed air use is customer oriented with a global focus.

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No activated carbon

Separates condensate emulsions and mixtures

Each drop of condensate in the compressed air system involves risks, and these risks can kill cost accounting and profitability at any time. Superior condensate management can only be achieved through the use of reliable and technologically advanced products like those offered by **BEKO** Technologies. With over one million installations of **BEKOMAT®** condensate drains, the numbers simply speak for themselves. **ÖWAMAT®** oil-water separators set the industrial standard for condensate treatment.

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236 Raceway Drive
Suite 1
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USA

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Kaeser SFC compressors:
The product of a better idea.

In the drive to save energy costs by precisely matching *air production* to *air demand*, Kaeser's Sigma Frequency Control compressors are the most energy-efficient variable speed, single-stage compressors you can find. The competition simply can't compare in performance *or* quality.

Kaeser SFC compressors offer a wider range of operation, from 20% partial load to 100% full load. Plus, our oversized *Sigma Profile*™ airend rotates at lower speeds for greater output while consuming less energy.

With near-unity power factory, built-in phase protection, and superior pressure control, our SFCs are built for a lifetime! And, since we offer them in the widest range of sizes – most with integral dryer options – we have just the right model for your needs. Of course, the best way to appreciate the superior engineering of Kaeser SFC compressors is to see them in operation, so call **866-516-6888** to find one near you.

KAESER COMPRESSORS

Built for a lifetime.™

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(866) 516-6888

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

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