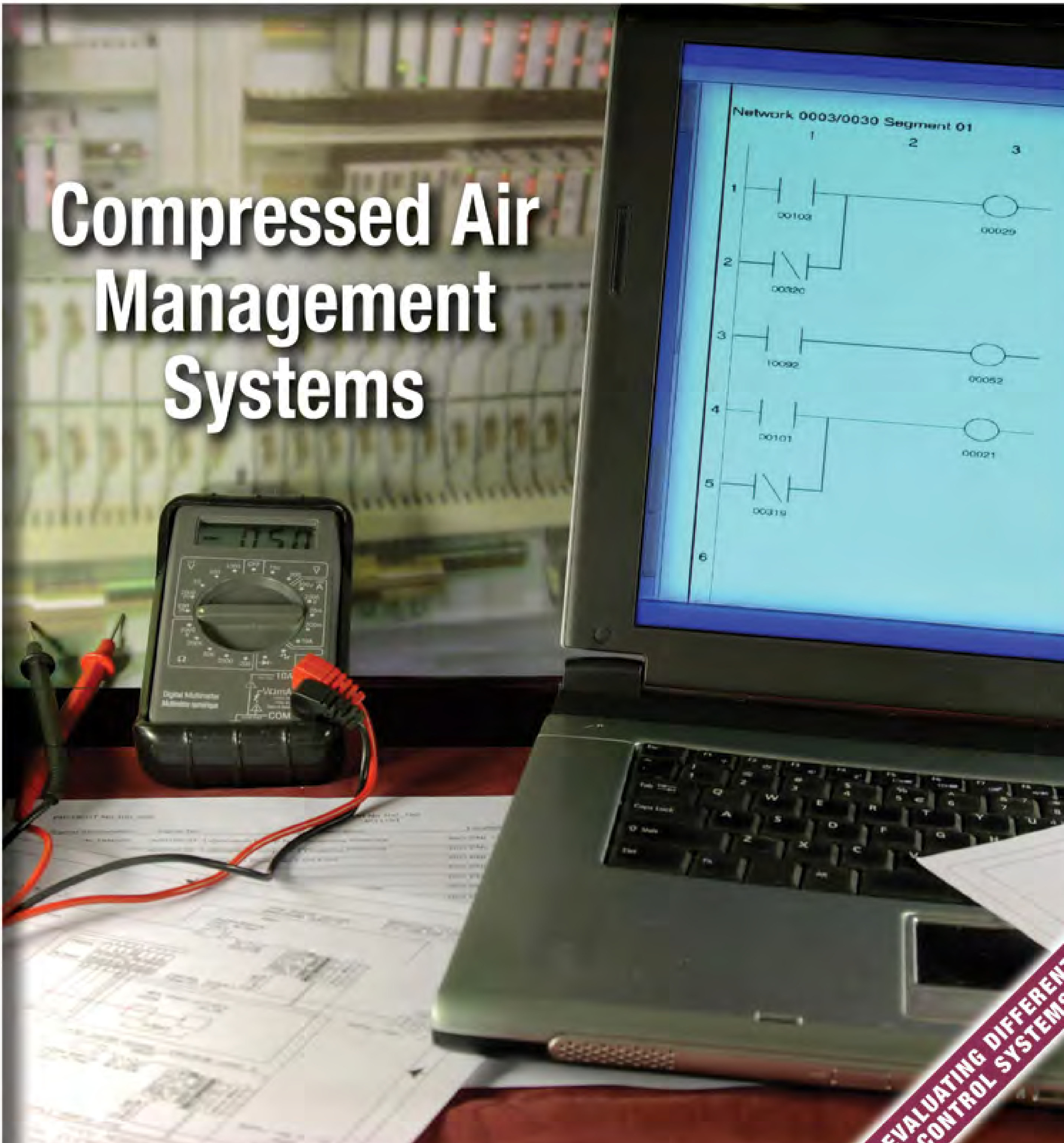
Grimmway Farms System Automation | Master Controllers Save Energy

October 2009

COMPRESSED AIR BEST PRACTICES®

Compressed Air Management Systems



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HITACHI
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SUSTAINABLE MANUFACTURING FEATURES

COLUMNS


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FROM THE EDITOR

Compressed Air Management Systems

The compressed air industry joins Kaeser Compressors in mourning the passing this month of Mr. Carl Kaeser. We offer our condolences to his family and all Kaeser employees around the world.

The System Assessment of the Month details the System Automation implemented by Grimmway Farms in California. Ecos Air and Accurate Air Engineering teamed up to provide Grimmway with a system which qualified for a 55% energy incentive from Pacific Gas & Electric.

Heat-reclaim "economics" of rotary screw air compressors are reviewed by Mr. Mike Wlodarski of HydroThrift Corporation. This is an interesting article written from the perspective of a cooling system manufacturer with significant experience in this field. There are great opportunities for most existing compressed air installations.

The topic of master controllers and management systems for compressed air supply equipment is examined in our Technology Provider articles. Air compressors, air treatment products and measurement devices can all work together to optimize a compressed air system — even if they are of different makes and models. In a new era where energy managers want data from their compressed air systems, demand for compressed air management systems is growing. Manufacturers of these technologies (like Pneu-Logic, SIGA Airleader and Standard Pneumatic Products) share their knowledge with us on the topic.

Some Energy Managers have expressed confusion over the differences between the types of master controllers and sequencers available on the market. Mr. Hank Van Ormer of Air Power USA shares his practical approach to system assessments. In his article, he provides some suggestions on how to evaluate the different central compressed air management systems available today.

Grimmway Farms received a $66,000 incentive check from Ecos Air and PG&E.

We hope you enjoy this edition, and thank you again for your support and for investing in industrial energy efficiency.

ROD SMITH
Editor
rod@airbestpractices.com

SUSTAINABLE MANUFACTURING NEWS

Siemens, Baxter, Rockwell Automation, 3M

SOURCED FROM THE WEB

SIEMENS

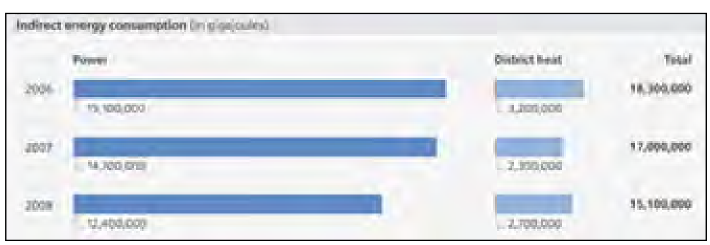
> "Although our total revenues grew by 9% in fiscal 2008, power consumption recorded at our environmentally relevant locations dropped by around 15%."
>
> — Siemens

Siemens Corporate Responsibility

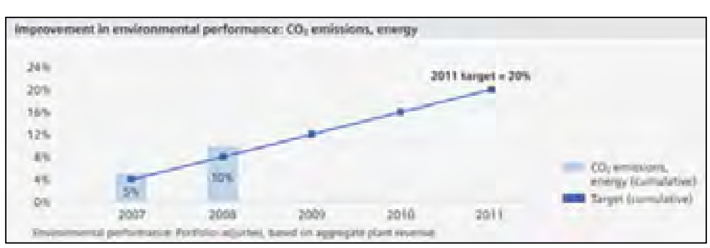
Energy consumption, water consumption, greenhouse gas emissions, VOC emissions, emissions of R11 equivalents and waste volumes are all key parameters that we track at a company level. In fiscal 2008, 315 locations in 37 countries (100% of the company units required to file reports — see the chapter on Environmental Protection in the "Management" section) submitted environmental performance data through SESIS (Siemens Environmental and Technical Safety Information System). In 2008, our reporting base changed once again: 46 new locations were added and 82 were removed — the latter primarily as a result of the sale of Siemens VDO.

Energy Consumption

Although our total revenues grew by 9% in fiscal 2008, power consumption recorded at our environmentally relevant locations dropped by around 15%. This is largely because the Siemens VDO Automotive (SV) manufacturing locations we sold had higher headcounts and consumed significantly larger quantities of power than the new factories and is also due to acquired businesses that we've incorporated into our reporting system.



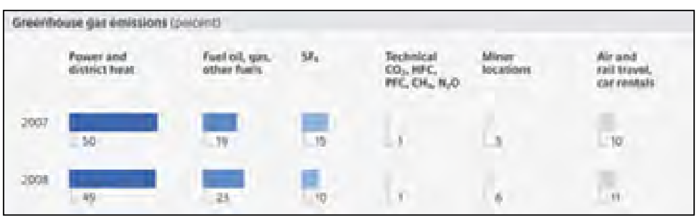
Our efficiency KPI for CO_2 emissions improved to 10% in the reporting period. This figure is derived from our CO_2 emissions from primary energy and power consumption and, therefore, lies between the previously stated energy KPIs.



In fiscal 2007, we decided to align our greenhouse gas reporting with guidelines issued by the World Business Council for Sustainable Development and the World Resources Institute (Greenhouse Gas Protocol). All of our greenhouse gas emissions figures are now calculated according to this system. Specifically, this means:

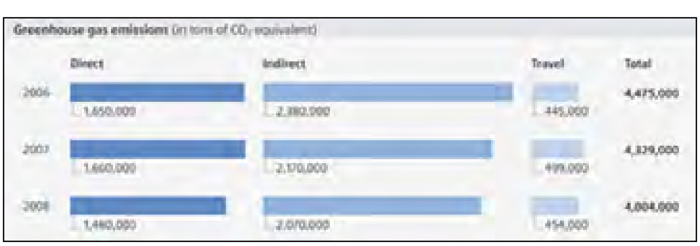
- Emissions figures are extrapolated to 100% if the data collected does not cover the whole of Siemens
- Reporting is based on continuing operations. In other words, figures are adjusted to reflect portfolio changes by eliminating emissions for those locations that have been sold. If no exact figures are available for emissions at recently acquired locations, these are estimated for prior years and added to the series
- The base year for the computation is fiscal 2005

In 2008, we again had our greenhouse gas report reviewed and verified by Det Norske Veritas (DNV). Besides ensuring transparency, the verification process gives us an opportunity to discuss our computation methods with experts in this field and to refine these methods from year to year.



Our greenhouse gas emissions in 2008 totaled four million tons. They were primarily caused by power generation, burning fossil fuels and the emission of sulfur hexafluoride (SF6) from the manufacture of high-voltage equipment converted into CO_2 equivalents. Other greenhouse emissions were caused by glass furnaces, cooling systems, test stations, small office locations and business travel.

As the series of figures below shows, our greenhouse gas emissions have dropped steadily since 2006, and in 2008, we succeeded in cutting output by 8% from the previous year.



Source: www.siemens.com

SUSTAINABLE MANUFACTURING NEWS

Siemens, Baxter, Rockwell Automation, 3M

Baxter Management of Energy Use and Cost

Effectively managing energy usage enhances business efficiency, conserves natural resources and benefits human, and other life, on earth. Reducing the use of fossil fuels, such as coal and fuel oil, enhances air quality by reducing fine particulates that contribute to adverse health effects, and helps limit the generation of greenhouse gas (GHG) emissions, which contribute to climate change. In addition, limiting the use of non-renewable energy sources helps preserve their availability for future generations.

While energy conservation benefits the environment, it also makes good business sense for Baxter, since energy is among the company's most significant manufacturing costs. Since 2005, while Baxter's sales increased nearly 24% through 2008, absolute energy usage increased just 3%. However, due to sharply increasing global energy prices, energy costs increased 42% during that time, to a total of $182 million. This underscores the importance of Baxter's ongoing energy management efforts. During the last decade, Baxter has strengthened its energy management program. In 1999, it re-energized its corporate energy management group, and in 2001, it established a formal position statement on Climate Change and Energy. In 2005, Baxter hired a director of energy management to lead long-term strategic energy planning, coordinate global energy conservation activities and support energy conservation projects.

Baxter's corporate energy management group oversees the company's global energy conservation activities and reports energy usage, cost and efficiency improvements quarterly to senior management. Since 2005, Baxter has increased the number of annual facility energy reviews, expanded the use of a third-party utility invoice payment service, established and provided training on facility "Lean" energy standards and promoted best practices in energy management across the company. In addition, to encourage the implementation of energy efficiency projects, Baxter has lowered its internal rate of return for such projects.

"Lean" Energy Program

In 2007, Baxter launched a "Lean" energy program for the company's 63 principal manufacturing facilities. The program established four sets of energy standards — prerequisite, bronze, silver and gold — to be phased in from 2007 to 2010. Each category defines 25–30 requirements a facility's energy program should meet. In 2008, 17 locations met 100% of the bronze-level requirements, and several facilities are on target to achieve silver and gold status.

Biennial Global Energy Conference

Baxter Facilities Engineering Services, with the support of the company's Manufacturing Council, coordinates a biennial Global Energy Conference for Baxter facility energy managers. The most recent conference was held in autumn 2008 in San Jose, California. Approximately 120 Baxter energy managers, corporate staff, outside presenters and guests attended this conference, which included a special focus on renewable energy and alternative power generation.

Performance

Baxter extended its commitment to reducing energy usage from operations from its original 2010 goal of a 20% reduction indexed to revenue, compared to 2005, to a 30% reduction by 2015, also indexed to revenue and compared to 2005. Energy usage from operations includes the energy used by Baxter-managed and Baxter-operated facilities, sales and truck fleets.

From 2005 to 2008, energy consumption for Baxter operations increased 3% in absolute terms, from 8,945 to 9,216 trillion joules. During this same period, Baxter improved overall energy efficiency (energy usage indexed to revenue) by 18%. This puts the company on track to meet its energy improvement goals.

Source: www.baxter.com

Rockwell Automation

Rockwell Automation Environmental Performance

Rockwell Automation concentrates most of its energy conservation programs on reducing electricity usage because electricity constitutes the majority of its energy consumption and carbon footprint. In 2008, when normalized to sales, Rockwell Automation reduced electricity usage in its 56 manufacturing locations by 9% as compared to 2007.

Only 10% of the carbon footprint is from natural gas usage. While that is a small portion of the total energy profile, we were disappointed that usage increased 18% in 2008 when normalized to sales. Liquid fuels are less than 1% of our carbon footprint and, when normalized to sales, we used 27% less compared to the previous year.

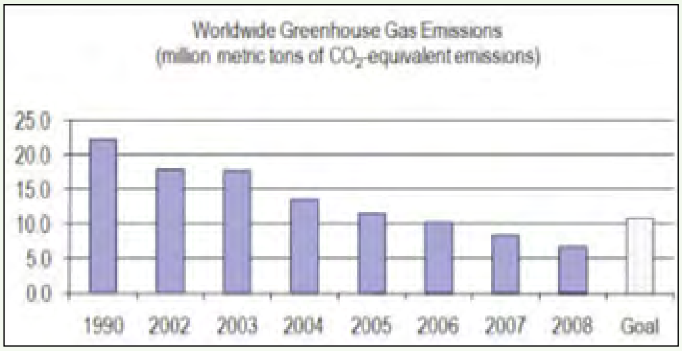
While liquid fuels and natural gas do result in CO_2 emissions, nearly 90% of our emissions are indirect because CO_2 generation takes place at the electric utility, not at our sites. For 2008, our total CO_2 emissions dropped 9%.

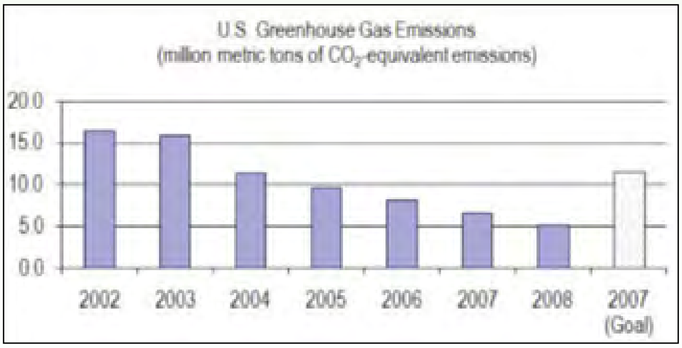
In the coming year, we will expand and redefine our global greenhouse gas reduction efforts, both in terms of the number of facilities we monitor and the scope of emissions we measure. We'll then set new baseline measurements to track energy use and greenhouse gas emissions. We've embarked on this effort as part of our new US EPA Climate Leaders membership.

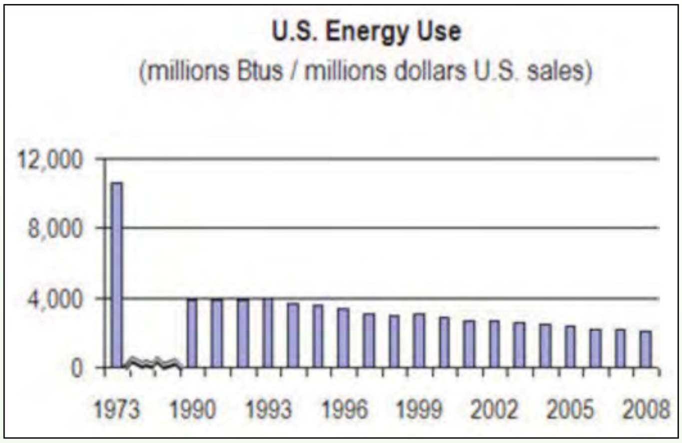
Source: www.rockwellautomation.com

SUSTAINABLE MANUFACTURING NEWS

Siemens, Baxter, Rockwell Automation, 3M







3M Climate Change and Energy Management

Recognition

In 2009, 3M received the ENERGY STAR Sustained Excellence Award for Energy Management from the EPA and the U.S. Department of Energy in recognition of continuous improvement in energy management. 2009 marked the sixth year in a row that 3M was recognized by ENERGY STAR — a record for an industrial company.

Reducing Greenhouse Gases

Greenhouse gas (GHG) emission reductions have been a long-time priority for 3M. Although the science of global climate change is evolving, 3M has taken, and continues to take, voluntary responsible action to reduce GHG emissions. 3M reduces its global greenhouse gas emissions (including both the basket of greenhouse gases outlined in the Kyoto Protocol and other greenhouse gases not included in the protocol) through manufacturing process improvements, energy conservation and additional pollution control equipment.

Setting Goals to Drive Progress

Rigorous greenhouse gas accounting systems and reduction goals are key components of 3M's greenhouse gas management strategy. 3M develops an annual inventory of its greenhouse gas emissions worldwide using the World Resource Institute/World Business Council for Sustainable Development GHG Protocol. See *Sustainability In-Depth: 3M's GHG Inventory Development* (PDF, 51KB) for more information on the inventory.

Global Goal — In 2002, 3M set a goal to reduce its worldwide GHG emissions by 50% (from a 1990 base year). 3M achieved this goal in 2006, and continues to drive additional reductions. In 2008, 3M reduced global GHG emissions by 69% from its 1990 base year.

United States Goal — 3M partnered with the Environmental Protection Agency through its Climate Leaders Program to reduce U.S. GHG emissions by 30% by 2007 (from a 2002 base year). At the end of 2007, 3M had exceeded this goal by reducing U.S. greenhouse gas emissions by 60% from 2002.

3M's energy efficiency efforts date back to 1973, when the 3M Energy Management Department was formed. Improvements result from employee programs that increase energy efficiency of existing operations, new equipment and facilities designed to be energy efficient and the development of new, more energy efficient 3M products and processes. Using Life Cycle Management, new product development teams work to improve the energy efficiency of 3M products. They consider energy efficiency in their choice of raw materials, product formulations and manufacturing processes.

To drive continuous improvement in energy management, the company has set a goal to improve energy efficiency by 20% from 2005–2010. This goal is in addition to previous energy efficiency efforts, which achieved an 80% improvement in energy efficiency at 3M's U.S. operations since 1973, and a 43% improvement in energy efficiency at 3M's operations worldwide since 1998.

During 2008, 3M implemented 212 energy projects, which saved over $9.7 million. 3M has realized $37 million in energy savings from its 2005 base year by implementing more than 1,400 employee-inspired projects. We continue to adopt new methods to improve energy efficiency, including the use of Six Sigma methodology and an increase in our use of alternative, renewable energy. BP

Source: www.3m.com

THE SYSTEM ASSESSMENT OF THE MONTH

Grimmway Farms Implements System Automation While Receiving an Incentive for 55% of the Total Project Cost

BY PATRICIA BOYD, ECOS AIR

October System Assessment of the Month

Where:	Arvin, CA
Industry:	Food Processing
Issues:	Multiple compressors are not automated and are therefore inefficient
Audit Type:	Compressed Air System

System Assessment Win/Win Results*

Reduction in Energy Use:	765,274 kWh
Reduction in CO_2 Emissions:	545 metric tons
Equivalent CO_2 for Homes:	72 homes
Equivalent CO_2 for Vehicles:	100 vehicles
Approximate Annual Savings:	$64,283
Investment:	$120,000
Energy Rebate:	$65,482
Simple ROI:	11 months

*Annual energy consumption

A family of Growing companies

Introduction

This article presents a case study of Grimmway Farms, a carrot growing and packing firm located in California's Central Valley, that was able to improve its compressed air system's efficiency after implementing system automation and making relatively small equipment and piping changes.

Grimmway Farms uses compressed air for the production and clean-up processes in their carrot packing plants. After having been approached by the Ecos Air Program (see sidebar), members of Grimmway's energy efficiency program realized that in addition to decreasing the continued energy use of their compressed air system while simultaneously improving overall performance, there may also be an opportunity to receive a considerable monetary incentive, which could offset the cost of the suggested energy reduction improvements.

Ecos Air worked with auditor Kyle Harris, a Department of Energy "Compressed Air System Energy Expert" and a major contributor to this article, to perform the assessment of the existing compressed air system.

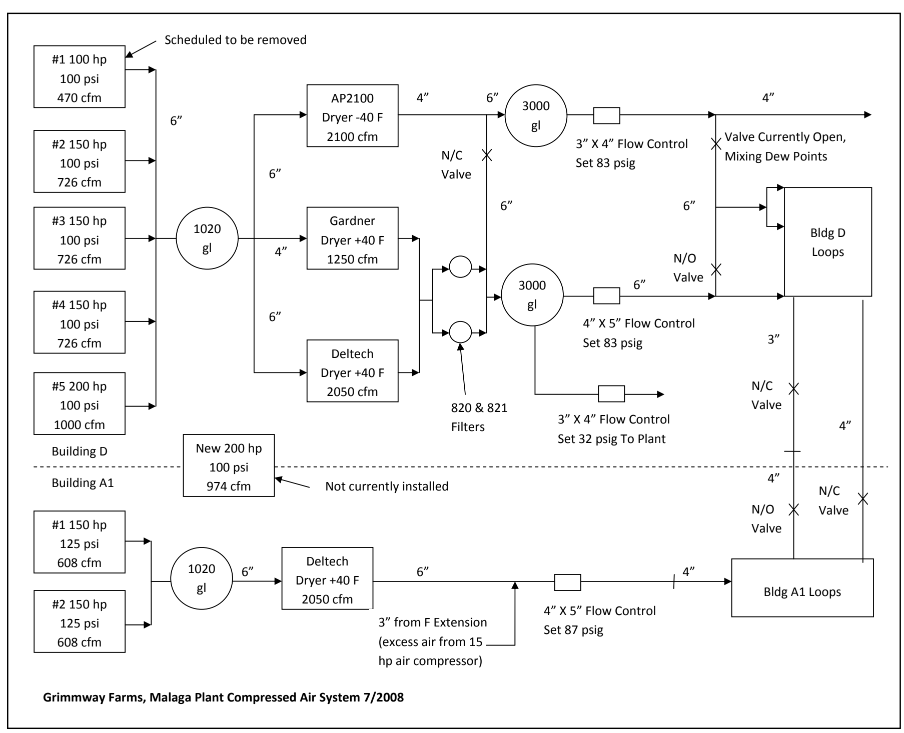


Figure 1 — Original Malaga Compressed Air System

System Before Assessment

The pre-project system (Figure 1), located in two buildings (D and A1) with normally closed interconnected piping, operated independently and consisted of 1 x 200 horsepower, 5 x 150 hp and 1 x 100 hp (not in operation) oil-flooded, variable displacement controlled, rotary screw air compressors. An additional new 200 hp air compressor had been previously purchased for the facility, but had not yet been installed.

Local controls for each of the Building D air compressors maintained a system pressure of 97–99 psig, with full flow at 97 psig, and no flow at approximately 102 psig. If unloaded for ten minutes, the compressors would automatically shut down until system pressure reached 90 psig, at which time they would restart. These air compressors discharged into a common 1,020-gallon air receiver before entering one of two refrigerated air dryers or a desiccant-filled blower purge air dryer. Compressed air from the blower purge air dryer discharged into a 3,000-gallon air receiver and then through a flow controller/demand expander, which was set at 83 psig. After exiting the refrigerated air dryers, the compressed air entered a separate 3,000-gallon receiver and discharged through one of two flow controller/demand expanders. One flow controller was set at 83 psig, while the second was set at 32 psig for a specific process in the plant. At the time of the assessment, the normally closed crossover valve between the discharge of the refrigerated compressed air dryers and the desiccant blower purge air dryer was found to be open.

Compressor System before Assessment		Compressor System after Assessment	
Operating Hours:	8736 hours	Operating Hours:	8736 hours
Power Cost kW/h:	$0.084	Power Cost kW/h:	$0.084
Avg. Air Flow:	1903 acfm	Avg. Air Flow:	1782 acfm
Plant Air Pressure:	100 psig, controlled to 85 psig and 32 psig	Plant Air Pressure:	100 psig, controlled to 83 psig and 32 psig
Compressed Air Specific Power:	21.7 kW/100 cfm	Compressed Air Specific Power:	18.2 kW/100 cfm
Annual Energy:	3,596,788 kWh	Annual Energy:	2,831,338 kWh
Annual Energy Cost:	$302,130	Annual Energy Cost:	$237,822

THE SYSTEM ASSESSMENT OF THE MONTH

Grimmway Farms Implements System Automation While Receiving an Incentive for 55% of the Total Project Cost

Incentive Details

Grimmway Farms received a substantial rebate of $65,482 (55% of the total project cost) from Pacific Gas & Electric's Ecos Air Program. This innovative program works with industrial facilities on behalf of a utility to search for users of compressed air, coordinate walkthroughs and site audits, manage all applications and forms, establish flow and kW baseline parameters, develop a financial summary with payback and verify final conditions to ensure that the savings claimed by the utility are genuine and verifiable when reporting to their utility commission.

While there are many utilities that provide kWh reduction incentives for customers that implement efficiency measures, the process is normally administered by either the customers themselves or by the equipment vendor. Alternatively, the Ecos Air Program has been developed for utilities willing to fund a vendor-neutral third-party contractor to implement an efficiency incentive program for industrial system compressed air users. In this case, the utility simply establishes a financial budget and leaves program execution to Ecos Air.

Building A1's compressor controls operated similarly, except system pressure was maintained at 106–108 psig with full flow at 106 psig and no flow at approximately 114 psig. They, too, would automatically shut down if unloaded for ten minutes, but would restart at approximately 95 psig. These air compressors discharged into a common 1,020-gallon air receiver, where the air entered a single refrigerated air dryer. The compressed air was then controlled by a flow controller/demand expander to a set point of 87 psig.

Baseline Determination

Data collection took place over a seven-day period during which plant personnel indicated that the plant was operating in a typical fashion. Compressor power and system pressure were collected via data loggers and data storage equipment, analyzed in LogTool v2 and then imported into AIRMaster+ v1.2, where various scenarios were modeled. Estimated annual energy consumption was extrapolated from the study period to a full year.

According to plant personnel, the Grimmway Farms air compressor system remains pressurized 24 hours per day, 7 days per week. Therefore, the number of annual hours used for all calculations was 8,736, which assumed one day of complete plant shutdown. The annual energy cost to operate only the compressors was calculated at the usage rate of $0.084 per kWh. Table 1 and Figure 2 illustrate the data collection findings.

Daytype	Total OpHrs	Avg Airflow (acfm)	Average Demand (kW)	Annual Energy (kWh)	Annual Energy Cost ($)
Sunday	1,248	802	190.0	237,141	19,920
Monday	1,248	2,315	496.3	619,398	52,029
Tuesday	1,248	2,452	516.7	644,784	54,162
Wednesday	1,248	2,284	485.4	605,810	50,888
Thursday	1,248	2,366	498.7	622,336	52,276
Friday	1,248	2,273	487.0	607,818	51,057
Saturday	1,248	826	207.9	259,501	21,798
System Totals	**8,736**	**1,903**	**411.7**	**3,596,788**	**302,130**

Table 1 — Baseline System Profile

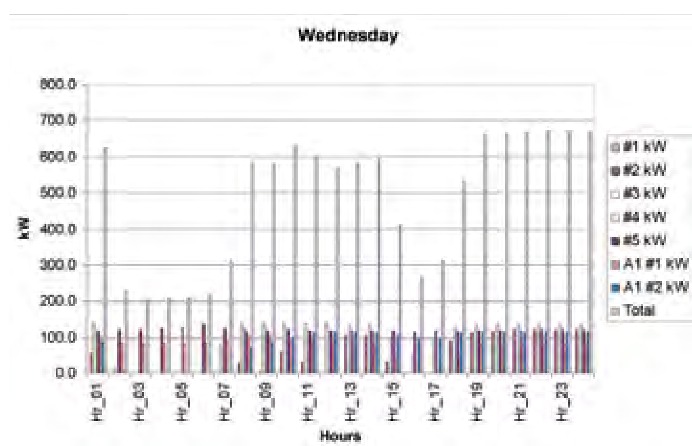


Figure 2 — Typical Day Profile

Issues with the System

Common to multiple compressor facilities without automated control systems or interconnected piping, the Grimmway Farms compressed air system was not optimally matching compressor output to system demand. Data collection proved this to be the case and multiple compressors were found to be operating partially loaded and, therefore, not running at maximum efficiency. The goal is to always have "base" compressors running at full load with "trim" units responding to swings in demand, rather than operating two or more compressors at partial load. Additionally, connecting the two separate compressed air systems would enable both loops to be supported by compressors in either building. The major modifications recommended were as follows:

- Automate the entire air compressor system
- Open the 3" and 4" headers connecting Buildings D and A1 to allow the compressed air to feed either building
- Install the 200 hp (new) compressor and remove the 100 hp (unused) compressor
- Install a new refrigerated air dryer, flow controller, three flow meters and a dew point meter for the lowest dew point process
- Lower overall system pressure

System After Assessment and Upgrades

The customer chose to use Accurate Air Engineering, Inc. to implement the above system improvement measures. Figure 3 is a simplified illustration of the post-project system.

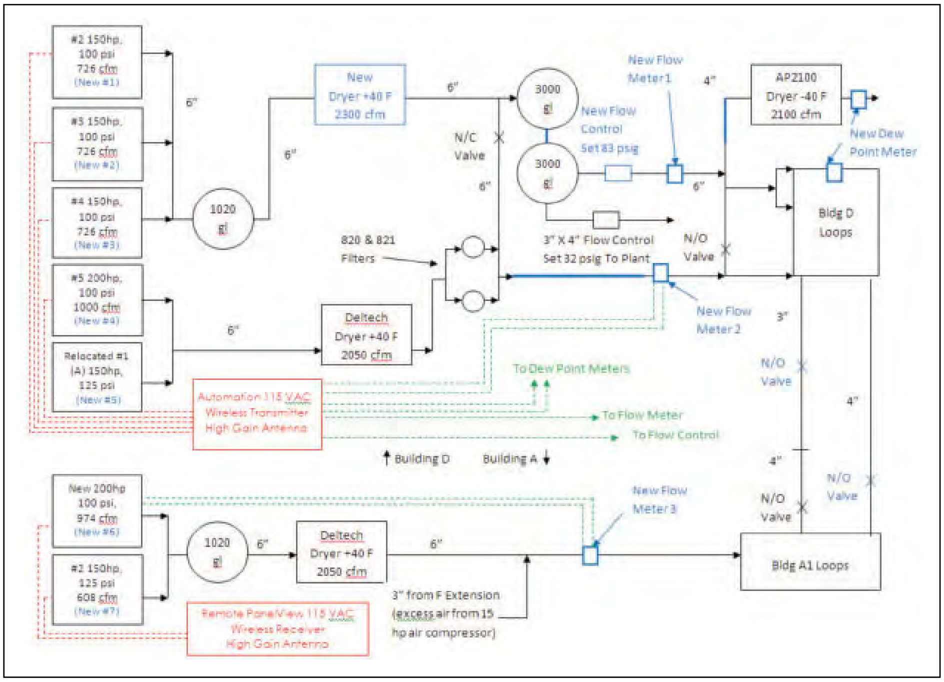


Figure 3 — Malaga Layout with Automation

THE SYSTEM ASSESSMENT OF THE MONTH

Grimmway Farms Implements System Automation While Receiving an Incentive for 55% of the Total Project Cost

The original compressor #1 (100 hp) in Building D was removed, as was the flow controller in Building A1. The new 200 hp compressor was installed in Building A in place of one of the 150 hp compressors, which was relocated into Building D. A central Gardner Denver control system was installed to automate all compressors in the system. This control system enables the compressors to operate within a narrow dead-band and at a lower pressure using a "Base Load and Trim" strategy. Compressors are now initiated only when needed in a fixed (last-in/first-out) order sequence. For convenience, the compressors were renumbered (Table 2).

Compressor Number	HP	CFM	Pressure psig		Use	Building
			Design	Operating		
1	150	726	100	84 - 98	Trim	D
2	150	726	100	84 – 98	Trim	D
3	150	726	100	84 – 98	Trim	D
4	200	1000	100	83	Base	D
5	150	608	125	83	Base	D
6	200	974	100	83	Base	A
7	150	608	125	83	Base	A

Table 2 — Summary of Compressor Ratings, Location and Use

The combined systems' "trim" station includes compressors #1, #2 and #3, which now operate from 84–98 pisg (rather than 98 psig). They discharge into the 1,020-gallon wet receiver before entering into a new refrigerated air dryer. Next, the air enters the combined 3,000-gallon dry receivers (the GD air dryer was removed and the two 3,000-gallon receivers connected) before flowing through a new 3,200 cfm flow controller/demand expander set at 83 psig ± 1 psig, which is maintained with a full PID digital control loop connected to the automation panel.

Building D's "base" compressors, #4 and #5, connect to the main supply header downstream of the new "trim" flow controller. Building A's compressors, #6 and #7, are also part of the "base" station and now feed both Building D and Building A. All "base" compressors, which originally operated from 98–107 psig, now operate 100% loaded at 83 psig. This is due to the fact that they are piped in downstream of the new Building D flow controller, which forces them to operate 100% loaded at a pressure that is lower than their design, enabling them to deliver the same flow using less power.

Control Scheme

To determine "trim" compressor loading, rate-of-change pressure is calculated and monitored at the two trim station 3,000-gallon air receivers. "Base" compressor loading is determined by downstream pressure in the plant.

From a zero flow point and with compressed air demand rising, the #1 (150 hp) "trim" compressor starts and runs load/no-load until fully loaded. When system demand exceeds the capacity of the #1 air compressor (rate of decay in 3,000 x 2 gallons = negative), the #3 (150 hp) "trim" air compressor will start and run load/no-load until it, too, is fully loaded. When system demand exceeds the capacity of the #1 and #3 (300 hp total) compressors, the #7 (150 hp) "base" compressor will start. The #1 and #3 air compressors will respond by unloading until the demand exceeds the new #7 air compressor. As load again increases, the "trim" compressors begin to load as described in the previously listed steps.

When the demand exceeds the capacity of the #1, #3 and #7 compressors (450 hp total), the #4 (200 hp) "trim" compressor initiates. Again, the steps listed above for the "trim" air compressors will repeat, and any additional demand will initiate the #5 (150 hp) compressor and, finally, the #6 (200 hp) air compressor. The #2 (150 hp) "trim" air compressor will start if another "trim" compressor fails, if any other air compressor fails and the demand is greater than the output of the operating air compressor(s) or if the demand exceeds the capacity of all other air compressors.

"Base" compressors drop out when the demand expander is 100% closed, "trim" compressors are unloaded and the system pressure rises to 1.5 psig above the demand expander set-point, or 84.5 psig.

> "As a result of the above changes to Grimmway Farm's compressed air system, compressor output more closely matches system demand, and continued energy costs have been reduced by approximately $64,000 annually."
>
> — Patricia Boyd, Ecos Air

Post-Monitoring Results

Post-monitoring results (Table 3 and Figure 4) were collected on the new automation system and downloaded to a computer for analysis and monitoring.

Post Installation Summary Measured					
Daytype	Total OpHrs	Avg Airflow, acfm	Ave Demand, kW	Annual Energy, kWh	Annual Energy Cost, $
Sunday	1,248	657	119.5	149,136	12,527
Monday	4,992	2,096	381.2	1,902,950	159,848
Friday	1,248	2,583	469.8	586,310	49,250
Saturday	1,248	849	154.5	192,816	16,197
System Totals	8,736	1,782	324.1	2,831,213	237,822

Table 3 — Post Monitoring Results

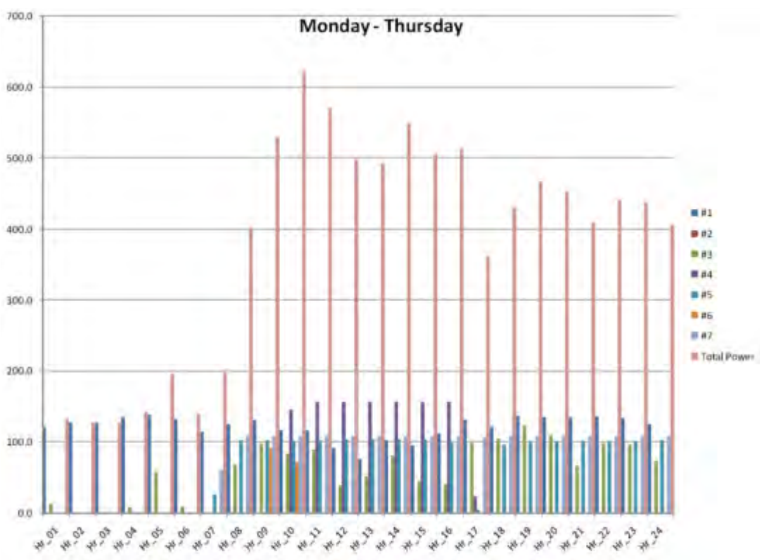


Figure 4 — Typical Post System Day Profile

Conclusion

As a result of the above changes to Grimmway Farm's compressed air system, compressor output more closely matches system demand, and continued energy costs have been reduced by approximately $64,000 annually. Additionally, they received a rebate of $65,000, which lowered the project costs by 55%. BP

Energy Savings Summary Calculation

3,596,788 kWh - 2,831,388 kWh = **765,400 kWh**

Annual Cost-Savings Calculation

$302,130 - $237,822 = **$64,308**

For more information, please contact Patricia Boyd, Technical Lead, Ecos Air, at Tel: 415-399-0661, e-mail pboyd@ecosconsulting.com, www.ecosair.com, or Kyle Harris at Tel: 661-619-2470, e-mail kharris@accurateair.com, www.accurateair.com.

SEVEN SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Heat-Reclaim Economics of Air- and Water-Cooled Air Compressors

BY MIKE WLODARSKI, HYDROTHRIFT CORPORATION

Introduction

It is widely recognized that compressed air systems account for 10% of all electricity, and roughly 16% of United States industrial motor system energy use. Seventy-percent of all manufacturing facilities in the U.S. use compressed air to drive a variety of process equipment. (1)

There are many ways that compressed air users can reduce their energy costs through air audits and by eliminating wasteful air-consuming processes, which can lead to a 10–15% system energy reduction, with simple paybacks in less than two years. (2)

System operators should also examine if reduced system pressure could be used. Use of a central control system can more effectively stage the existing air compressors to cyclical demand. Increased storage capacity can also reduce the unnecessary high-demand cycling of compressors.

This article is mainly directed at identifying and quantifying the potential for heat reclaim from the air compressors themselves. Both air-cooled and water-cooled air compressors can be used to provide cost savings in a manufacturing plant through the use of a properly designed and sized heat-reclamation system.

Seven Key Sustainability Projects

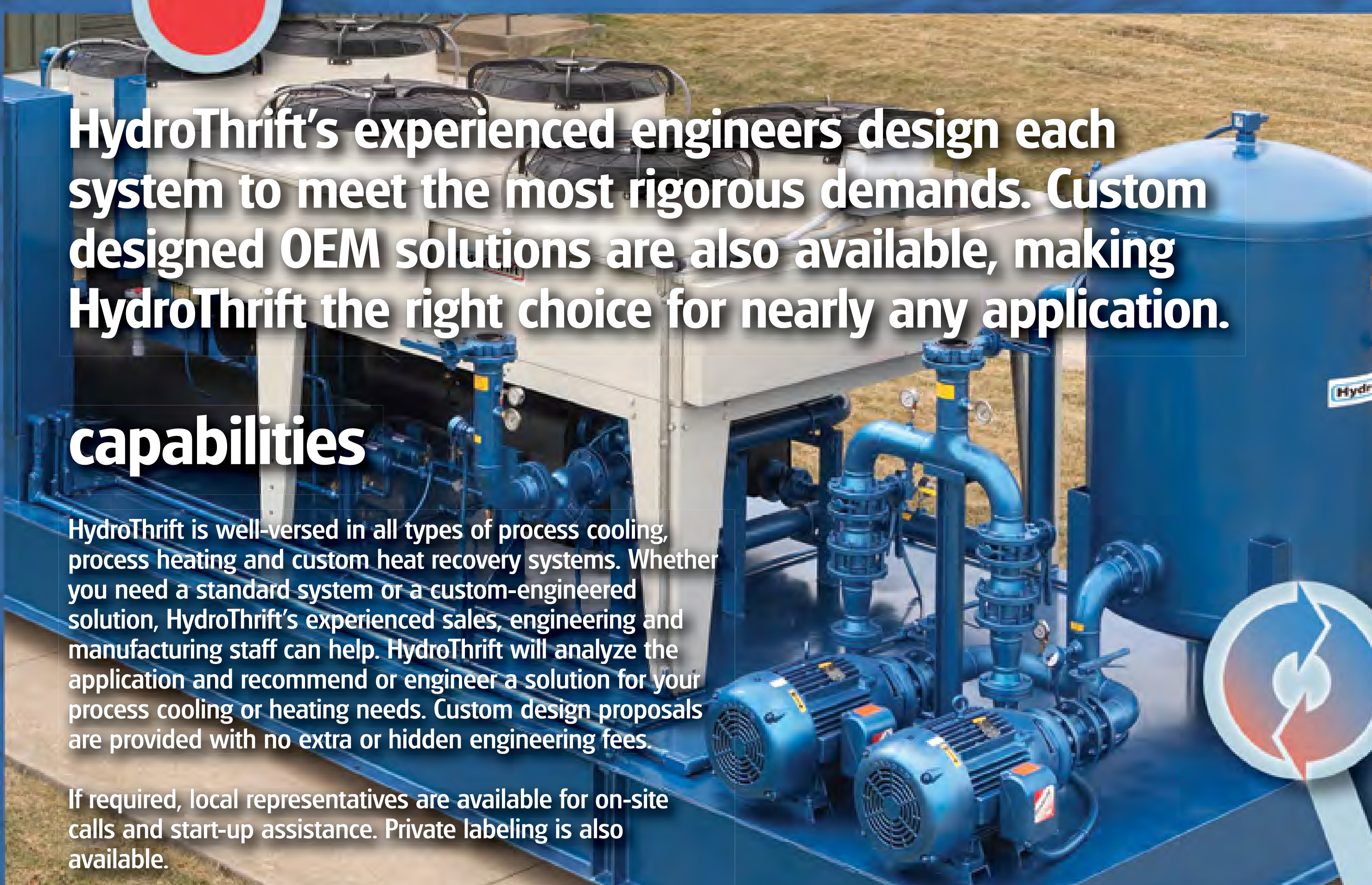
1. Metering
2. Demand Control
3. HVAC Optimization
4. Compressed Air
5. Lighting
6. **Heat Recovery**
7. Project Implementation and Funding

HydroThrift
Industrial Cooling Systems

about Hydrothrift

DESIGNERS AND MANUFACTURERS OF ENGINEERED EQUIPMENT THAT WITHSTANDS THE MOST DEMANDING ENVIRONMENTS.

For more than 30 years, HydroThrift has been building industry-leading cooling systems, designed and manufactured with careful attention to quality. With more than 15,000 thermal transfer systems installed around the globe, HydroThrift has built a reputation for quality and integrity that is second to none. Every HydroThrift system is guaranteed to work as quoted, providing customers with peace of mind.



HydroThrift's experienced engineers design each system to meet the most rigorous demands. Custom designed OEM solutions are also available, making HydroThrift the right choice for nearly any application.

capabilities

HydroThrift is well-versed in all types of process cooling, process heating and custom heat recovery systems. Whether you need a standard system or a custom-engineered solution, HydroThrift's experienced sales, engineering and manufacturing staff can help. HydroThrift will analyze the application and recommend or engineer a solution for your process cooling or heating needs. Custom design proposals are provided with no extra or hidden engineering fees.

If required, local representatives are available for on-site calls and start-up assistance. Private labeling is also available.

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SEVEN SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Calculating Reclaimable BTUs

It is possible to reduce your plant's total "carbon footprint", energy consumption and operating costs by recovering the excess heat air that compressors produce.

The electric motor puts energy into the compressed air stream through the compression process. Motor power is typically rated in horsepower. One horsepower is the equivalent of 2,545 BTU per hour. Although most air compressors are sold in nominal horsepower sizes, they generally can operate at loads 10% above the motor nameplate rating to achieve rated compressor discharge pressure and full capacity output. The horsepower at the compressor shaft, also referred to as brake horsepower (bhp), can be 10% above motor nameplate horsepower and consume most of the motor's 1.15 service factor safely. Therefore, a 100 hp compressor (110 bhp) converts electricity into almost 280,000 BTU per hour at full load. In addition, the air-cooled motor itself, having an assumed efficiency of 93%, dissipates an additional 19,600 BTU of heat per hour.

The air compressor increases the pressure and proportionately reduces the volume of the air. The energy potential of the original entering air is now at a much higher level due to the increased pressure, ready to do work downstream in the compressed air system.

It is possible to extract, by heat transfer, as much as 80–90% of the energy that the electric motor placed into the compressed air. Heat must be removed to maintain the compressor tolerances and clearances, and the compressed air usually must be cooled to make it suitable for most processes. The compressed air still contains energy to do useful work, even after the excess heat has been removed.

Heat and work are two different methods of transferring energy. After the compression process increases the air pressure and raises its temperature, the amount of energy not used as work, the excess heat of compression, is now available for reuse. Unfortunately, most facilities now "dump" this excess heat outside when they could be reusing it and reducing operating costs.

The most common uses for the recovered energy include industrial process heating, supplemental space heating, makeup air heating, domestic or process hot water heating or boiler make-up water pre-heating.

Air-Cooled Air Compressors

Typically, the heat-reclaim potential from an air-cooled compressor has been limited to supplemental space heating. When considering the use of air-cooled compressors, properly sized ductwork and the use of booster fans to direct the heat being reclaimed from a central compressor room to the needed location of the reclaimed heat can be a significant expense.

Many times, the air-cooled compressors are relegated to "boiler rooms" that do not have proper ventilation. These centralized compressors can experience elevated operating temperatures that reduce equipment life, increase maintenance and repair cost and, ultimately, potentially yield an unreliable air system. The initial cost of a good ventilation system is usually far less than the ongoing, increased maintenance costs of a hot operating environment. It is advisable to consult with HVAC experts to ensure proper ventilation, and to evaluate possible heat-recovery opportunities with air-cooled compressors.

The larger the air compressor system, the harder it is to reclaim a majority of the generated heat, due to the large air flows required. At 250 bhp, an air-cooled air compressor will generate about 636,000 BTU/Hr of heat. This will require about 15,000 cfm of air movement.

The compressor ventilating system design should also consider the additional effect on the rest of the plant's ventilating system, including heating, air conditioning and possible negative and positive pressures that can affect the performance of the air compressor.

Water-Cooled Air Compressors

The heat-reclaim potential from a water-cooled compressor has the flexibility to allow for varied forms of heat usage. There are two major types of water-cooled systems available: open-cooling loops and closed-cooling loops. Open-loop cooling is accomplished by using recirculating, open-loop cooling tower water, or once-through well water or city water, that is then discharged to the sewer or environment.

Once-Through Cooling Systems

Once-through cooling systems can be effective at raising the temperature of the incoming water from 50 °F to about 90 °F, and can then be used for preheating boiler feed water, domestic or process-heated water. This water must eventually be discharged to a sanitary sewer, or a permit for discharging to the environment must be obtained. Since the water is not treated, scale buildup from dissolved solids and potential corrosion of the air compressor heat exchanger must be factored into the life-cycle maintenance costs of an air compressor system.

The cost of discharging this water can be more expensive than the incoming cost of water due to the sewer fees, environmental testing and permits and possible treatment required.

Recirculating Open-Loop Cooling Systems

Cooling towers are the most common form of this type of system. These systems utilize the principle of evaporation to cool the water to below-ambient dry-bulb conditions. Most tower systems are designed to provide 85 °F cooling water in the U.S., based upon a 75–78 °F wet-bulb temperature.

A cooling tower will drastically reduce the amount of water consumption compared to a once-through system. They have, however, the requirement of additional water treatment costs to reduce the potential for:

- Scale from the higher concentration of dissolved solids in the cooling water
- Potential biological contamination of the cooling water from algae and bacteria
- Increased filtration of the cooling water from the atmospheric dirt and debris blown into the water from the tower fans

Most cooling towers are designed for a 10 °F rise in temperature — but can be designed to go higher. The scale formation potential is increased as the temperature of the water goes up. Care must be used to make sure the hot water does not exceed the temperature rating of the PVC fill that is in most cooling towers to avoid decomposition of the fill.

Open-loop cooling water can be used for preheating boiler feed water, domestic or process-heated water. It might be used for space heating potential, but the typical lower inlet temperatures (95° F) produce a lower-grade heated air from the cooling coil that is sometimes considered "too cool".

Also, at these lower temperatures the surface area of the coil is larger to enable proper heat extraction. Tower water should not be used to temper building make-up air because when the inlet ambient temperature is below freezing, there is a strong chance that the coils might freeze.

A Closed-loop Evaporative Cooler System

A Closed-loop Heat Exchanger

Closed-Loop Recirculating Cooling System

There are four main types of closed-loop cooling systems that are available: dry type, dry type with trim cooler, evaporative type and water-to-water heat exchanger systems.

The main advantage of all of these systems is that, since they are closed-loop, you can almost eliminate water-caused maintenance issues with your compressors. Besides the initial expense of filling them with an ethylene or propylene glycol mixture with corrosion inhibitors, they require no ongoing water treatment, except for checking the concentration yearly for your winter ambient air conditions and to verify the proper pH levels.

Since the compressor heat exchangers will remain virtually scale free, one can take a higher temperature differential across the compressors heat exchangers without loss of cooling to the equipment. Most compressors are designed to allow for a 25–30 °F rise in temperature across a clean heat exchanger. If a new closed-loop cooling system is retrofitted to an existing system that previously was on an open-cooling water loop, the heat exchanger must be cleaned before placement on a new closed-loop cooling system.

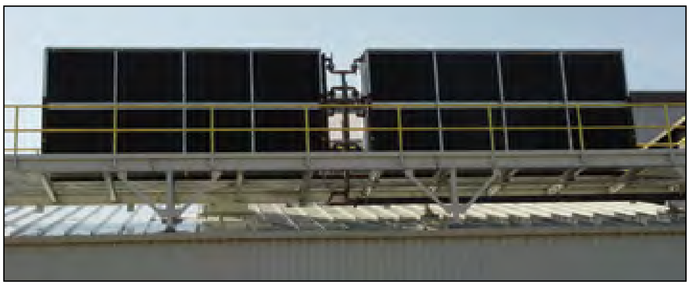
A Closed-loop Dry Cooler

Closed-loop systems enable better space heating potential because of the higher fluid temperatures returning from the load. These higher temperatures allow the discharge air from the heat reclaim coils to typically be in the high 90 °F range. Again, with a higher operating system temperature, the size of the cooling coil can be reduced and still enable proper cooling of the air compressor cooling fluid. Also, since they will have the proper solution of glycol for protection from freezing in winter conditions, they could be used for preheating make-up air on a central air handler.

SEVEN SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

It is also easier to transport the hot fluid through a piping system than through ductwork for areas where heat reclamation is needed most. If space heating in an area needs a more diffused distribution of hot air, numerous smaller air-to-water coils can be used, rather than one large coil.

Please Note: A properly designed heat reclaim system does not reduce the size of the primary cooling system. If you are not utilizing the heat reclaim system for any reason, the primary cooling system must still be sized to reject the total heat load generated by the compressors outdoors.



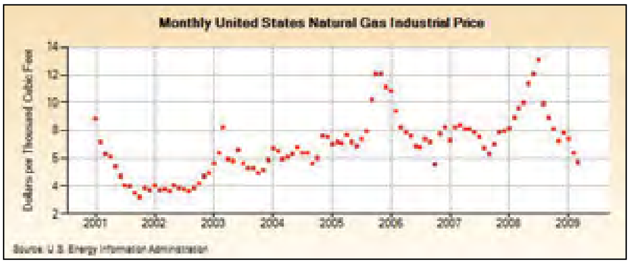
A Large Dry Cooler System

Heat-Reclaim Analysis

Let's take a look at the dollar and cents of the heat-reclaim potential available. Production of natural gas is described in terms of standard cubic feet, which is a measure of quantity of gas at 60 °F and 14.65-pounds per square inch of pressure. Similar to the convention used for oil, the term "mcf" means 1,000 cubic feet of gas, and "mmcf" means 1 million cubic feet of gas.

An "mmBTU" (1,000,000 BTU) is roughly equivalent to 970 cubic feet of gas. Your gas bill may be priced on mcf, or 1,000 cubic feet. Consumers frequently think of an mcf of gas as being equivalent to one mmBTU. It is actually mcf (1,000 cubic feet) = 1,030,928 BTU. Some gas bills are still priced in "therms", which is defined as 1 therm = 100,000 BTU.

Natural gas market future prices are sold on the New York Mercantile Exchange, and spot prices are typically set at the Henry Hub and are denominated in $/mmBTU (one million British Thermal Units) and are generally seen to be the primary price set for the North American natural gas market. This pricing is the cost to the distribution companies. Your pricing will be higher due to the transportation costs added on by the distribution companies. You should check you current billing statement for accurate data.



The Henry Hub is a point on the natural gas pipeline system in Erath, Louisiana. It is owned by Sabine Pipe Line, LLC. It interconnects with nine interstate and four intrastate pipelines: Acadian, Columbia Gulf Transmission, Gulf South Pipeline, Bridgeline, NGPL, Sea Robin, Southern Natural Pipeline, Texas Gas Transmission, Transcontinental Pipeline, Trunkline Pipeline, Jefferson Island and Sabine.

Oil production companies measure oil production in terms of barrels. A barrel, usually abbreviated as "bbl", is 42 U.S. gallons. A common methodology in the oil industry is to use a prefix of "m" to indicate 1,000 and a prefix of "mm" to indicate 1 million. Therefore, one thousand barrels is commonly denoted as "mbbl" and one million barrels is denoted as "mmbbl".

If you are using oil to fuel your boiler, we can convert the oil usage into a gas energy equivalent basis using barrels of oil equivalent (BOE). One BOE has the energy equivalent of 6,040 cubic feet of gas — or 6.04 mcf x 1,030,928 BTU/mcf = 6,226,805 BTU per barrel of oil usage. The U.S. Internal Revenue Service defines it as equal to 5.8 x 106 BTU (5,800,000 BTU's).

Your results should be based upon your actual heat load, your local cost for natural gas and the best estimate you have on your operating conditions (how many weeks per year and hrs/day/week). This example is for your reference and guidance only. Current Natural Gas prices at the Henry Hub can be found at http://tonto.eia.doe.gov/oog/info/ngw/ngupdate.asp.

Historical industrial natural gas prices by state can be found at http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_a_EPG0_PIN_DMcf_a.htm.

Example

Let us assume that we have a 400 hp, water-cooled air compressor that will generate 1,018,000 BTU/hr. We can save energy by either:

- Utilizing the hot water coming off of the air compressor to provide space heating and shutting off gas-fired space heaters
- Preheating boiler feed water
- Preheating makeup domestic or process hot water coming in from the city water supply

Let us also assume that we have a very efficient burner on either the space heater or boiler at 80% efficiency. Most new high-efficiency burners approach this figure, while existing older units might be in the 60% range.

Current natural gas wellhead futures pricing (September delivery 2009) = $3.58/mmBTU (not including distribution costs). Typical industrial natural gas pricing, including distribution cost, is usually about $2.00 more per mmBTU. Current natural gas prices are at a seven-year low.

This example shows savings for space heating. Potentially, if you are preheating water, you might be able to save energy every hour that your plant is operating. If we were able to recycle 1,018,000 BTU/hr for 4032 hours per year (assuming ambient air temperature at 70 °F or lower), we would save 4,104 mmBTU/yr.

If we reduced heating by natural gas at an 80% burner efficiency, 5,130 mmBTU/yr input gas energy would be required to generate the 4,104 mmBTU/yr heating output volume being saved. Multiply 5,130 mmBTU/yr by $5.58/mmBTU and the savings equal $28,625 per year.

CO2 Reduction Potential

If you are interested in reducing your carbon footprint, using the same example as above, this would also reduce your CO_2 emissions by about 5,130 mmBTU/yr X 113 lb CO_2/mmBTU = 579,690 lb CO_2/yr. Again, these calculations are for a 400 hp compressor. For a 100 hp compressor, one could realize a $7,156 savings per year and 144,922 lb CO_2 reduction.

As one can see, there are compelling reasons to consider integrating a heat-reclamation system, either into a new installation or retrofitting an existing system. System payback is quite varied depending on the operating schedule of the facility, climatic conditions and the potential use of the reclaimed heat. An additional life cycle consideration should be the reduction of maintenance and the potential longer air compressor life cycle that can be accomplished with a properly designed cooling system.

If you are considering using what is otherwise discarded heat from your compressors, you should contact a cooling professional to help you evaluate your system. Heat recovery and "going green" is on everyone's hot list. It needs to be done correctly, however, to provide the proper estimated payback. BP

For more information, please contact HydroThrift Corporation at email: sales@hydrothrift.com, Tel: 330-837-5141 or visit www.hydrothrift.com.

Bibliography:

(1) Assessment of the Market for Compressed Air Efficiency Services; Office of the Energy Efficiency and Renewable Energy;

U.S. Department of Energy; June 2001. DOE/GO-102001-1197

Also XENERGY, Inc (1998) United States Industrial Electric Motor Systems Market Opportunities Assessment. Washington D.C.; U.S. Department of Energy, Office of Industrial Technologies, and Oak Ridge National Laboratory

(2) XENERGY, Inc (1998) United States Industrial Electric Motor Systems Market Opportunities Assessment. Washington D.C.; U.S. Department of Energy, Office of Industrial Technologies, and Oak Ridge National Laboratory

Additional reading:

Compressed Air Challenge, www.compressedairchallenge.org

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Industrial Technologies Program, DOE/GO-102033-1822

United States Natural Gas Industrial Price (Dollars per Thousand Cubic Feet)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	8.84	7.21	6.30	6.08	5.46	4.75	4.10	3.99	3.50	3.18	3.88	3.69
2002	4.05	3.70	3.78	3.64	4.07	3.86	3.80	3.62	3.89	4.18	4.72	4.92
2003	5.65	6.40	8.27	5.96	5.78	6.59	5.69	5.28	5.32	4.93	5.19	5.90
2004	6.72	6.52	5.97	6.06	6.34	6.82	6.41	6.36	5.68	6.03	7.64	7.54
2005	7.06	7.15	7.12	7.71	7.19	6.91	7.40	7.98	10.18	12.06	12.11	11.17
2006	10.85	9.38	8.24	7.93	7.63	6.92	6.78	7.36	7.21	5.62	7.74	8.23
2007	7.35	8.25	8.43	8.14	8.10	7.92	7.50	6.72	6.28	7.06	7.87	7.99
2008	8.20	8.90	9.58	9.96	11.47	11.97	13.05	10.04	8.90	8.01	7.14	7.75
2009	7.43	6.41	5.70	5.02								

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Easy-to-Implement Master Control and Monitoring Systems

BY JAN HOETZEL, SIGA GREEN TECHNOLOGIES

Jan Hoetzel, General Manager, SIGA Green Technologies

Introduction

Compressed air is one of the most expensive energy sources used in our industrial plants. However, most compressed air systems have large energy savings potential. Easy-to-implement master control and monitoring systems provide crucial system information, including the key performance indicators required to manage air compressors and their associated energy costs. Master control systems run air compressors based on actual air demand and automatically select the most energy efficient compressor combination. They reduce unwanted unload running time and wasted energy, regardless of air demand, and continuously provide essential compressed air performance and cost information.

The Problem

Most segments of industry continue to have little information on what their compressed air system is doing. Little performance and efficiency data or cost information is available for a very expensive system. Accurate data to charge compressed air costs to different departments in the facility is not retrievable. It is common to have compressed air cost assigned to departments by using the amount of square feet a process, or a department, uses in the factory — not the amount of compressed air it uses! This provides no incentive to save compressed air at the department level.

Multiple air compressors are installed in most facilities. As the facility grows, more air compressors are added. It is common to see more than one air compressor room serving the facility with a complete lack of an overall air compressor control strategy.

Confusion over Compressor Controls

As awareness of the energy costs related to compressed air has grown, the end user has been bombarded with information about the on-board compressor controls. Each on-board air compressor controller can optimize the efficiency of that particular machine. Air compressor controllers include modulation, load/unload, inlet valve and variable-speed drive controls.

What the individual compressor controller cannot do, however, is work together with the unique demands of the factory and all the other installed air compressors in order to optimize energy efficiency. For this, the market offers net-pressure cascading controls, various sequencers and master controllers. All of these technologies can be effective in saving energy under specific operating circumstances. However, under different operating conditions such as 2nd or 3rd shift, weekends or holidays, these technologies will not save energy.

Many factory employees we speak to are confused and frustrated by the lack of knowledge in how to appropriately deploy compressor control strategies. Some have installed sequencers, but are not seeing energy savings and have turned them off. Others have purchased variable speed drive air compressors, but their energy bill has not been reduced. Many end users do not have the visibility they desire to manage the compressed air system or to know if the control strategies they have purchased are working.

While the various compressor control technologies can deliver energy savings, the difficulty lies with choosing the appropriate application. Plant conditions change and the compressor control can no longer deliver the original results. There can also be performance issues with specific air compressors that arise, which result in the control strategy not performing as desired.

Airleader Master Control and Monitoring

The first Airleader air compressor control was invented twenty years ago in Germany by Mr. Werner Weidner of WF Steuerungstechnik GmbH. Mr. Weidner founded WF Steuerungstechnik GmbH with the clear company mission of improving the efficiency of air compressor systems through intelligent compressor controls. Today, the Airleader product family consists of different air compressor controls, monitoring systems and data loggers for compressed air system audits. Based in southern Germany, the technology is private-labeled for air compressor manufacturers, sold to distributors and also delivered directly to end users as part of compressed air audits. Our tremendous success in Europe, with more than 6,000 units sold, as well as the positive feedback from our clients, dealers and OEM customers, gave WF Steuerungstechnik the confidence to go overseas. In 2008, WF Steuerungstechnik GmbH partnered with SIGA Green Technologies to bring the Airleader product family to the North American market.

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Easy-to-Implement Master Control and Monitoring Systems

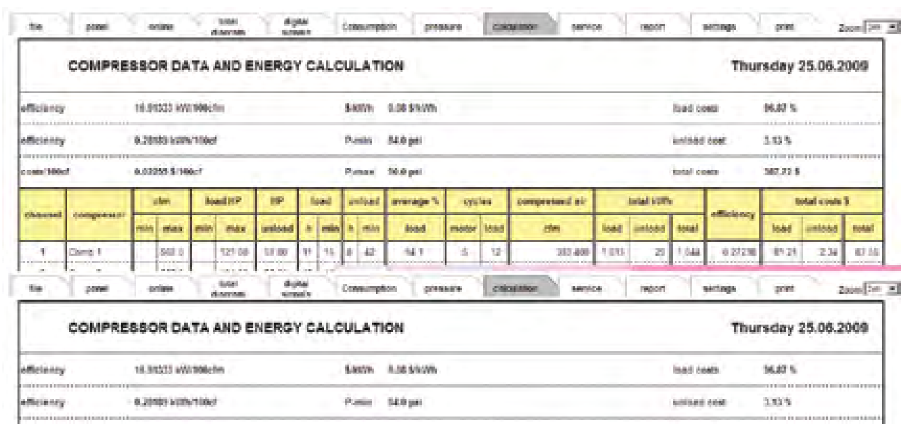
kW/100 cfm is the Key Performance Indicator

Technology Simplifies the Solution

My personal experience comes from working as a manager and engineer for Tier 2 automotive suppliers. We recognized compressed air was a critical "4th Utility" in the facility and so we focused primarily on whether or not we had enough compressed air to produce our products. We knew we spent a lot of money to power the air compressors, but we did not have any visibility into these costs.

The Airleader family of master control and monitoring products provided the solution. The master controller will optimize compressor performance automatically, while the monitoring provides the data required for a manager to visualize and manage the compressed air system from the office.

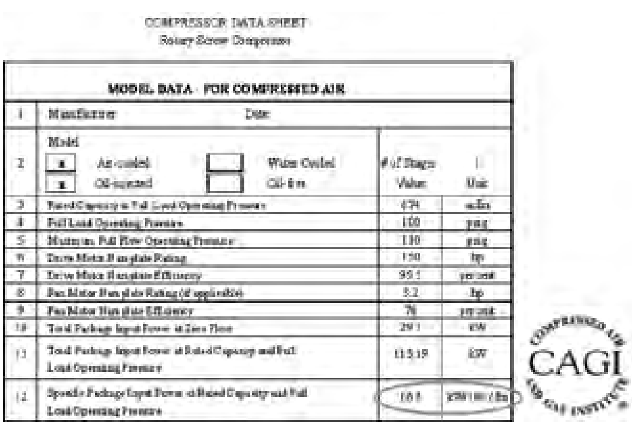
Compressor Data and Energy Calculation provides details to optimize a compressed air system and keep it that way.



The Key Performance Indicator (KPI): kW/100 cfm

While the Airleader software can produce many reports on different areas, we recommend that managers focus on one Key Performance Indicator (KPI): kW/100 cfm. This represents how much energy (in kW) is used to deliver how much air flow (cfm). The Airleader provides the tools required to monitor this KPI for the entire facility and for each air compressor.

Another advantage to using kW/100 cfm as a KPI is that air compressor suppliers can provide you this number. Members of the Compressed Air and Gas Institute (CAGI) supply "CAGI Data Sheets" with their air compressor products. Virtually all major air compressor manufacturers are members of CAGI (www.cagi.org). This enables the end user to get an "apples-to-apples" comparison of air compressors when buying new ones. More importantly, it enables an end user to benchmark their system and control whether the factory-achieved KPI of kW/100 cfm is close to what the performance rating states on the CAGI Data Sheet.

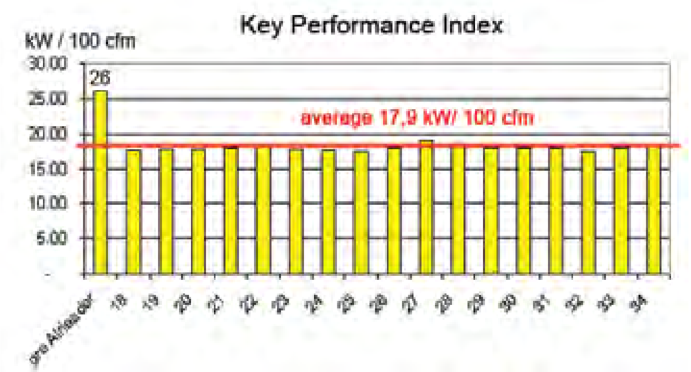


CAGI Data Sheets provides KPI kW/100 cfm.

The Airleader Master Controller documents which air compressors are most efficient. Each unit is monitored, and the manager is given a detailed report including a kW/100 cfm for every air compressor. As circumstances in the plant or with the air compressor change, the master controller measures and monitors the performance of each compressor and of the system. If the performance of a compressor deteriorates, the master controller provides information and alerts.

Factories Should Use kW/100 cfm as a Key Performance Indicator

The chart Key Performance Index (KPI) shows that, after the installation of the master control, the KPI improved from 26 kW/100 cfm to 17.8 kW/100 cfm. Whatever changes and improvements we did to the system in the following weeks, the system always adjusted and the KPI averaged around 17.9 kW/100 cfm. System monitoring is the only way to ensure that your control delivers the promised results.



Accumulated Intelligence Makes it Easy to Save

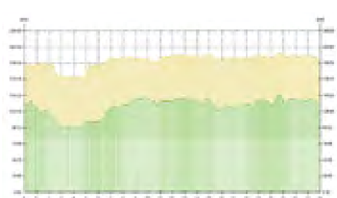
The primary advantage of a master controller is that it will automatically recognize changes in the demand side (air demand) and intelligently choose which components of the supply side (the air compressors) of the system can meet the changed demand most efficiently.

The intelligence of a master controller is invaluable, as it will select the best combination for each unique air-demand situation. The Airleader Master Control comes with an eight-fold learning window. Over time, the master control learns the overall system dynamics and, based upon the speed of pressure change, determines whether to turn on a big or small compressor. Depending if Pmax or Pmin is approached very quickly or slowly, the master controller has the accumulated intelligence to decide which compressor is the appropriate compressor to bring on or turn off, thereby assuring best energy results.

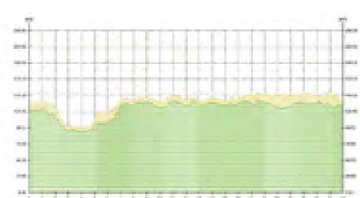
In contrast, a sequencer has a rigid pressure band and simply takes the next compressor on-line (e.g., a 200 hp compressor #2 which is pre-programmed). Alternatively, if Pmax is approached very slowly, a master controller might take on compressor #3, which is only a 50 hp compressor. This can create a significant reduction in unloaded power consumption and load cycling. We have seen many cases where a sequencer has a large compressor (e.g., 200 hp) programmed as base load compressor, and, during off hours, this compressor is running very inefficiently, while a smaller 50 hp compressor would have been sufficient.

The master controller has no base load compressor. Instead, each compressor in the system can act as the base load, peak load or operate on its own. The Airleader Master Control will learn and adapt automatically to changes in the system, whether additional storage tanks are added or air usage is changing. One of the primary benefits is that the master controller will automatically reduce no-load energy consumption.

Load/Unload Charts (Green Load/Yellow Unload)



Without Airleader



With Airleader

> "Master control systems run air compressors based on actual air demand and automatically select the most energy efficient compressor combination."
>
> — Jan Hoetzel, SIGA Green Technologies

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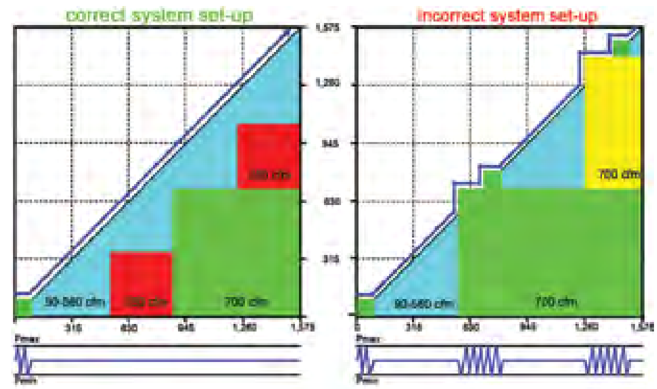
Easy-to-Implement Master Control and Monitoring Systems

"The Airleader family of products includes a data logger specifically designed for compressed air systems."

— Jan Hoetzel, SIGA Green Technologies

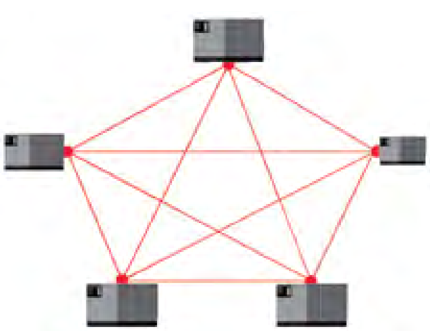
Control Strategies



Many sites we have evaluated have installed variable speed drive (VSD) compressors, but have not achieved the desired energy savings. The VSD compressor, and the rest of the compressors, do not interact and/or are improperly sized. We, at Airleader, developed a tool to simulate system performance, assuring that the compressors are sized correctly to provide the most economical and energy-efficient solution. We provide this simulation to our partners, dealers and clients. A properly designed system with a VSD compressor run by an Airleader Master Control can achieve as little as 0.1% unload energy. For a system without a VSD compressor, the unload energy can be as low as 1%. The following graphs show the simulation of correct and incorrect system set-up.

Gathering Data

The Airleader Master Controller has up to 52 analog inputs and 24 digital inputs. The Airleader CN is another model with 132 analog and 96 digital inputs. It acts as "the brain", where many, many pieces of information about the compressed air system can be sent and analyzed.



Various analog sensors and digital signals can be added to increase awareness, to alert or to improve preventive maintenance. Additional pressure transducers to monitor plant pressure in various locations or differential pressure transducers are very useful to monitor pressure drop on compressed air filters.

Three-phase transducers measure the exact kW consumption of every air compressor and "learn" how the air compressor performs under different circumstances.

Flow meters are important if you want to charge different departments for their individual compressed air usage. Flow is the only way to truly measure the compressed air consumption in each area. We tie flow meters into the master controller and this enables our customers to finally charge each department according to use — not square footage!

Compressed air dew point can be monitored with information sent from a dew point meter. Alarm functionality exists in which plant personnel can receive an alarm e-mail if dew point suffers. Zero air-loss condensate drains can also communicate with the master controller and provide alarms if there is a malfunction. Process temperature gauges communicate with the master controller and trigger alarms if, for example, cooling water temperatures are too high, which will cause the air compressors to overheat or shut down. This enables preventive maintenance, and emergency shut downs can be averted.

Compressed air dryers can also be connected to communicate with the master controller.

Communicating the Data

The air compressors communicate with the master controller via an RS 485 Module. The Web-based system can be accessed remotely via VPN Clients worldwide. The OPC (open-connectivity) interface allows data transfer to all types of in-house control systems, supporting Profi-Bus, Modbus, Win-CC and others.

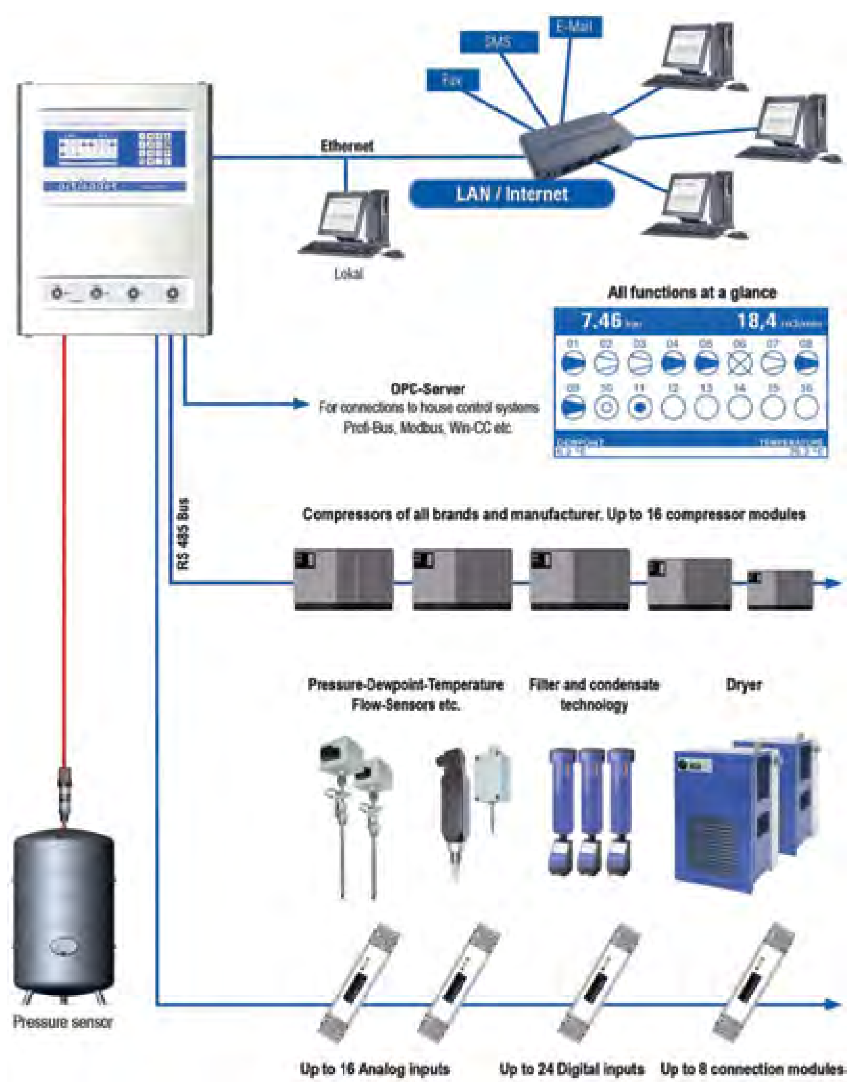
The Airleader family of products includes a data logger specifically designed for compressed air systems. This data logger comes with a software package that generates reports with tables and graphs and evaluates the KPI kW/cfm for system benchmarks that are needed to analyze the status quo of compressed air systems and make continuous improvements.

Conclusion

A master control will ensure that your air supply side (the air compressors) will automatically, and most efficiently, follow compressed air demand in the plant. The monitoring system keeps track of system performance and cost information. It shows the results of improvement efforts, and lets you immediately verify the savings (e.g., from a leak project).

Managers can monitor the system and charge different departments appropriately for their air consumption based upon flow. KPI (Key Performance Index) kW/100 cfm can be monitored and managed, and alarms can be set to notify managers of system malfunctions or of increases in compressed air related costs. BP

For more information, contact Jan Hoetzel, SIGA Green Technologies, Tel: (616) 828-0716. Jan.hoetzel@siga-greentec.com, www.airleader.us.



THE TECHNOLOGY PROVIDER

Compressed Air Management Systems Assist Sustainability Programs

BY COMPRESSED AIR BEST PRACTICES®

Compressed Air Best Practices® spoke with Mark Reed, President, and Dusty Smith, Director of Engineering, Pneu-Logic Corporation.

Good morning. How is "sustainability" changing the market for compressed air management systems?

Good morning. We are finding significant changes in the industry with regards to which managers are involved in our discussions. With energy awareness and costs at high levels, we now find that "C-level" executives and plant managers are becoming much more interested in compressed air systems and the opportunities available to drive costs down. In the past, we sold compressor controls primarily to plant engineers and maintenance managers who were very experienced in the operational aspects of production systems. We now spend more time discussing energy-saving opportunities with chief operating officers and chief executive officers, as well as with the plant team.

The second change is the topic itself. We are no longer simply discussing compressor controls. We are examining compressed air management, as a whole, with the client. This involves topics like management reporting with regards to kW consumption, dollar costs and greenhouse gas emissions.

This takes the conversation to the "C-level", as we are impacting sustainability programs in a positive manner. Executives are really interested in reducing their carbon footprint and eventually monetizing their carbon credits. Our PL4000 technology can track and aggregate carbon credits. Now, you have a manageable tool supporting a corporation's ability to realize a payback on their energy initiatives.

What advances in application trends are you experiencing?

A significant advancement in application trends is in what we call "managing zones". This is when the compressed air management system provides the client with the ability to look at different "zones" in the system. Some of our clients have an expansive compressed air network with two or three compressor rooms, along with production floor compressors. Our PL4000 technology is being used to enable managers to break up the network into separate "zones", and monitor and manage them.

Zones can involve managing air quality. As an example, an aluminum extruder had a plant floor air compressor providing compressed air to a painting process. Desiccant dryers were installed to provide the low-dew point air required. The duty cycle was very intermittent, and the customer said they knew they were "over-drying" the compressed air, which, in turn, was creating unnecessary energy costs. We worked with them to make this process a "zone" we would manage with our technology. We placed dew point sensors in-line, and were able to automate the performance of the desiccant dryers to avoid the unnecessary energy costs — while maintaining the correct dew point. Alarm functions were also set up to send automatic alarm emails to managers if dew point or energy costs deviated from the accepted specification for the zone.

Zones can also be specific demand-side air users. A customer was experiencing abnormally high maintenance and replacement costs on a pneumatic power wrench. Upon examination, the root cause was that the wrench was receiving compressed air at a pressure of 100 psig — instead of the specified 45 psig. We placed pressure transducers at the location and started monitoring and managing the pressure of this "zone" with very positive results.

What impact on maintenance costs can these management systems have?

That is a great question, because maintenance is a topic many people don't think about when discussing compressed air management systems. Our clients have found that maintenance can be one of the largest beneficiaries of our systems!

Our compressed air management systems can enable users to switch from "time-based" to "condition-based" maintenance programs for their installed air compressors and compressed air treatment products. The technology will monitor actual usage patterns and data log the multiple air compressors, dryers and filters. We can monitor run-time and oil temperature in the air compressors. The technology will also automatically rotate air compressors to even out run-times.

Factories spend a lot of money on the consumables required to appropriately maintain their compressed air equipment. By helping them switch to "condition-based" maintenance programs, we can help them reduce these costs and improve productivity by reducing the number of maintenance interruptions.

Are there any new trends with financing and/or rebates?

Our technology allows for exciting advancements in financing options. The measurement and data-logging technology we deploy enables us to provide what we call "proof-statements" to our clients, documenting the actual and verified performance of their compressed air system. When we compare this to the data gathered during our base-lining studies, the customer is able to receive hard proof of the realized energy savings and carbon emission reductions.

These more highly sophisticated measurements have helped us to develop new financing partners and opportunities. We are developing a new program where customers do not need to supply any up-front capital to install our systems. The customer makes their payments based upon documented energy savings. We have a customer who is paying for their system, over a four-year period, based upon the realized energy savings of our compressed air management system. This is a managed service, guaranteeing ROI for the customer. We anticipate an increase in these types of contracts.

With regards to rebates, we are seeing more funds become available through BC Hydro and other public utility departments that underwrite portions of big projects. For smaller systems, the Oregon Energy Trust is very active here. We recently introduced new management products, namely the PL500 and PL1000, designed for smaller compressed air systems. The Oregon Energy Trust has us do a simple walk-through and then make a recommendation. The Trust will rebate up to 50% of the equipment purchase cost for the customer. A third party does the verification measurement for the Oregon Energy Trust.

"Our PL4000 technology can track and aggregate carbon credits."

— Mark Reed, President, Pneu-Logic

Dusty Smith of Pneu-Logic tunes a PL4000 compressor management system

Mark Reed, President of Pneu-Logic Corporation

THE TECHNOLOGY PROVIDER

Compressed Air Management Systems Assist Sustainability Programs

How do your systems interface with in-house controls?

We sell direct to strategic accounts like Weyerhaeuser, Toyota and FEMSA. This will continue to be a big part of our strategy because it breeds customer intimacy. Although we are primarily an engineering and technology firm, it is critical that we remain close to major users so that we can continue to develop ground-breaking technologies.

An example of this is what we call our "Distributed Compressor Module". We have given plant engineers at some of our strategic accounts access to the invisibility files in our PLCs. We work with FEMSA, the brewery operator, which has standardized on Allen Bradley PLCs. Boeing is another corporation with a strong bias towards Allen Bradley platforms. They appreciate our flexibility and technology capabilities in providing full integration into their in-house systems. Our open systems and architecture enables us to go into multi-vendor environments. We have a generic SCADA server that accommodates most DCS systems that we encounter in the United States through a Modbus TCP connection.

I see you have received an award for international sales?

Yes. In May of this year, we were honored to receive, from the City of Portland, the Mayor's International Business Award in the New Exporter category. We have found demand for our technologies in foreign markets like South Africa and Mexico, where customers are paying 15–20 cents per kilowatt/hour. Industries that use a lot of compressed air, like pulp and paper, mining, metal fabrication and Tier 2 automotive companies, have given us the opportunity to do a lot of engineering work successfully with them.

What sales channels do you deploy?

Aside from our direct strategic accounts, we also have a large private label agreement with Norgren. They have a business unit called Norgren IQ "Technology by Pneu-Logic". Norgren is using its global base of customers and its expertise in pneumatics to take our technology to market. We are also in the process of announcing a new OEM agreement with a compressor manufacturer. Pneu-Logic also works with select air compressor sales and service companies who are focused on reducing the energy costs of their customers.

Let's discuss technology. When is a lead/lag controller appropriate?

Pneu-Logic offers compressed air management solutions for all compressor installations, large and small, as we recognize that each facility has a unique set of circumstances. There is a lot of small manufacturing here in Oregon, with 25 hp systems that can really benefit from these types of controls.

First, let's define "lead/lag". Inconsistency in the industry has created some confusion around the usage of this term. We see "lead/lag" controllers as potentially appropriate for installations with two air compressors — one is lead (the base demand compressor) and one is lag (trim). Other firms use lead/lag terminology for multiple air compressors, where one is lead and multiple others are lag. Even more confusing is that some firms say lead/lag and actually refer to lead as the trim compressor.

We feel it's easier to think of trim and base controllers. That's how we define our PL500 pressure-based system. We find that there are far too many compressor controllers that work off of electro-pneumatic controls (pressure switches and/or timer relays). These systems are inexpensive to purchase, but almost impossible to tune because of the pneumatic components, which can have a wide range of tolerance.

There is a big advantage to using one pressure transducer vs. two or three switches on traditional systems. Three mechanical components (pressure switches) have to be set with a dial, and it is common to see them work against each other. Another issue can be accuracy. The accuracy range may be larger than the load/unload band. Within the HMI, you can visualize what is happening to plant pressure from the single transducer, see the compressor pressure and make decisions and tuning adjustments.

The Pneu-Logic PL500 uses a Web-based HMI with one pressure transducer — which dictates control of both air compressors. It has a micro-controller, permitting monitoring, reporting and management functions. Monitoring individual load and unload, restart delays and pressure trending can all be done through Internet Explorer. If you have a network, you can monitor what is happening in your compressor room — even if you have "just" two small air compressors.

A Pneu-Logic Master Controller Installed at a Lumber Mill

Let's discuss "Sequencers".

We believe that sequencers can be used in installations with more than two air compressors and, importantly, in plants with consistent demand profiles. They are also effective when the air compressors are of similar size and output efficiency.

Pneu-Logic offers the PL1000, which has a PLC version and a microcontroller version. It is browser-based and requires no software to be utilized. When you have similar-sized air compressors (like three or four 300 hp air compressors), you can simply sequence them because they are all the same size (if they are all created equal from an efficiency standpoint). If you have mixed air compressor manufacturers of the same size, you can still use a sequencer by identifying the most efficient as trim and base. While measuring pressure rate-of-change, we deploy a targeting pressure sequencer using a single pressure transducer and pressure point. All sequencers are pretty similar, but still differ in the minutia. Most have set points and emergency pressure points and utilize pressure rate of change.

Plants with a lot of varying loads can have problems with sequencers using pressure rate-of-change controls. This is very hard to tune in effectively. For this reason, we often see sequencers that are not implemented properly. They can become a nuisance, or even detrimental to a plant. Many are shipped to a plant and are not properly installed or tuned.

How about master controllers?

The PL4000 Master Control System is designed for multi-compressor installations of differing technologies where demand may fluctuate widely. A master controller can account for air flow demanded. A mine might have several centrifugal air compressors and some smaller rotary screw air compressors. This type of client has to decide which air compressor to start, based upon airflow. When demand is going down, do you shut down the big centrifugal or the smaller rotary screw?

Eric Bessey, Chief Project Engineer for Pneu-Logic, configures a PL4000 Master Controller

This is the where the master controller technology performs the critical function of measuring actual efficiency of each air compressor, and then making the right decision on which air compressors to operate. We add on a layer of monitoring functionality of pressure, flow and power, and this discovers that not all air compressors are created equal! A master controller provides an efficiency index for each air compressor (cfm per kW) index, ranks the air compressors and deploys them in the control algorithm.

Another situation for a master controller is when you want to take into account certain demand events — like a production line that starts up at a certain time. The plant might also have some piping issues and no budget for repairs. A master controller can adapt to custom situations like this. This is the most flexible solution.

Finally, as mentioned before, master controllers offer sophisticated monitoring and reporting capabilities with regards to kW, flow, pressure, energy costs and carbon emissions.

THE TECHNOLOGY PROVIDER

Compressed Air Management Systems Assist Sustainability Programs

Why do your master controllers focus on airflow?

We use air flow meters to get a reading on the air flow profile of the plant. We prefer mass air flow meters that are pilot-tube type or thermal mass flow meters. Both technologies are relatively inexpensive and have some measure of repeatable accuracy.

They must be installed at the exit of the compressor room, where one can measure total air demand. You can put them on each air compressor or, if there is a common header at the exit, you can put it there. If you have dryers that are purging, you should locate the flow meter upstream as they are just another form of demand.

Once you know flow, you have choices that sequencers don't have. You can now decide to trade three air compressors for one. A sequencer always goes from compressor #1 to compressor #2 to compressor #3 and so on — a master controller using flow gives you total flexibility.

How do you manage remote/differing locations?

Remote IO cards can be used to have one master controller manage multiple air compressors in several locations. It's almost always a hard-wire situation. We have used radio in a couple of situations. We had a river and a major road separating compressor rooms once, and we did use radio and industrial wireless solutions. The microcontrollers on the compressors can function as the remote IO card in most cases. Modbus protocol is popular in North America, and PROFIBUS protocol is popular in Europe. This is very cost effective, since you don't have to double-instrument. You can use the pressure transducers native to the air compressor, along with the compressor's remaining instrument set.

What lies in the future for Pneu-Logic?

Pneu-Logic is focused on reducing industrial energy consumption. We estimate that, since 2005, we have helped our top 30 customers save over $20 million in energy costs. We will continue to develop technologies and sales channels to keep achieving these goals.

This takes us back to the topic of "zones". If a plant engineer wants to manage compressed air, refrigeration, steam and water in a common consol, we expect in the future to help him break the processes down into zones. We will provide engineering with the same user interface and track savings zone-by-zone. Pneu-Logic is a management and control provider of all these integrated services. We have started with compressed air, and will evolve into other processes where we can leverage our patents and engineering capabilities. BP

For more information, please contact Mark Reed, Pneu-Logic Corporation, Tel: 503-718-0126, e-mail: mark.reed@pneulogic.com, www.pneulogic.com.

THE SYSTEM ASSESSMENT

Evaluating Central Compressed Air Management Systems

BY HANK VAN ORMER, AIR POWER USA

The hardest part about evaluating the capabilities of various central air management control systems for multiple pieces of compressed air equipment, specifically air compressors, is that, according to their marketing sales materials, they all essentially do the same thing.

Productivity and profits are very directly linked to the compressed air system, as is waste elimination. High-performance central compressed air management systems can respond quickly to even extreme system fluctuations, improving productivity and minimizing energy waste. This is accomplished with modern software systems that analyze and process appropriate data and trigger proactive actions — before the dynamics affect the compressed air production system. This is an advancement, as compared to the old-style solution where a central air system's action occurs after an event or events. Do all central air management systems do this with all units? No, they certainly don't! To start with, ask appropriate questions:

- Can you handle positive displacement air compressors and dynamic (centrifugal)? Separately? Together?
- Can you handle all brands? All types of capacity controls? Old and new units?
- Will your central air system tie in with auxiliary equipment such as dryers, cooling towers, pumping stations and crossover valves (high pressure to low pressure)?
- Can the system be accessed remotely?
- Will it notify appropriate personnel for service if required?
- What is the data-analyzing protocol?

The list can go on and on, but in the end you will still have a lot of systems to look at and try to best fit to your circumstances.

THE SYSTEM ASSESSMENT

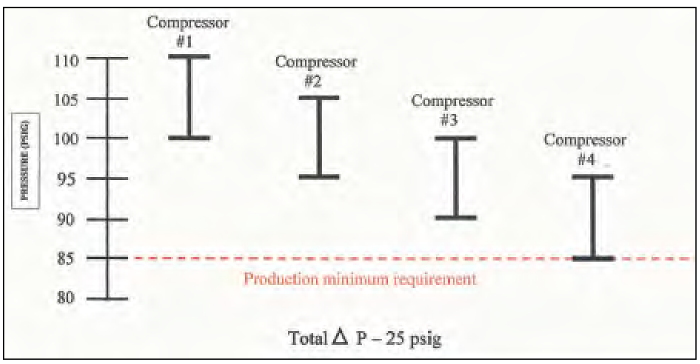
Evaluating Central Compressed Air Management Systems

Where Have We Come From?

For many years, a central control or air management system was really just a sequencing system that brought compressor units on and off from a preset alignment against a sensed compressed air system pressure.

After a simple blow-off valve, which "blows off" excess air when maximum pressure is needed, the next-step compressor central control system was the cascade type pressure control. Air compressors were set up on descending preset operating bands that, with four units as shown here with a 10 psig operating band, required 25 psig from high- to low-system pressure, just to operate all units.

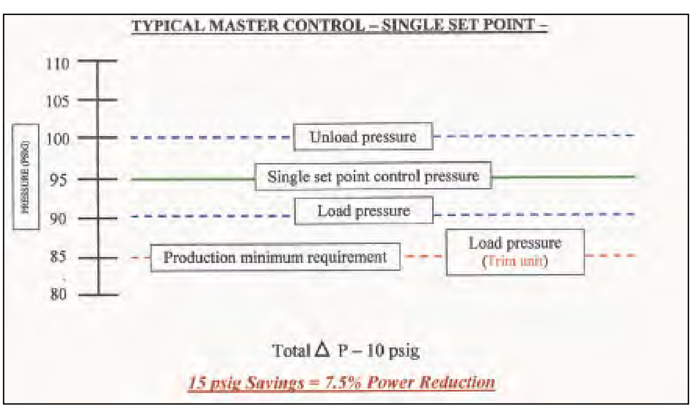
Typical Cascade Control Settings



Through the 1980s and 1990s, improvements began to take shape. With the development of electronics, the operating bands were tightened, thereby saving energy. The PID controller was used to identify the rate of change and combine this with a system that set a single-target system pressure, and to develop methods to bring on only the proper alignment of units to do the job.

Easy to say — not so easy to do.

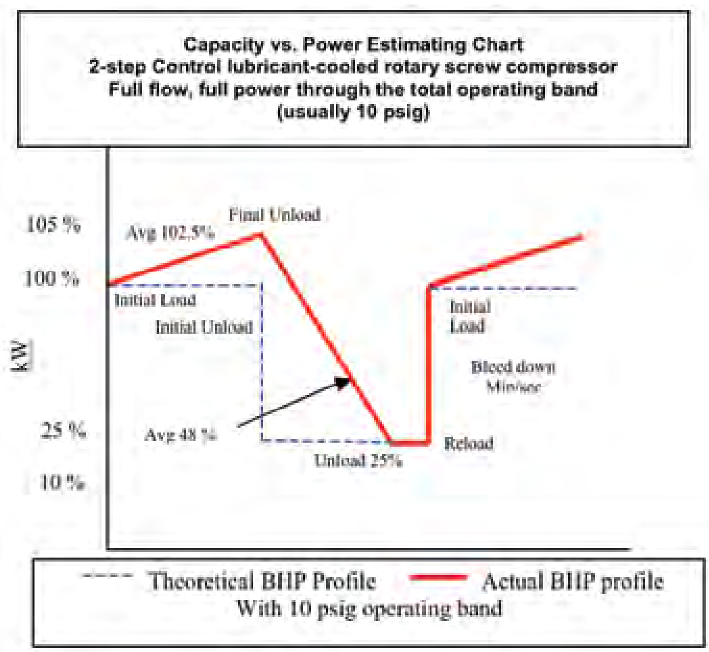
During the 1990s and into the 21st century, central air management system protocol development followed this path with many achievements.



Note: Advanced electronic controls allowed a much smaller or tighter operating band with this cascade system — a significant improvement.

The most talented controls personnel were also often the least knowledgeable compressed air personnel, and vice versa. There was a tendency to reconfigure all rotary compressor controls (modulation, variable displacement and sometimes even variable speed drive) to two-step or load/no load unit capacity control to make them "easier" to work into those "tried and true" programs that always worked. Sometimes this worked well, other times it did not, depending on the available unit selection and local interconnecting piping. Lubricant-cooled rotary screw compressors further complicated this situation, as they all required a specific *minimum off time to be able to blow down to full idle and lowest input kW at idle.* This time delay can range from seven seconds to three minutes, depending on the size, model and age of the unit. To reach these results often required (and still requires) correct piping, and the performance is very "storage dependent".

And so, technology progressed with many systems still trying to *react* faster after the system "event", to match the system dynamics. This included tighter bands and more storage at higher pressure (more energy to produce), to buy more time to *react* to the system dynamics.



In many cases, these reactions worked fine, depending on the situation. However, here is one situation where they did not work, and here's why:

At a powdered metals plant in North Central Pennsylvania, the operation had the following demand profile with established targets for the control system:

Demand Profile	Central Air Management Target
Average Flow = 1750 scfm	Average Flow = 1750 scfm
Maximum Flow = 2150 scfm *(This is a very tight demand profile and should be relatively easy to respond to effectively)*	Maximum Flow = 2150 scfm (1) base = 1800 scfm (1) trim = 440 scfm 100 hp part-time
Nominal Operating Pressure = 100 psig	Pressure Range = 100 ± 2 psig

The air supply consisted of:

- (1) 400 hp two-stage variable displacement rotary screw 1850 scfm at 100 psig
- (3) 100 hp single-stage constant speed inlet modulation control 440 scfm at 100 psig
- Central Air Management Control System Design Parameters:
- Tie all four units to a central air management system; system pressure based
- Convert all units to load/no load control (two-step) because:
  - The supplier felt it "was the most efficient"…and…
  - "This was the only protocol" that existed in the software
  - Operate a ±2 psig target band

They also installed two 3,500-gallon air receivers as storage to create the allowable permissive time for the controls to *react*.

Note: The piping in Figure 1:

- Single-point entry and exit to the first air receiver. Air cannot leave the receiver when the line pressure is higher than the receiver. As soon as the trim compressor loads in, the line pressure rises more rapidly than the receiver, blocking the stored air within seconds, and rapid response is destroyed
- The second receiver can only get air to the system control after the pressure falls in the first receiver. In this case, it may never get out
- The pressure flow controller is there to stabilize system pressure, but it does have a 5 psig pressure loss built-in. The 5 psid loss will increase as the entry pressure falls. This item would not be required in a properly controlled system because the central controller can deliver a steady lower pressure
- If the 400 hp unit is unloaded, it must fight its way past all the 100 hp units that are loading into the header with 90° crossing tee's in order to reload. The *back pressure* causes it, and the 100 hp units, to short cycle. The actual operating pressure band ranges from 103–117 psig, with all the action taking place in the piping, which is at a higher pressure than the receivers (103 psig), most of the time effectively blocking them from the system

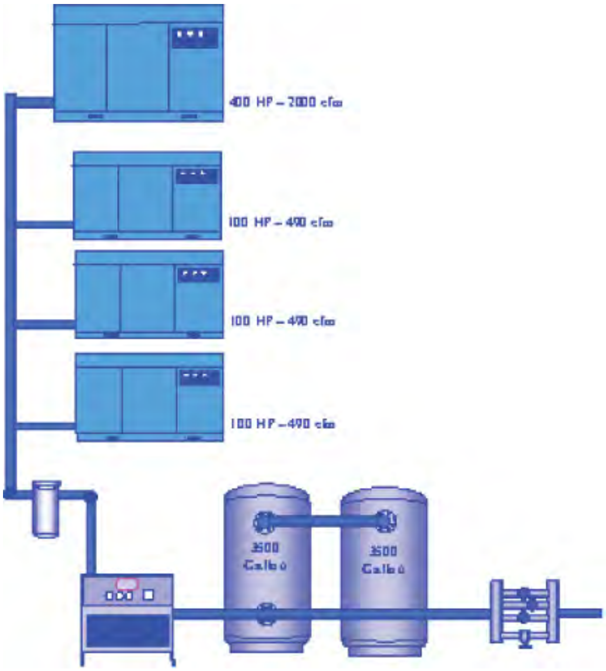


Figure 1

THE SYSTEM ASSESSMENT

Evaluating Central Compressed Air Management Systems

Operating Sequence

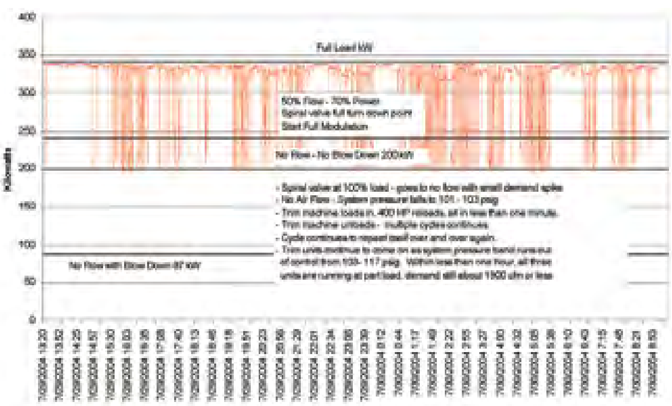
The 400 hp unit is at base load at a lower average demand flow (1,600 scfm) even than its full load flow of 1,750 scfm *unloaded*. 1,750 scfm is removed from the system, drawing 1,600 scfm with full 7,000-gallon storage available immediately. *It is not* due to delay in "turning the air around" — cycle time would be a little less than 40 seconds before the first and/or second 100 hp unit loaded in, and the 400 hp is still blowing down. The piping pressure rises faster than the receiver's stored air, effectively blocking its exit from the receivers. The 400 hp reloads and the cycle starts all over again.

The Tale Is in the Tape

24-hour trended curves from the new central air management monitoring system shows:

- Three units on line — all at part load
- 2,948 cfm on line/1720 cfm average demand/base unit
- Peaks to 1,900–2,000 cfm
- Pressure swings from 103–117 psig
- The two-step controller has a much slower response time than either the variable displacement or modulation control. Therefore, it cannot respond as effectively to these system dynamics

"Five-Step" Spiral Valve Control on 400 HP Compressor Converted to Two-Step Load/No Load Control



What Happened?

Incorrect piping and software incapable of utilizing the variable displacement capacity control system interfered with proper component operation. The piping configuration blocked the timely use of the large air receivers (7,000-gallon).

Proposed System	Actual Result
Loaded Units	
(1) 400-hp base	(1) 400-hp part load
(1) 100-hp trim (part time)	(1) 100-hp – part load (1) 100-hp part load
Average Operating kW = 337	Average Operating kW = 427.65
Pressure Range 100 psig (±2 psig)	Pressure Range 103 – 117 psig
At $.05 kWh / 8760 hrs yr = $39,639/year wasted	

"Core" Design Fault

Fault is due to a lack of a central air management control system to take advantage of the positive operating characteristics of a variable displacement control (five-step). If the protocol in the software could interpret the load position, this problem would have been averted. As the pressure rose to the unload point, the 400 hp unit would have gone to 87–88% flow (1,575 scfm; a drop off of only 225 scfm). The 100 hp would not have come on and the system would have been stable. This would occur all the way down to 900 scfm. Above 1,000 scfm, the 225 scfm redirection would not cause the collapse of the system. The same level of storage would not have been required for proper operation and the pressure/flow controller could have been eliminated (capital cost and 5 psid). Proper piping design will still be required.

What This Shows

A two-step, or load/no load, control system sensing pressure to control is, at best, only a reactive-type system and cannot begin to operate until after the system pressure move has occurred. We can streamline these actions and build-in permissive time, but the more complex the design, the more opportunity for problems and the less user friendly the total program is. In the case study shown here, the plant manager and plant engineer thought everything was okay for a year, until they looked at their recorded data! No calls, no problems — but energy dollars were going down the drain.

Over the last decade, the system pressure-based central control systems have developed more and more effective ways to operate with a narrow control (avoiding excess pressure) and hold the production header pressure very tight (±1 psig). However, this often suggests, or even requires, a large storage receiver of compressed air and a pressure flow controller (demand expander, intermediate controller, pressure regulator, etc).

Eliminating the cascade system has been accomplished by software that establishes a single operating system pressure band control to which all the units respond. To oversimplify, these systems usually still run on a single-load or no-load local capacity control on the compressors.

A signal goes to each unit, full load or full unload. All units are kept at full load except the trim unit. Unneeded units are at idle or shut off. Further performance is written into the software, calculating the rate of pressure rise or rate of pressure drop, to select the appropriate response in compressor size to delete or add from the available units.

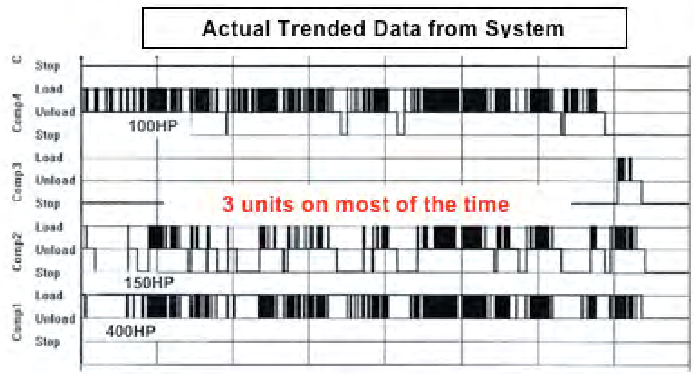
Other programs may incorporate specific trending in the software analysis to help estimate the best action "after the event". This can be very helpful because it will dampen any quick response to a random short-term pressure rise or fall and help stabilize the system.

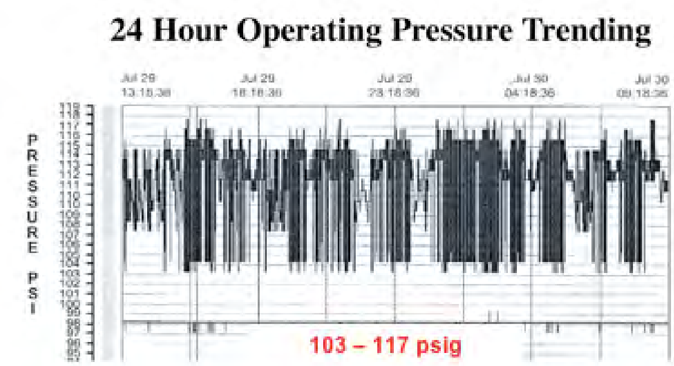
Other such informational processes on available machine sizes, peak loads, minimum loads, etc., can be worked in. This increases the transfer and processing of high volumes of data and the complexity of the protocol, but also enhances the flexibility.

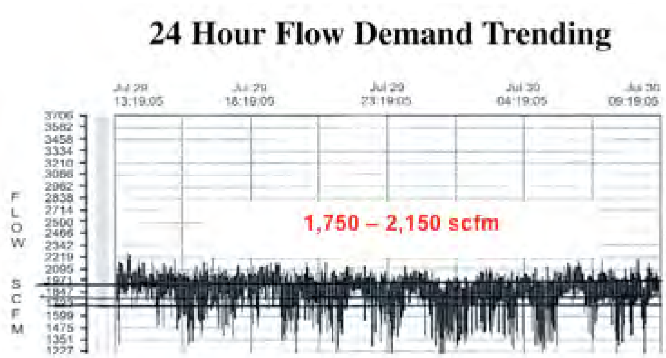
Summary

We have taken the operating system pressure-based central control air management and control protocol about as far as it can go. Regardless of its response time, no action can be taken *until after* something has happened to the system (i.e., too high or too low pressure). Its only method to interpret what is happening is system pressure. This will miss any type of malfunction that impedes the compressed air flow, such as:

- Collapsing inlet filter hose connection at load (we have seen this several times)
- Inlet control valve out of adjustment or not executing full travel
- Discharge check valve stuck partially open
- Heavily fouled separator
- Local capacity control out of adjustment or failed
- Many other malfunctions







THE SYSTEM ASSESSMENT

Evaluating Central Compressed Air Management Systems

"High-performance central compressed air management systems can respond quickly to even extreme system fluctuations, improving productivity and minimizing energy waste."

— Hank Van Ormer, Air Power USA

During the 1990s, great progress was made using flow-based data, individual unit load position, reactive specific power (efficiency) and, particularly, mass flow compressors (centrifugals) and ambient or inlet air conditions.

From the late 1990s into the 21st century, new advancements into software protocols were developed to take action on the software-predicted event *before* the event occurred, enabling it to be more proactive. Built into these modern protocols were such things as:

- Relative efficiency of each unit of compressed air supply, considered at full load, type of capacity control and part load capability to activate sequencing/alignment
- Permissive start and/or reaction time required
- Low- and high-pressure limitations
- All units lined up in a preferred sequence. The preferred sequence is modified when operating conditions call for it
- System pressure, compressor discharge pressure, storage pressure, system flow, unit flow, motor input kW (power), all combined and compared real time to accurately portray the actual system operating conditions
  - Changes in flow demand are picked up at the very beginning of a potential cycle and proper required action, if any, can be started before any effect is showing. Timely control action can often completely avoid any effect
- Capable of handling all types and brands of air compressors in a single system
- Capable of handling and controlling auxiliary equipment, such as dryers, filters, cooling systems, etc. They include such things as controlling the adjustable purge on a desiccant dryer and/or monitoring the true performance of a refrigerated or desiccant dryer
- Offer a customized remote monitoring system which can be viewed from anywhere in the world with a computer and web browser
- Preventative service maintenance reminders
- Notify appropriate contacts when service is, or has been, required
- Remote control of system with password protection
- Communicate to one or several central locations

The list of control and monitoring opportunities goes on and on. The modern central air management system is more than a sequencer. It can be a great working partner to help you monitor and keep those hard-won compressed air energy savings. BP

For more information, please contact Hank Van Ormer, Air Power USA, Tel: 740-862-4112, e-mail: hankvanormer@aol.com, www.airpowerusainc.com.

THE TECHNOLOGY PROVIDER

Control Systems for Small- and Medium-Size Air Compressors

BY BOB FOEGE, STANDARD PNEUMATIC PRODUCTS

Energy Efficiency Is Also Possible for 25 Horsepower Air Compressors

In today's world, where "green" is "gold", the efficient operation of multiple air compressors has taken on a new sense of urgency. In an era where giant manufacturing campuses with huge compressed air systems are quickly disappearing, the emphasis now shifts to improving the efficiency of the higher numbers of installed small- and medium-size air compressors. With electrical rates on the rise and limited capital expenditure budgets, facilities are interested in improving the energy efficiency of their existing air compressors. Retrofitting the control systems provides a viable alternative.

The Universal Autodual Model ADSE Operates Two Rotary or Recip Compressors with Automatic Lead/Lag Control.

It is a fact that the basic, air-cooled, reciprocating air compressor is still the most popular and affordable way to get compressed air to operate your small plant systems. However, the available reciprocating compressor control systems are still based on either start/stop or constant speed technology — both of which date back to 100-year-old technology.

So, the user operating two 25 hp reciprocating air compressors, for example, has the choice of either start/stop or constant speed control options, or a confusing mixture of the two. Too many start/stop cycles and the whole mechanical system is compromised, with resulting starter and motor failures. Or, a complete shutdown of the system can occur as a result of overheating. Operating the machines in the constant-speed mode can result in uncontrolled and excess idling. This can compromise the plant filtration system with excess oil carryover and then, of course, the attendant increase in the cost of operation.

THE TECHNOLOGY PROVIDER

Control Systems for Small- and Medium-Size Air Compressors

The Automatic Dual Control System

Installing a modern automatic dual control on each compressor in the system allows each machine a selectable idle period before stopping. This provides all of the advantages of the start/stop and constant speed systems in that it limits both destructive cycling and constant idling, and it cools the motor/starter and compressor before stopping a machine that is no longer needed to meet plant capacity.

Automatic or manual selection lead/lag control balances the wear on each compressor and, because of gradient pressure settings on each machine, never operates a compressor unless there is a need for more capacity. A totally-unloaded, timed soft-start is a major requirement for healthy system operation, and motor and starter life echoes that. An emergency shutdown system that operates simply and effectively on existing low oil level, low oil pressure or high air temperature signals has the ability to send a remote signal to indicate a shutdown. Pressure control is maintained by pressure transducers combined with a display panel, making pressure selection accurate (+/- 0.5%) and easy. The system does not use mechanical pressure switches. Since we all know that an air compressor operates at its most efficient point when it is OFF, then that is the goal that this controller meets.

The Basic Universal Autodual Controller Model AD Converts a Recip or Rotary Air Compressor to High Efficiency Operation.

Universal Aftermarket Application

The Universal Autodual is currently in use on air-cooled (all makes and types) and water-cooled, double-acting air compressors (ESV, ESH, HB, WG-9, WN-112, YC) worldwide.

Even small compressor systems can yield substantial savings. A recent aftermarket installation of a dual system, comprised of two Champion 7.5 hp start/stop compressors, is in a large tire retailer in Westchester County, New York. The local utility, ConEdison, had a power-monitoring system in place. After nine months of operation with the Autodual ADSE controller (automatic dual control, auto lead/lag alternation), the power savings was annualizing at about $1,700 for the system.

The Universal Autodual controllers are equally at home with rotary screw air compressors. There are installations on air compressors up to 250 hp in size.

In a sawmill in Maine, two basic Universal Autodual controllers with automatic (cycles on the clock) lead/lag control were installed on two 250 hp Quincy Northwest rotary screw air compressors with constant-run, modulating controls. The conversion to automatic dual control resulted in the lag compressor automatically stopping 19 hours per day on average. The installed cost of the Universal Autodual Controllers (about $5,000) was written off in about three weeks, and the sawmill continues to accrue the power savings while reducing annual compressor turning hours by about 6,000.

A recent conversion was made to five LeRoi 100 hp constant-run, modulating-control rotary screw air compressors in Texas. They installed the automatic dual control and lead/lag operation, which stopped one compressor in the first shift and two in the second and third shifts (on average). This resulted in substantial operating savings and reduced turning times. The Universal Autodual converts older and less-efficient modulating constant-run rotaries of all sizes, including tank mounts, bringing new life and efficient operation to otherwise toxic installations.

Make the "Hodgepodge" Efficient!

The Universal Autodual will automatically link compressors of different makes and types that are so typical of the compressor "hodgepodge" existing in many operating facilities. For example, it is not unusual to connect a rotary to a recip in automatic lead/lag configuration to operate the smaller machine in the lead position for second and third shifts. The larger air compressor is placed in the lag position and is always ready to automatically pick up any usual capacity requirement if necessary. First shift operation converts automatically to the larger rotary, with the smaller recip in the ready-lag position.

Conclusion

In an economy that requires tighter control over machinery operation, customers can utilize high-efficiency compressor controllers to revitalize an existing system and to operate at high efficiency, automatically, in virtually any load environment. Remember, air compressors operate at their most efficient point when they are off. BP

For more information, please contact Bob Foege, Standard Pneumatic Products, Inc., Tel: 203-270-1400, e-mail: sales@stdpneumatics.com, www.stdpneumatics.com.

RESOURCES FOR ENERGY ENGINEERS

TRAINING CALENDAR

TITLE	SPONSOR(S)	LOCATION	DATE	INFORMATION
Compressed Air Challenge® Fundamentals of Compressed Air	Northwest Energy Efficiency Alliance Idaho Power Co., BPA, WSU	Nampa, ID	9/30/09	tel: 505-241-4404 www.compressedairchallenge.org
Compressed Air Challenge® Fundamentals of Compressed Air	National Grid DOE EERE UMASS Energy Efficiency Partnership	Waltham, MA	10/8/09	Mark Gerrish tel: 413-545-2853 mfgerrish@ecs.umass.edu www.compressedairchallenge.org
Compressed Air System Benchmarking, System Sizing and Simulation	SIGA Green Technologies	Webinar 3 P.M. EST	10/22/09	Jan Hoetzel tel: 616-828-1024 jan.hoetzel@siga-greentec.com www.airleader.us
Compressed Air Challenge® Fundamentals of Compressed Air	Manitoba Hydro	Winnipeg, MB	10/27/09	Veronica Walls tel: 204-360-7229 vwalls@hydro.mb.ca www.compressedairchallenge.org

Editor's Note: If you conduct compressed air system training and would like to post it in this area, please e-mail your info to rod@airbestpractices.com.

INDUSTRY NEWS

Mourning the Loss of Carl Kaeser

Carl Kaeser, Chief Executive Officer of Kaeser Kompressoren GmbH, passed away on July 8, 2009, shortly after his 95th birthday. Under Carl Kaeser's leadership, Kaeser Kompressoren evolved from a regional and national compressor manufacturer into one of the world's most successful compressed air systems providers.

Carl Kaeser, CEO of Kaeser Kompressoren GmbH passed away on the 8th of July 2009, shortly after his 95th birthday.

Up until the beginning of the 1970s, the main focus of Kaeser Kompressoren's product range was reciprocating compressors. However, thanks to Carl Kaeser's keen insight, the company developed the groundbreaking and highly efficient "Sigma Profile" rotary screw compressor. His drive and pioneering spirit were clearly demonstrated again by the decision to integrate compressor and modern digital technology in order to achieve enhanced efficiency and reliability. The "Sigma Control" system was the first industrial PC controller of its kind to be standard on a rotary screw compressor.

RESOURCES FOR ENERGY ENGINEERS

INDUSTRY NEWS

Mourning the Loss of Carl Kaeser (cont.)

Both technically and commercially accomplished, Carl Kaeser continued to steer the company on its successful course — together with his son Thomas Kaeser, who joined him in the early 1980s — right up until just a few weeks before his passing. Under his leadership, the company grew to its present total of almost 4,000 employees worldwide.

After German reunification, Carl Kaeser once again proved his visionary foresight with the acquisition of Germany's oldest compressor plant, situated in Gera. He subsequently not only added compressed air refrigeration dryers to Kaeser's product portfolio, but rotary blowers as well.

Everyone in the company felt Carl Kaeser's presence. He sought out dialogue and direct personal contact, and he was always willing to listen to his employees' concerns. When a decision had to be made, he always took the direct route and confidently led his team at all times. Furthermore, his impressive knowledge of operational details and methods, along with his vision and commitment, made him a leader upon whom employees relied and whom they valued and trusted.

Carl Kaeser was especially proud of the fact that so many employees had been with his company for a long time and relished the celebration of employees' five, 10, 25, 40 or even 50 years of service. However, he personally held the distinction of being the longest-serving Kaeser employee, with over 70 years of dedication to the company founded by his own father in 1919.

Carl Kaeser received numerous honors for his lifetime achievements. He was a recipient of the Bavarian Order of Merit, the Order of Merit of the Federal Republic of Germany (First Class) and the State Medal for Special Services to the Bavarian Economy, and he was made a Freeman of the town of Coburg and Honorary Senator at the University of Coburg. He will be greatly missed, though he will always be present in the hearts and minds of friends and colleagues around the globe.

Kaeser Compressors
Tel: 800-777-7873
www.kaeser.com

PRODUCT PICKS

New GA Series Compressor

Atlas Copco announced the latest offering in the 110–160 kW (150–200 hp) category — the GA FIT. The entry-level GA FIT range provides air compressor technology for customers in need of standard efficiency levels. With the addition of the GA FIT, the GA range of air compressors now encompasses four option levels in order to provide additional customization for all types of users. Ensuring a long and trouble-free life at the lowest possible cost, the GA FIT utilizes the latest generation of Atlas Copco's oil-injected screw element in order to provide reliable service in the harshest environments, even in ambient temperatures up to 115 °F/46 °C.

Completing Atlas Copco's GA 110–160 kW range are the GA Standard, GA + and GA VSD (variable speed drive) versions. Each variant provides an increased level of performance and benefits, such as energy recovery, modulating controls, phase sequence relay and additional energy-saving technologies. The GA FIT models are available from stock within the United States.

Atlas Copco
www.atlascopco.us

PRODUCT PICKS

New Compressed Air Data Logger

SIGA Green Technologies announces the new Airleader high-performance data logger. It has eight channels and performs one-second data recordings for precise compressed air system evaluations. Its large memory can record data for weeks without memory overflow. The system records 4–20mA signals. Any 4–20mA pressure transducer, flow meter, dew point sensor, differential pressure transducer, temperature sensor, ampere and three-phase kW current transducer can be installed.

The data logger works with an easy-to-use software program to evaluate data and generate reports that contain graphs and tables. The zoom function enables detailed analysis. Data can be downloaded with a USB stick or cable for fast on-site data evaluation. This assures the collection of good and complete data before the system is dismantled, avoiding expensive double work.

The data logger precisely captures energy and output data. It can be used to document exact kWh savings for utilities' energy efficiency incentive programs.

Flexible data logging merges data from multiple compressor rooms into an overall system evaluation. Wireless set-up is optional for data logging of pressure transducers throughout the plant or for compressors in remote locations.

SIGA Green Technologies
Tel: 616-828-1024
E-mail: info@airleader.us
www.airleader.us

New Generation Air Compressor

Boge America Inc. announced the launch of the second generation SD 20-2, SD 24-2 and SD 29-2 screw compressors with integral dryers. These compact compressed air stations offer a space-saving solution. The new generation 20, 25 and 30 hp models form part of the Boge S Series product range. The award winning Boge S Series design incorporates a clever cabinet layout with a high-quality finish and maximum efficiency. All maintenance parts are easily accessible from one side of the compressor, keeping maintenance costs to a minimum.

The new generation SD Series models are available in the standard pressure of 115–190 psig. Output capacities range from 67–122 cfm and motor power from 20–30 hp.

BOGE America
Tel: 770-874-1570
www.boge.com/us

RESOURCES FOR ENERGY ENGINEERS

LITERATURE & SERVICES PICKS

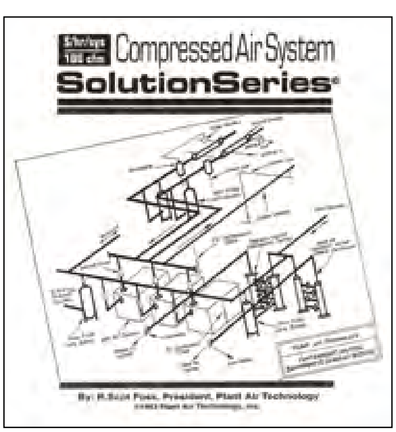
The Compressed Air System Solution Series©

Scot Foss has provided his expertise to many of the world's leading manufacturing and processing corporations by finding solutions to their problems. Foss is one of the world's leading experts in compressed air systems, known for his sometimes-controversial approach to the issues that face plant engineers, maintenance managers and production engineers.

Written in a conversational format, this 1,100-page book with 165 illustrations brings you solutions with a straight on, common sense approach supported by technology. The author focuses on concepts and applications, which are guaranteed to improve production results and energy efficiency. The chapters of the book are as follows:

1. Change Your Way of Thinking about Compressed Air
2. Designing a New System
3. Troubleshooting the System
4. Instrumentation and Information Management
5. Compressed Air Storage and Using Potential Energy
6. Piping and Piping Systems
7. Compressor and System's Controls
8. The Business of Demand
9. Supply Energy
10. Cleaning Up Compressed Air
11. Standards and Specification

The cost of the book is $295.00. To order the book, make a check or PO out to: Air's a Gas, Inc., 3728 Berenstain Drive, St. Augustine, FL 32092, or call 904-940-6940, fax 904-940-6941 or e-mail: airsagas@aol.com. A portion of the proceeds from this book will be donated to selected children's charities.



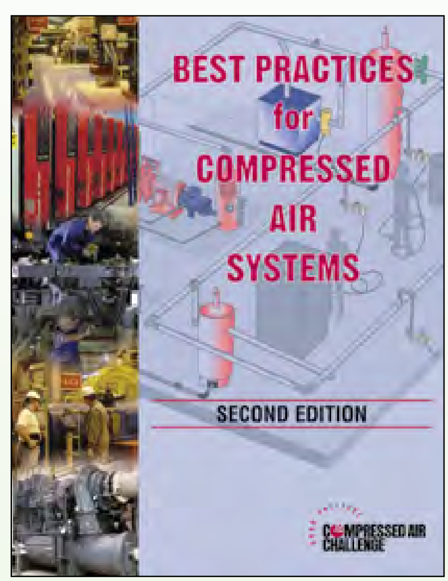
New Edition of "Best Practices for Compressed Air Systems®" from the Compressed Air Challenge®

The Compressed Air Challenge® has released the Second Edition of their authoritative "Best Practices for Compressed Air Systems®."* The Best Practices manual provides tools needed to reduce operating costs associated with compressed air and to improve the reliability of the entire system. The 325-page manual addresses the improvement opportunities from air entering the compressor inlet filter, through the compressor and to storage, treatment, distribution and end uses, both appropriate and potentially inappropriate. Numerous examples of how to efficiently control existing and new multiple compressor systems are provided in one of the many appendices.

The Best Practices manual created by the Compressed Air Challenge® begins with the considerations for analyzing existing systems or designing new ones. The reader can determine how to use measurements to audit their own system, how to calculate the cost of compressed air and even how interpret electric utility bills. Best practice recommendations for selection, installation, maintenance and operation of all the equipment are included in each section. BP

**The Best Practices for Compressed Air Systems® manual is a product of the Compressed Air Challenge®, co-authored by Bill Scales and David McCulloch and is not associated with Compressed Air Best Practices® Magazine.*

Compressed Air Challenge®
www.compressedairchallenge.org



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 on September 14, 2009.

SEPTEMBER 14, 2009 PRICE PERFORMANCE	SYMBOL	OPEN PRICE	1 MONTH	6 MONTHS	12 MONTHS	DIVIDEND (ANNUAL YIELD)
Parker-Hannifin	PH	$50.20	$50.00	$30.77	$59.90	1.99%
Ingersoll Rand	IR	$32.09	$29.11	$14.11	$35.03	1.90%
Gardner Denver	GDI	$34.50	$30.96	$19.80	$41.07	—
United Technologies	UTX	$61.99	$58.08	$40.89	$63.41	2.48%
Donaldson	DCI	$36.11	$39.41	$25.22	$40.40	1.27%
EnPro Industries	NPO	$23.31	$22.44	$14.70	$42.89	—
SPX Corp	SPW	$63.52	$58.54	$50.16	$104.21	1.57%

Parker Reports Quarterly Results

Parker Hannifin Corporation (NYSE: PH) reported results for the fourth quarter and fiscal year ending June 30, 2009. Fiscal 2009 sales were $10.3 billion, a decline of 15.1% from $12.1 billion in the previous year. Fiscal 2009 net income declined 46.4% to $508.5 million, from $949.5 million in fiscal 2008. Earnings per diluted share declined 43.4% to $3.13, compared with $5.53 in the previous year. Cash flow from operations for fiscal 2009 was $1.1 billion, or 11% of sales, compared with $1.3 billion, or 10.8% of sales in the prior year.

"We started the year strongly. However, our performance in the second half of the year reflected the impact of the ongoing global recession, which resulted in significantly reduced order rates," said Chairman, CEO and President Don Washkewicz. "As we had anticipated, our focus on implementing the Win Strategy throughout much of this decade has reshaped our company and allowed us to weather this downturn much more successfully than in previous recessions. We are especially pleased with our very strong operating cash flow, both in the quarter and for the year, and that we maintained total segment operating margins approaching 10% for the year. Additionally, we are proud of the fact that our decline in operating profit during the quarter was 32% of the decline in revenue, and includes the effect of acquisitions, inventory reduction and reductions in force."

WALL STREET WATCH

Fiscal 2009 fourth quarter sales were $2.2 billion, a decline of 33.9% from $3.3 billion in the same quarter a year ago. Net income for the fourth quarter declined 80.4% to $49.5 million, from $252.6 million in the fourth quarter of fiscal 2008. Earnings per diluted share for the quarter declined 79.2% to $0.31, compared with $1.47 in last year's fourth quarter. Cash flow from operations in the quarter was $413.1 million, or a record 18.7% percent of sales, compared with $452.8 million, or 13.5%, in the fourth quarter of fiscal 2008. The company used its cash flow to pay down $321 million in outstanding debt in the quarter.

Reflecting on the quarter, Washkewicz added, "Our fourth quarter performance was influenced by order rates, which declined year-over-year and sequentially from the third quarter levels. This led to a 32% decline in organic sales for the quarter, while foreign currency translation negatively impacted sales by 5% and acquisitions contributed 3% to sales. The decline in sales was the primary driver of lower profitability levels, and our Industrial International segment was hit particularly hard, as reductions in workforce have taken longer to implement. However, with cash being our primary focus, I am particularly pleased that fourth quarter cash flow reached such a strong level. We remain committed to deploying cash to pay down debt and strengthening our balance sheet to prepare the company to fund future growth opportunities, while maintaining our long-standing dividend increase record.

"As we move into fiscal 2010, we will continue to manage our business for cash, while maintaining productivity levels and reducing inventories. Actions to reduce our workforce to align with customer order rates, a broad-based wage freeze, reduced work weeks and significantly reduced discretionary spending are anticipated to benefit us more fully in the year ahead. While many challenges and uncertainties await, our ability to respond reflects favorably on our management team and is a credit to the remarkable performance of Parker employees throughout our company. They have stepped up to the challenges presented to them with their capabilities, loyalty, perseverance and sacrifice."

Segment Results

In the Industrial North America segment, fourth-quarter sales declined 33.3% to $777.5 million, and operating income declined 67% to $53.7 million, compared with the same period a year ago. For the full year, Industrial North America sales declined 12.1% to $3.7 billion, and operating income declined 35% to $394.9 million, compared with fiscal 2008.

In the Industrial International segment, fourth-quarter sales declined 42.6% to $793.2 million, and the segment reported an operating loss of $5.7 million, compared with an operating profit of $213.0 million in the same period a year ago. For the full year, Industrial International sales declined 22.2% to $3.9 billion, and operating income declined 55.6% to $350.7 million, compared with fiscal 2008.

Donaldson Announces 4th Quarter Results

Donaldson Company, Inc. (NYSE: DCI) announced its financial results for its fourth quarter ended July 31, 2009.

Summarized financial results for the periods ended July 31 are as follows (dollars in millions, except per share data):

	THREE MONTHS ENDED JULY 31			TWELVE MONTHS ENDED JULY 31		
	2009	2008	CHANGE	2009	2008	CHANGE
NET SALES	$421.3	$607.4	-30.6%	$1,868.6	$2,232.5	-16.3%
OPERATING INCOME	34.8	67.9	-48.8%	170.0	245.8	-30.9%
NET EARNINGS	23.6	48.6	-51.5%	131.9	172.0	-23.3%
DILUTED EPS	$0.30	$0.60	-50.0%	$1.67	$2.12	-21.2%

Included in the above results are pre-tax restructuring expenses of $6.7 million in the quarter and $17.8 million for the year. The impact of these restructuring expenses reduced diluted EPS by $0.05 in the quarter and $0.15 for the year. Excluding the impact of these restructuring expenses, diluted EPS was $0.35 in the quarter and $1.82 for the year.

"None of us anticipated how dramatically the global recession would impact our customers and, consequently, our sales levels over the past six months," said Bill Cook, Chairman, President and CEO. "However, I am very proud of how quickly and effectively our Donaldson team has responded. As a result of our restructuring efforts, cost reduction initiatives and working capital improvement projects, we delivered a sequential improvement in our gross margin during our fourth quarter.

"In addition, we continued to improve our already-strong liquidity position as we generated substantial free cash flow of $61 million and $231 million for the fourth quarter and year, respectively. This has allowed us to continue to invest in our business for the future and reduce debt by $49 million this quarter, while still increasing our global cash reserves and maintaining our dividend.

"While we continue to be significantly impacted by the global recession, we are seeing signs that some of our end markets were beginning to stabilize in our fourth quarter, as our overall sales were up 2% from our third quarter.

"Compared to our very strong prior year, our overall fourth quarter sales were down 31% and, excluding the impact of currency translation, were down 27%. In our Engine Products segment, local currency sales decreased 27%. In our Industrial Products segment, local currency sales also decreased 27%. Market conditions were also weak globally as our local currency sales decreased by 19% in Asia, 25% in the Americas and 35% in Europe.

"We continued working on our restructuring plans, but did not complete all of our anticipated actions by the end of the quarter. Unfortunately, these restructuring actions included further workforce reductions of 100 employees in our fourth quarter, for a total workforce reduction of 2,800, or 21%, since the beginning of our fiscal year. From the actions we completed, we realized savings of approximately $23 million in the quarter and $43 million for the year. We anticipate that the cumulative effect of the restructuring actions completed in FY09 will generate over $100 million of annualized cost savings at our current sales levels.

"While we project many of our businesses to remain steady at their current levels during the first half of FY10, we expect difficult year-over-year comparisons for the first two quarters of FY10, and then slowly improving comparisons in the second half of the year. Our restructuring efforts will size us appropriately if economic activity remains at these currently depressed levels for an extended period, while also providing us with the financial strength to capitalize on growth opportunities as they emerge." BP

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THE MARKETPLACE

TECHNOLOGY

COMPRESSED AIR BEST PRACTICES®

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1	$250	5-9	$185
2	230	10-24	170
3	210	25-49	150
4	195	50+	135

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