Oregon Mill Saves 4.5 million kWh/yr. Paper Mill Saves $215,000/yr.

April 2011

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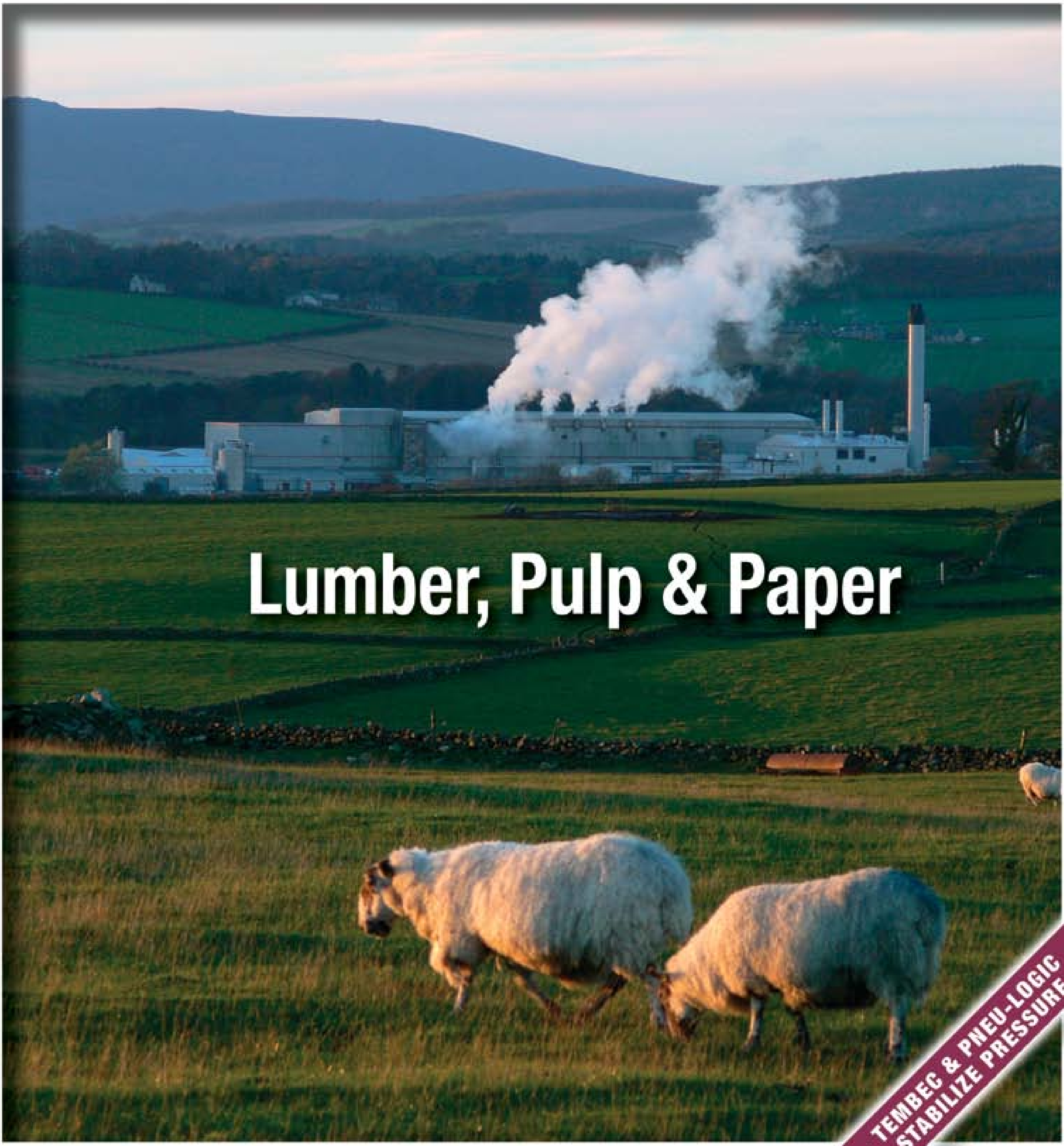

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SUSTAINABLE MANUFACTURING FEATURES

COLUMNS

FROM THE EDITOR

Lumber, Pulp & Paper

Across the U.S. and Canada, sawmills and pulp and paper mills were all severely impacted by the housing crash in the U.S. Mills were closed and thousands lost their jobs. Just a few years later, the situation has improved significantly for this industry thanks to a big new customer — China.

My gratitude goes to a British Columbia lumber industry engineer, Mr. Jon Pritchard, P. Eng., from the Tembec Company. In our article, "Tembec Sawmill and Pneu-Logic Stabilize Air Pressure", Mr. Pritchard explains how they were able to eliminate significant pressure swings and thereby improve their production processes — and reduce their energy costs by twenty percent. The use of a flow controller, a 10,000 gallon air receiver tank, and advanced compressed air system controls provided the solution. Mr. Pritchard also provides us with an educational overview of how air cylinders are used throughout the sawmill.

Mr. Tim Dugan, P.E., of Compression Engineering provides us with a very interesting system assessment story called, "Three Energy Efficiency Measures for a Pulp & Paper Mill." The EEM's allow this mill to save well over $200,000 per year in energy costs and, thanks to a significant utility incentive, benefit from a simple project ROI of one year.

In our Technology Provider column, Warren Rupp Inc. provides us with an article about a new line of AODD pumps they have developed. What's interesting to us about this product line is that it consumes less compressed air than traditional AODD pumps, while retaining all the positive pumping characteristics of this technology.

We hope you enjoy this edition. Thank you for your support and for investing in *Compressed Air Best Practices*®. BP

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

"Three energy efficiency measures saved a pulp & paper mill well over $200,000 per year in energy costs."

— Rod Smith

SUSTAINABLE MANUFACTURING NEWS

Kimberly-Clark, Weyerhaeuser, Stora Enso, Smurfit Kappa

SOURCED FROM THE WEB

Kimberly-Clark

Energy costs are among Kimberly-Clark's largest operating expenses. There are no easy solutions to energy issues. We can help increase energy efficiency and use cost-effective renewable and alternative energy sources, which prepares us for a future where energy supplies may be more limited and costly.

Our long-term objective is to be highly energy efficient and use renewable energy where practical and cost effective.

Kimberly-Clark's Global Energy Services Team, comprised of experienced energy engineers and energy supply professionals, evaluate energy suppliers, negotiate supply contracts, purchase energy, assess alternative energy projects, conduct energy efficiency audits and implement technical energy solutions such as combined heat and power technology.

Goal: Reduce energy consumption by achieving best-in-class energy-efficiency targets. Each facility has targets based on benchmarks for each manufacturing process. These are combined with facility production levels to create facility-specific targets.

Results: For the past two consecutive years, the U.S. Environmental Protection Agency has awarded K-C with its ENERGY STAR Partner of the Year award in recognition of our comprehensive approach to energy management. Contributions include:

- Rigorous tracking of energy usage at K-C facilities
- Energy efficient equipment and lighting fixtures
- Programs to raise awareness about how to improve energy efficiency and provide greater use of renewable energy sources

Kimberly-Clark is a member of ENERGY STAR, a joint program of the EPA and the U.S. Department of Energy that helps U.S. companies measure energy use, set goals, track savings and recognize improvements.

Kimberly-Clark was awarded by EPA ENERGY STAR Program as 2010 ENERGY STAR Partner of the Year in the category of Energy Management Program. This is the second time we have received ENERGY STAR recognition. The EPA's Green Power Partnership is a voluntary program that helps companies increase their use of low-carbon energy by offering expert advice, technical support, tools and resources. K-C is 19th on the EPA's National Top 50 list of the largest green power users.

Kimberly-Clark is an Energy Partner of the EPA Landfill Methane Outreach Program, which promotes the use of methane produced within landfills to replace fossil fuels as an energy source and thereby reduce greenhouse gas emissions.

Source: www.kimberly-clark.com

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SUSTAINABLE MANUFACTURING NEWS

Kimberly-Clark, Weyerhaeuser, Stora Enso, Smurfit Kappa

Weyerhaeuser's Focus on Energy Efficiency and Water Conservation

ENERGY USE

Millions of BTUs per ton of production at Weyerhaeuser's manufacturing operations

	2005	2006	2007	2008	2009
CELLULOSE FIBERS[1]	32.5	31.5	32.8	31.1	30.9
WOOD PRODUCTS	2.69	2.58	2.64	2.88	2.89

Data reflects performance of Weyerhaeuser's 2009 portfolio of cellulose fibers mills. In March 2007, Weyerhaeuser's fine paper business and related assets were combined with Domtar Inc. to create a new fine paper company, Domtar Corporation. In August 2008, Weyerhaeuser's containerboard, packaging and recycling business was sold to International Paper. Operations involved in those transactions have been removed from historical data.

CELLULOSE FIBER MILL ENERGY USE

Millions of BTUs per ton of production[1]

	2005	2006	2007	2008	2009
FOSSIL FUEL CONSUMPTION	4.2	2.7	3.9	3.9	4.0
BIOMASS FUEL ENERGY FROM CHEMICAL-RECOVERY PROCESS AND MANUFACTURING RESIDUALS	24.7	24.1	25.1	23.7	23.2
PURCHASED ELECTRICITY	2.7	3.7	2.7	2.6	2.7
PURCHASED STEAM	0.9	1.0	1.0	1.0	1.2
TOTAL ENERGY CONSUMED PER TON OF PRODUCTION	32.5	31.5	32.8	31.1	30.9
PERCENTAGE OF ENERGY CONSUMED GENERATED FROM BIOMASS FUEL	76%	77%	77%	76%	75%

WOOD PRODUCTS FACILITIES ENERGY USE

Millions of BTUs per ton of production at Weyerhaeuser's wood products facilities[1]

	2005	2006	2007	2008	2009
FOSSIL FUEL CONSUMPTION	0.46	0.44	0.42	0.46	0.41
BIOMASS FUELS	1.58	1.52	1.67	1.81	1.99
PURCHASED ELECTRICITY	0.38	0.38	0.39	0.41	0.41
PURCHASED STEAM	0.28	0.24	0.16	0.19	0.08
TOTAL ENERGY CONSUMED PER TON OF PRODUCTION	2.70	2.58	2.64	2.88	2.89
PERCENTAGE OF ENERGY CONSUMED GENERATED FROM BIOMASS FUEL	53%	58%	63%	63%	69%

In March 2007, Weyerhaeuser's fine paper business and related assets were combined with Domtar to create a new fine paper company, Domtar Corporation. Sawmills included in the Domtar transaction or other sales transactions have been removed from historical data.

WATER USE

Total water use: Estimated gallons of water used per ton of production

	2005	2006	2007	2008	2009
CELLULOSE FIBER MILLS TOTAL WASTE-WATER DISCHARGED1, 2	17,192	16,018	15,978	14,409	13,954
WOOD PRODUCTS FACILITIES WATER USE	104	91	90	90	95

Wastewater discharged is used as a surrogate measurement for water use and includes separate cooling water discharges.

Data reflects performance of Weyerhaeuser's 2009 portfolio of cellulose fibers mills. In March 2007, Weyerhaeuser's fine paper business and related assets were combined with Domtar Inc. to create a new fine paper company, Domtar Corporation. In August 2008, Weyerhaeuser's containerboard, packaging and recycling business was sold to International Paper. Operations involved in those transactions have been removed from historical data.

In 2009, we continued our focus on energy efficiency and sought opportunities to reduce energy intensity in the manufacturing of our products. We continued systematically evaluating our energy use within our operating facilities to identify opportunities for efficiencies and savings. We implemented best practices, both operational and technological, to reduce energy use while increasing awareness in sustainable energy efficiency. Progress in reducing our energy intensity has been hampered by market conditions which have meant that many of our manufacturing operations have run below capacity, and thus, less efficiently.

In 2010, Weyerhaeuser's cellulose fibers and iLevel businesses took the U.S. Department of Energy Save Energy Now LEADER pledge. As part of this pledge, these operations committed to reduce energy intensity by 25% over 10 years.

Weyerhaeuser also participated with the U.S. EPA in the development of a Pulp & Paper Energy Guide and Energy Performance Indicator Tools for pulp mills and integrated pulp & paper mills. These tools can be used to guide future energy efficiency activities.

2009 accomplishments included:

- Achieving more than 4,000,000 kWh in sustainable electrical usage reduction via compressed air and lighting best practices, which reduced our greenhouse gas emissions by 726 metric tons
- Reducing power purchases by more than 32,000,000 kWh via process systems retrofits, which reduced our greenhouse gas emissions by more than 6,500 metric tons

Water Use and Conservation

We recognize water use and water quality as global social and environmental issues. In 2009, we participated in a forest products industry research study that evaluated best practices and approaches to reducing water use in pulp and paper manufacturing. Research indicates that approximately 88% of the water used in the forest products manufacturing process is treated and returned to the environment.

Making pulp and paper requires large volumes of water, and we are working on ways to reduce water use in our operations. As part of our membership in the U.S. Business Roundtable S.E.E. Change initiative, we set a water-use reduction goal in May 2008 to reduce water use at our cellulose fibers mills 20% by 2012, from a 2007 baseline. We achieved a 12.5% water use reduction in 2009 compared to our 2007 baseline. The goal-setting process included analyzing water use

In 2009, Weyerhaeuser achieved more than 4,000,000 kWh in sustainable electrical usage reduction via compressed air and lighting best practices, which reduced our greenhouse gas emissions by 726 metric tons.

at our cellulose fibers mills and comparing performance to industry benchmarks. We include separate cooling water discharges as part of our total water use at these mills.

We also monitor our effect on water tables in our forestry operations. For instance, in Uruguay, where we've planted trees on former grazing land, we initiated a long-term study in 1999 to determine the effect of the land use change on the region's water table. Since then, we've collaborated with a Uruguayan organization and North Carolina State University to determine the effects of change in land use, including annual water yield, peak runoff rates, and water quality.

Source: www.weyerhaeuser.com

Weyerhaeuser

SUSTAINABLE MANUFACTURING NEWS

Kimberly-Clark, Weyerhaeuser, Stora Enso, Smurfit Kappa

Stora Enso Improves Energy Efficiency

Improving energy efficiency

The best way to cut costs and work towards our environmental goals is to reduce our energy use. In 2010 our overall electricity efficiency improved by 3% from 2009. In 2009 we had set individual targets for each of our business areas to further improve energy efficiency. Fine Paper and Packaging Business Areas reached their targets of reducing specific energy consumption by at least 2%. Publication Paper reached its target of reducing electricity consumption by 1%. The baseline year for these targets was 2009. These business areas have kept the same percentage improvement targets for 2011, with their energy consumption levels for 2010 as the new baseline.

Better use of the combined heat and power (CHP) potential of our mills can increase the power-to-heat ratio of our internal energy production. This means that for each MWh of heat that we produce we also aim to maximise the amounts of electricity generated. The Group's overall power-to-heat ratio improved from 21% in 2009 to 22% in 2010.

Our centralised energy efficiency fund, which was set up in 2008 to support our mills energy efficiency projects, supported 22 projects in 2010. We will continue to support such energy efficiency projects and have already selected 34 projects that will receive support during 2011.

To further promote smart and efficient energy use we started a new training programme focusing on energy saving in 2010. Six of our European mills were selected for this scheme, with one member of personnel at each mill trained to act as an internal energy saving agent. Our goal is to establish a network of energy saving experts covering all Stora Enso mills by the end of 2011, to share experiences and spread best practices.

Our special energy saving efforts initiated in 2009 continued in 2010. Potential energy savings were identified through audits at Hylte, Skoghall, Langerbrugge, Veitsiluoto, Imatra and Anjalankoski mills. This information will be used in the planning and implementation of energy efficiency investments and improvements at these mills. During 2011 similar audits are planned to be conducted at Nymölla, Sunila, Corbehem, Uetersen, Imatra, Kabel and Maxau mills.

CO_2 reduction target

We are actively working to reduce greenhouse gas emissions from our production, and we have set a target to reduce fossil CO_2 emissions per saleable tonne of pulp, paper and board by 20% from 2006 levels by the end of 2020. This target covers both emissions generated directly by our own facilities (Scope 1), and indirect emissions

Smurfit Kappa Group

The pulp and paper industry is energy intensive and has a responsibility to look carefully at the impact of fossil fuels. Given the volatility in pricing of energy over the past number of years, there is also a commercial imperative to achieve the most efficient use of energy. SKG looks upon improved energy usage as a major priority.

In terms of improving production efficiencies we have been making additional investment in co-generation. In 2009, Smurfit Kappa Zülpich Papier (the biggest of SKG's German recycled paper mills, located near Cologne) began building a new multi-fuel boiler for the production of electricity and steam for the paper mill which will be operational in 2010.

The power boiler doubles the capacity of the old boiler to 100 tons of steam, while utilizing the same technology. It will burn both brown coal from local sources and biogas, derived from anaerobic process water treatment at the mill.

40,000 tons of organic waste from the paper recycling process will also be consumed, of which 20,000 tons will come from the mill itself and the other 20,000 tons will come from other paper mills in the Group. 15 MW of electricity will be produced, which will increase the mill's self sufficiency with regard to electricity to almost 100%. The start up of this power plant is scheduled for September 2010.

Taking into account the higher efficiency of a cogeneration plant compared to a conventional electrical power station, this investment will allow a decrease in overall fossil CO_2 emissions by 4% for producing the same amount of steam and electricity (source: EIA database average figures for Germany 2007). This results from the fact that the new boiler has a higher efficiency than the existing one although the mill's on-site fossil CO_2 emissions will rise as brown coal will replace part of the natural gas currently burned.

Energy efficiency initiatives

During 2009 the project for a biomass boiler at Cellulose du Pin made considerable progress. In the course of 2009, four SKG mills have been audited by an expert external company to assess energy consumption. Audits have been carried out by Allplan in Cellulose du Pin (France), Mengibar (Spain), SSK (UK) and Ania (Italy). To implement the actionable points revealed by the audits we invested in excess of €1 million to save 10 GWh of electricity, representing variously between 0.2% and 2% of electricity consumption by these mills. External energy audits of additional mills will continue during 2010.

In Europe, the co-generation ratio for 2009 increased by 7% compared to 2008, for the use of electricity for all our operations. The main reason for this increase, besides lower paper production levels, comes from our two mills in Austria and Slovakia that returned to operating their CHP at their normal levels after maintenance work in 2008. The steam turbine at the SKG kraftliner mill in Piteå (Sweden) also operated for the first time for a full year.

In 2009 we achieved the commitment we made in our 2007 Report to increase by 5% our own rate of electricity produced from Combined Heat and Power (CHP) plants. This was achieved a year earlier than planned.

StoraEnso

produced during the generation of the electricity and heat we purchase (Scope 2).

By the end of 2010 we had reduced our CO_2 emissions per tonne of product from our pulp, paper and board mills by 20% compared to our baseline year 2006. Since this means we have already reached our target, we have made a commitment to set a new, tougher target during 2011.

This significant reduction has been achieved mainly through improved productivity, the use of more efficient equipment and streamlined processes, the reduced use of fossil fuels, and improved efficiency in our power and heat generation. Another significant reason for the CO_2 reductions achieved has been increased purchases of electricity generated from low carbon energy sources.

Source: www.storaenso.com

Smurfit Kappa Group

In Latin America we made even greater progress than in Europe as the rate of electricity produced by CHP plants increased by 10%. This increase is mainly the result of the installation of the new RB3 recovery boiler in Cali, with its additional capacity for electricity generation.

Some other initiatives and investments were decided upon in 2009, all of them aiming to achieve our main objective of reducing our fossil fuel consumption. A good example of this is the use of biofuel in lime kilns at our Piteå mill in Sweden (see side panel).

Smurfit-Stone has reduced direct energy consumption by 19.6% and indirect consumption by 14.3% since our baselines measured from 1999 to 2001. We have achieved these reductions by improving operations and practices throughout the company. For example, new evaporator systems and use of biomass in our mills are enabling fuel consumption reductions and boiler retirement.

Source: www.smurfitkappa.com

THE SYSTEM ASSESSMENT

Three Energy Efficiency Measures for a Pulp & Paper Mill

BY TIM DUGAN, P.E., COMPRESSION ENGINEERING CORPORATION

Introduction

Recently, this major pulp & paper mill made compressed air optimization a mill-wide priority. At the request of the utility company providing energy to the mill, Compression Energy Services performed a comprehensive energy analysis that outlined the following four energy efficiency measures (EEM's) for the mill to consider.

EEM #1: A comprehensive compressed air management system that runs the optimal compressors in the optimal mode.

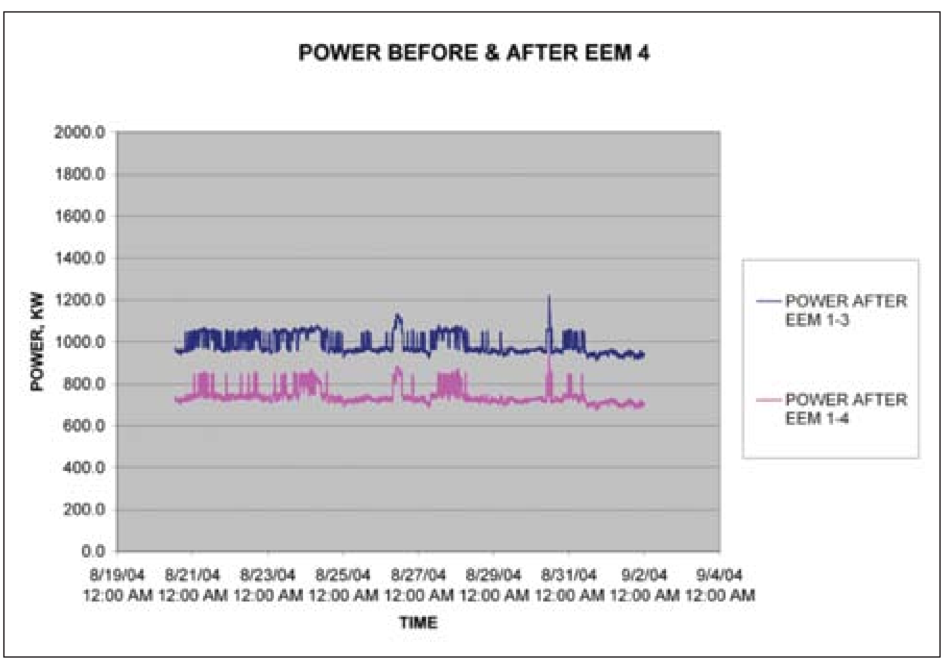
EEM #2: Upgrading the compressors to run more efficiently, particularly at lower pressures.

EEM #3: Replacing the dryers to eliminate purge and allow pressure reduction.

EEM #4: Replacing many of the large dead-load uses of compressed air with alternate technologies.

There are four "energy efficiency measures" (EEM's) that this report recommends. However, since the cost risk and implementation difficulty is highest for measure 3, with the least energy savings and highest EEM payback, we are providing two project packages. The lower cost, lower risk package is EEM 1, 2, and 4 and can provide energy savings of 4.5 million kWh/yr. and $206,808 per year with a ROI of one year.

Due to article length limitations, this document will share only the findings of the EEM 1, 2, and 4 project package.



Baseline Compressed Air Equipment

The compressed air equipment is located in the Power & Recovery Compressor Room and in the Paper Machine Compressor Room. The equipment detail is listed below. At the end of the article we have provided a box diagram of the equipment in the system.

Power & Recovery Compressor Room:

(2) 700 HP Centac Centrifugals (approx. 2,636 acfm full-load capacity)

(1) 300 HP Screw compressor (approx. 1488 acfm full load capacity)

(2) 1300 scfm heatless dryers

(1) 1000 scfm blower purge dryer (approx. 6000 gal storage, (3) 2000 gal.)

Paper Machine compressor room:

(1) 700 hp Centac Centrifugal (approx. 2,748 acfm full-load capacity)

(1) 1000 scfm heatless dryer

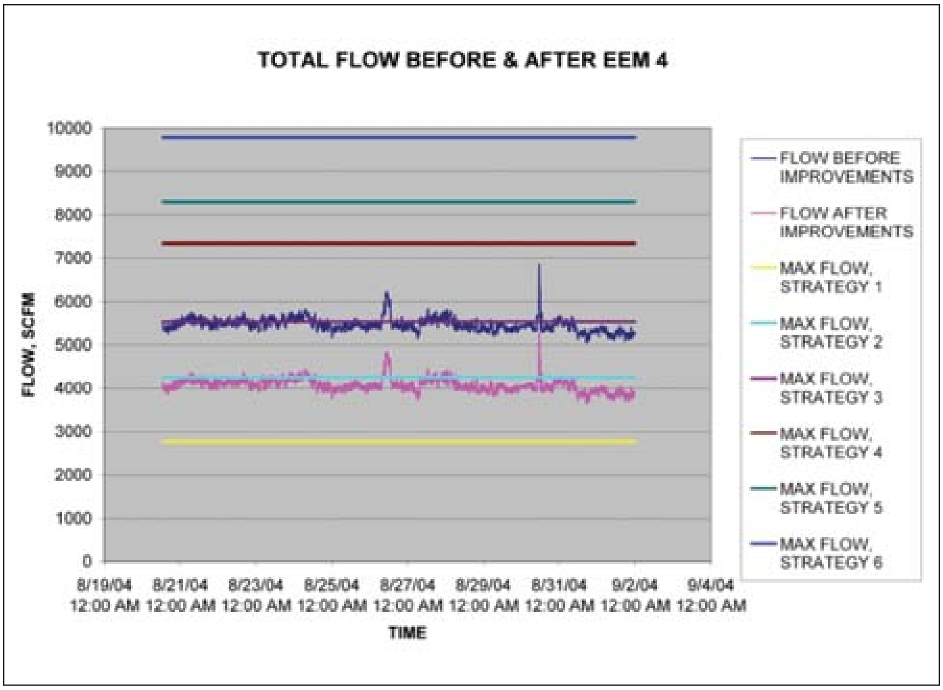
(1) 600 scfm heatless dryer

(2) 1300 scfm heatless dryers (approx. 2000 gal storage)

Controls Baseline

Typical operation over the baseline period includes a variety of partly manual and automatic control modes, which result in four compressors running rather than three (which is a rough measure of optimal control) about 52% of the time. This was determined from long-term main motor current trend data from Customer.

The sub-optimal condition of four compressors running occurs because of the lack of an integrated management system. They have enough automation to get the standby compressor to automatically start if pressure drops to a critical point, if the average pressure is below 80 psig for more than 5 minutes or under 70 psig instantaneously. However, the standby compressor does not automatically stop once the event that caused it to start has passed. There is no control system in place that can determine when a compressor should be unloaded and safely shut off, so that it won't immediately need to be restarted. The average compressor discharge pressure is about 97 psig.



System Integration Baseline

The baseline piping system is cross-connected on the wet side, between two compressor rooms, one in the Power and Recovery (P&R) side of the mill, and the other below the paper machines (PM). These two compressor rooms produce all of the dryer air needed for the Instrument Air (IA) and Pulp and Paper Mill Air (MA) systems, which comprise the entire compressed air system for the mill. These two subsystems are presently segregated, even though they are essentially at about the same pressure (85 psig) and dew point (-40 ˚F). The IA system as a whole is connected by a 3" header that runs through the mill. However, the line size is not adequate to allow the IA system to be fed from either the P&R or PM compressor room. The MA appears that it might have an adequate header size to be fed from

THE SYSTEM ASSESSMENT

Three Energy Efficiency Measures for a Pulp & Paper Mill

either side. Thus, the PM compressor, Centac 3, can never be shut down without rental compressors being brought in, which is very expensive.

Compressed Air Usage Baseline

The baseline constant usages of compressed air that are not related to variances in production are referred to as "dead loads" in this report. Dead loads include many continuous blowing compressed air usages, the largest for cooling and diverting. Both of these applications can be handled with small blowers far more efficiently. There are also air bars, which can be replaced with blowers and/or high efficiency air nozzles.

Energy Efficiency Measure #1 (EEM1): A Compressor Management System

In order to run the optimal compressors in the optimal mode at all times, with all potential flow ranges, a compressor management system is needed. It will effectively eliminate centrifugal compressor blow-off and rotary screw compressor modulation control, both of which are inefficient part-load control modes. It performs two basic functions, optimal part-load control of all four compressors, and optimal staging of which compressors to be running.

EEM1 Source of Energy Savings

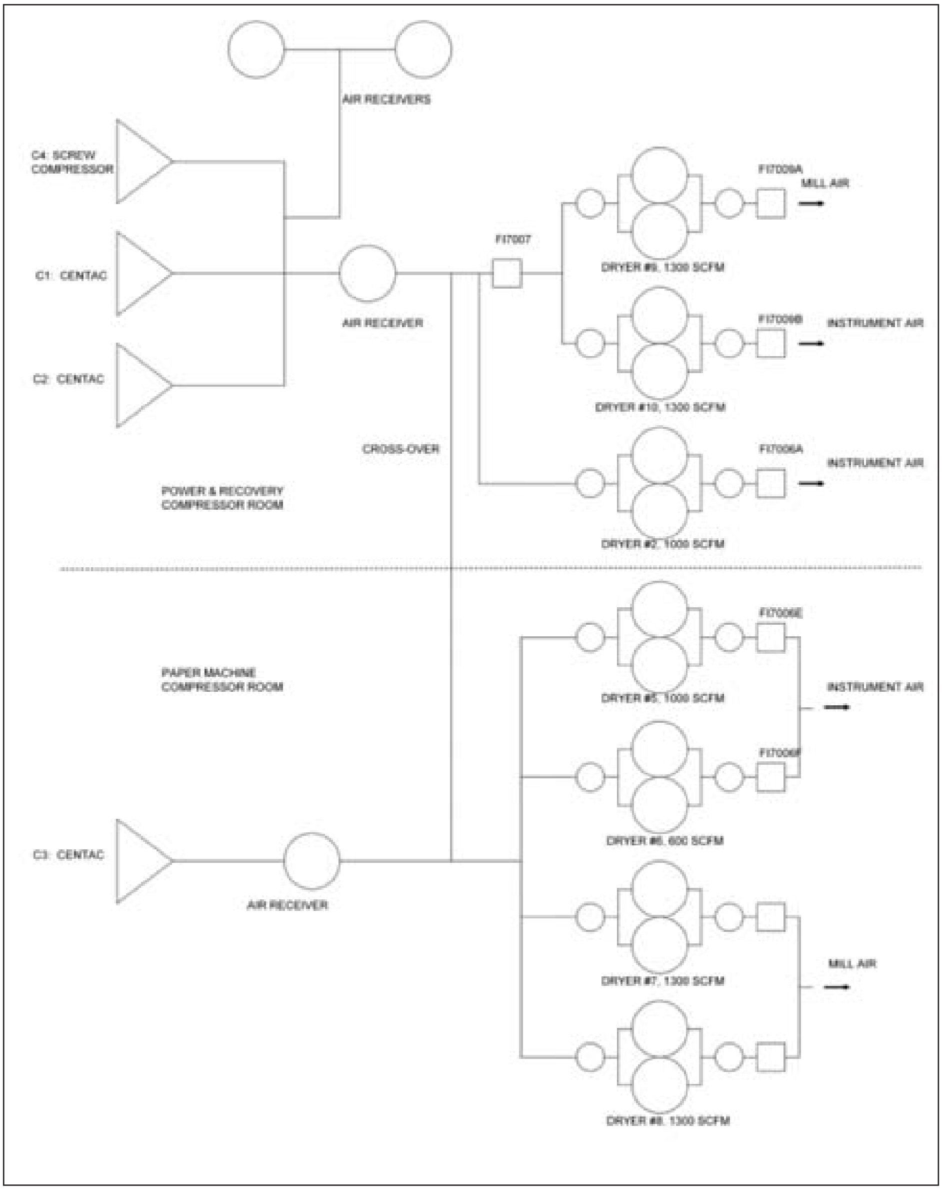
The elimination of centrifugal compressor blow-off is the source of the savings. The management system will only allow the compressors to be running in their most efficient part-load modes, fully-loaded, or off. For the centrifugal compressor, the optimum part-load control mode is inlet modulation. For the screw compressor, this is load-unload.

EEM1 Specific Equipment Recommendations

There are several ways to implement the management system controls. At this point, we have identified two that the customer can implement, one that requires less in-house programming than the other. The first is to upgrade the compressor panels ("CMC" panels) and have them load-share in a peer-to-peer manner. This leverages the investment already made for the CMC upgrades made three years ago, and simplifies the implementation, but does not require a stand-alone proprietary vendor controller to be added. A supervisory PLC will be needed however. The second method is to do all the control in-house. It is our understanding that Air Relief can do load-sharing as well, but it might require new compressor panels, which would be quite expensive. However, they might have upgraded their technology recently, so they are an optional vendor to develop an open PLC-driven solution.

Recommended Methodology: Peer-to-Peer Load-sharing with Supervisory PLC

1. Upgrade all three Centac CMC control panels with the latest 32-bit control



Baseline System Diagram

board, allowing the peer-to-peer load-sharing and ambient control software to run.

2. Install ambient control software on all three Centac CMC control panels, allowing them to modulate down as far as possible, just above the surge point. If the surge point with inlet guide vanes is 72% of full load flow (typical), the ambient software should allow the compressors to run within about 5% of this point, about 78%. This will allow enough "swing" for the management system to work properly.

3. Install peer-to-peer load-sharing on all three of the Centac CMC control panels. This will run them in the inlet modulation mode only, down to their maximum turn-down point, and then unload and shut down one compressor. It will also re-start the compressor if needed. Sequencing is included. The load-sharing software essentially changes each compressor's target modulation pressure setting until they are all balanced, sharing the load without any of them in blow-off.

4. Install an interface on the master CMC panel to communicate to a stand-alone PLC panel. This is called the UCM (universal communications module).

5. The load-sharing system needs to output the real-time target pressure and re-load pressure to the Customer PLC system (see item 4). Only one is required.

6. Install new pressure-flow control system to isolate the Quincy 300 HP compressor (C4) and the two outside air receivers from the rest of the system. Some re-piping will be necessary. See Appendix 7.3 for a system diagram. The pressure-flow controller will maintain a constant outlet pressure. The pressure-flow controller set point and C4 load/unload and start/stop are all controlled by the new PLC (see item 7).

7. Install new PLC system that controls C4 and the pressure-flow controller, with real-time input from the Centac load-sharing system, through the UCM. See 2.2.3 for set points. The screw compressor is already set up for remote load and start.

8. Install new 350 HP motor for the screw compressor, allowing it to run fully loaded up to as high as 120 psig. Presently, the compressor is rated for a maximum of 100 psig at full load, not high enough for the load-unload operation in this specification.

Alternate Methodology: In-house Load-sharing Control

1. Upgrade all three Centac CMC control panels with the latest 32-bit control board, allowing the ambient control software to run.

2. Install ambient control software on all three Centac CMC control panels for maximum turn-down.

3. Install interfaces on all three CMC panels to communicate to a stand-alone PLC panel. These are called UCMs (universal communications modules).

4. Install a new PLC system that performs load-sharing for the Centacs, as well as pressure-flow controller and C4 control. The load-sharing logic will need to be gleaned from IR, which might be difficult. The pressure-flow controller and C4 logic will be the same as above. This will run the Centacs in the inlet modulation mode only, down to their maximum turn-down point, and then unload and shut down one compressor. It will also re-start the compressor if needed. Sequencing is included. The load-sharing software

THE SYSTEM ASSESSMENT

Three Energy Efficiency Measures for a Pulp & Paper Mill

essentially changes each compressor's target modulation pressure setting until they are all balanced, sharing the load without any of them in blow-off. The real-time load-sharing value will be used for the pressure-flow controller and C4 control (see Section 2.2.3 for initial set points).

5. Install new pressure-flow control system to isolate the Quincy 300 HP compressor (C4) and the two outside air receivers from the rest of the system. Some re-piping will be necessary. See Appendix 7.3 for a system diagram. The pressure-flow controller will maintain a constant outlet pressure. The pressure-flow controller set point and C4 load/unload and start/stop are all controlled by the new PLC (see item 7).

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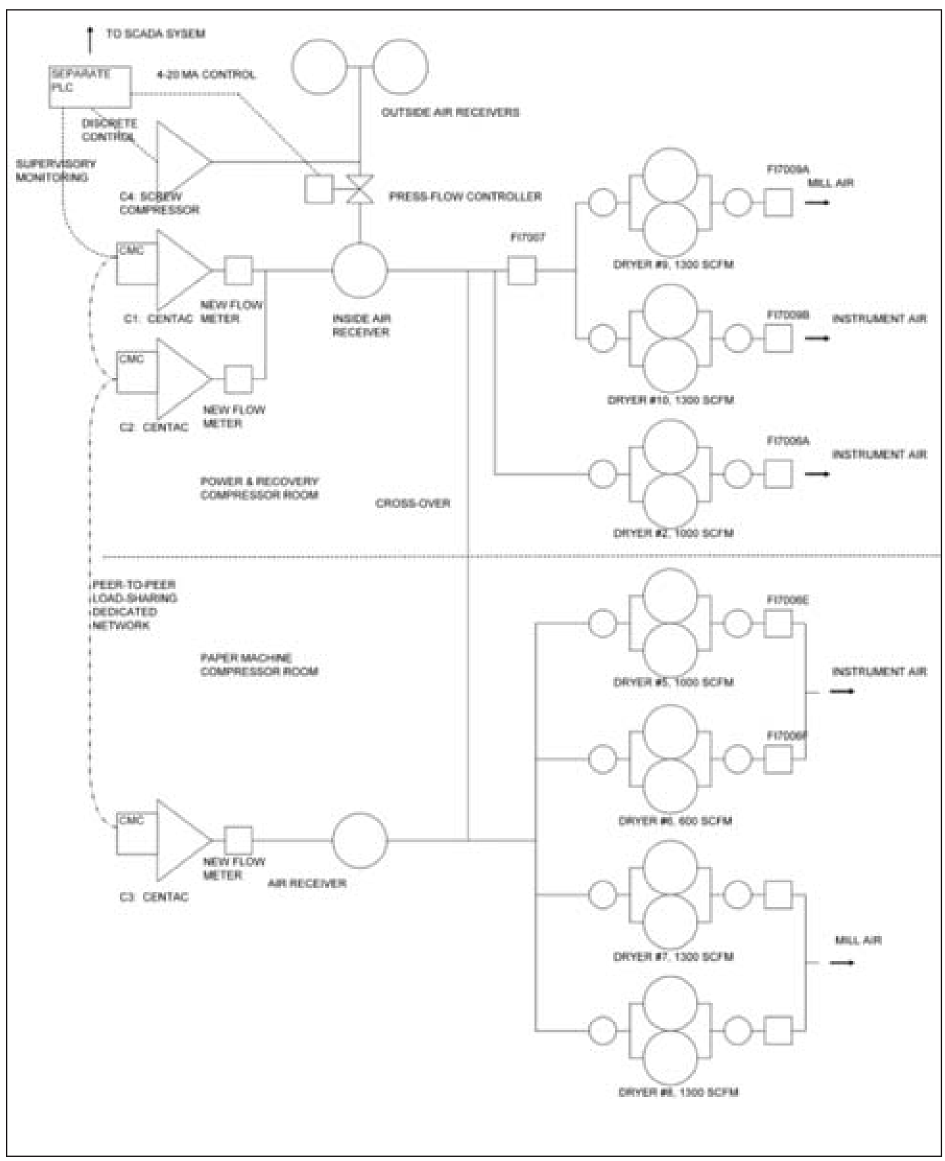
The energy savings opportunity presented by EEM's 1, 2, and 4 is 4.5 million kWh/yr., worth $206,808 in energy savings per year.



EEM1&2&4 Recommended System Diagram

The peer-to-peer system will most likely be less expensive to implement than the in-house option. Since Customer can implement the in-house methodology in many ways, we have not estimated the cost yet. The cost estimate is presently based on the peer-to-peer methodology, and for the remainder of this report, we assume that is Customer's methodology.

This will result in the following staging order and control modes (flows are approximate, not all Centacs can play all roles):

STRATEGY NO.	FLOW RANGE	DESCRIPTION
1	0-2667 scfm	(1) Centac, inlet modulation & blow-off
2	2667-4155 scfm	(1) Centac, base-loaded; C4 load-unload
3	4155-5416 scfm	(2) Centacs, both inlet modulation
4	5416-6904 scfm	(2) Centacs, base-loaded, C4 load-unload
5	6904-8021 scfm	(3) Centacs, all inlet modulation
6	8021-9509 scfm	(3) Centacs, base-loaded, C4 load-unload

Energy Efficiency Measure #2 (EEM2): Modify Compressors for Reduced Pressure

Energy savings for EEM2 are only possible if EEM1 has been previously implemented. This measure will modify the compressors for optimal performance in the pressure range that the system is already at, and for future reduced pressures. The management system will then automatically reduce compressor power as a result. This incremental reduction in energy is attributed to EEM2. This EEM only affects the compressor efficiency, not the control logic, flow or pressure. The existing centrifugal compressors were designed for far higher pressure than they are operating. In addition, they are two stage compressors, while new units of that size are three-stage, much more efficient. Since compressor replacement is quite expensive, we investigated two-stage compressor element upgrades to optimize performance as best as possible.

EEM2 Source of Energy Savings

The present compressors are optimized for 125 psig operation and are inefficient at lower than 100 psig. Since they are at the "choked flow" point at pressures lower than the design envelope, reducing pressure without modifying

(Continued on page 35.)

THE TECHNOLOGY PROVIDER

New AODD Pump Controls Reduce Compressed Air Consumption

BY MARK McCOURT AND DEAN THORNBERRY, IDEX AODD

Air-operated double diaphragm pumps gain energy efficiency and reduce maintenance costs with innovative technology.

AirVantage ENERGY SAVING TECHNOLOGY

Air-operated double-diaphragm (AODD) pumps are known for their positive attributes of handling fluids that are heavily laden with solids, abrasive materials, shear sensitive liquids (paints and coatings) and the ability to pump soft solids without damaging the product. They are also popular because they are lightweight, portable and easy to use due to their pneumatic power.

With the increasing awareness of energy costs and government and corporate goals to conserve energy, the pumping efficiency of AODD pumps has become a topic of discussion and a challenge for AODD pump end users. Recent technology has been developed that increases the pumping efficiency of AODD pumps and reduces energy costs by up to 50%, which equates to millions of dollars in annual savings.

AirVantage Pumps from Warren Rupp, Inc.

New AODD Pump Control Technology

New, patent-pending technology is available from Warren Rupp, Inc. that optimizes pump efficiency and uses adaptive optimization as pump application parameters change. This method maintains all the positive attributes of AODD pumps while employing the latest control technology. The devices are electromechanically controlled using a micro-processor and linear feedback system to monitor pump actuation and adjust the air supply according to the required performance, thus optimizing energy efficiency.

One of the key differences is that this new technology automatically adjusts to maintain optimum efficiency for different and changing pump application parameters. This is made possible through the application of a patented feedback technology that monitors the full range of motion of the diaphragm movement including position, velocity and acceleration.

The technology still allows for simple installation by integrating electrical power generation into the system, eliminating the need to provide electrical power to the AODD pump. Ease of installation for the end user is, therefore, maintained. An optional power supply is available if preferred by the end user. This new technology is also fail-safe in the event of any failures within the device. The pump will operate as a standard AODD pump and will maintain the end user's processing objectives without interruption. By maintaining the robust characteristics of standard AODD pumps, this technology eliminates the risk of any increase in process downtime for the end user due to the integration of this type of solution.

Manipulating Air Supply

The new energy reduction technology manipulates the air supply to obtain the same geometrical characteristics of pump operation and efficiency gains with respect to diaphragm deformation and force reduction at the beginning of the pump stroke, which is the same as what occurred with the earlier methods. One of the key differences is that this new technology automatically adjusts to maintain optimum efficiency for different and changing pump application parameters. This is made possible through the application of a patented feedback technology that monitors the full range of motion of the diaphragm movement including position, velocity and acceleration. This information is read by the microprocessor. Then, associated algorithms are applied to control a valve system that manipulates the flow of air supplied to the pump.

The air flow is manipulated in a way that allows for full air supply flow at the beginning of the pump stroke and then reduces the air supply flow at different points during the stroke that are dependent on the specific application parameters. This flexible supply flow reduction enables increased pump efficiency regardless of differing pump applications. As the pump discharges pressure, the air supply pressure and fluid viscosity changes, and the system automatically adapts and optimizes the pump efficiency.

Learning Algorithm Optimizes the Process

The end user does not need to supply the operating parameters to the processor. The system contains a learning algorithm that learns the pump's operation without

Pump Efficiency is Retained with Flexible Air Supply Flow Reductions

THE TECHNOLOGY PROVIDER

New AODD Pump Controls Reduce Compressed Air Consumption

Feed Energy, based in Sioux City, Iowa participated in a three-month performance trial to confirm projected savings. The product was evaluated at 10, 30, 60 and 90 days post installation. During this period the system was confirmed to reduce air usage from 125 scfm to 61 scfm, which is a 51% energy reduction from baseline equipment measurements. The results were taken to MidAmerica Energy, the local electrical utility, who then certified the engineered solution under the 2010 Iowa Non-Residential Custom Systems Rebate Program. Mid-America approved the project and rewarded Feed Energy with a $1,200 rebate toward the purchase of this equipment.

air manipulation, as standard pump operation, and then starts the optimization process. The feedback and control systems continually servos about the diaphragm velocity and enable continuous optimization for maximum energy savings across a real-world pump application. The system will relearn as the application parameters change or the pump is placed into a new application, providing utmost ease of use for the end user.

The combination of adaptive optimization, self-learning capability and integrated power generation advantages found in this technology enables end users to enjoy all the positive attributes of traditional AODD pumps while reducing energy costs.

Success Story: Iowa Vegetable-Oil Producer Experiences Energy Savings

For nearly twenty-five years, Feed Energy (Sioux City, Iowa) has been the premier supplier of high-quality liquid feed solutions for livestock and poultry. The company specializes in premium vegetable oil production and is certified by the American Feed Industry Association (AFIA).

The manufacturing of this type of product requires liquid transfer capabilities to mix, blend and circulate fluids for proper formulation and to separate water content for maximum yield. The company uses AODD pumps for high-transfer, high-circulation processes because they are portable and require minimal maintenance.

Because these pumps require compressed air for operation, capacity limitations can arise as companies add more pumps to expand production. In Feed Energy's case, additional online pumps constrained system air volume capacity to a point that the company considered purchasing an additional air compressor to increase productivity and performance.

In total, Feed Energy would reduce energy consumption by as much as 60 kW and save over $12,000 in annual operating costs by deploying the air saving technology to all eight of its three-inch pumps within the Sioux City, IA location.

THE TECHNOLOGY PROVIDER

New AODD Pump Controls Reduce Compressed Air Consumption

Pump Curve Calculations Show 50% Savings

Understanding the challenges at Feed Energy, Warren Rupp, Inc. proposed a solution of installing a new air control technology to reduce compressed air usage. Pump curve calculations showed that over 50% air savings was possible, which would lead to many benefits for the company including energy savings of as much as $1,500 per year and a reduction of 10 horsepower at the air compressor. In total, Feed Energy would reduce energy consumption by as much as 60 kW and save over $12,000 in annual operating costs by deploying the air saving technology to all eight of its three-inch pumps within the Sioux City, IA location.

The company participated in a three-month performance trial to confirm projected savings. The product was evaluated at 10, 30, 60 and 90 days post installation. During this period the system was confirmed to reduce air usage from 125 scfm to 61 scfm, which is a 51% energy reduction from baseline equipment measurements. The results were taken to MidAmerica Energy, the local electrical utility, who then certified the engineered solution under the 2010 Iowa Non-Residential Custom Systems Rebate Program. Mid-America approved the project and rewarded Feed Energy with a $1,200 rebate toward the purchase of this equipment.

In summary, Feed Energy benefited from using the new technology by qualifying for a government-funded utility rebate, saving energy costs, and expanding their plant-wide compressed air volume without having to purchase new air compressors or capital equipment. BP

For more information, contact Dean Thornberry, Warren Rupp, Inc., Tel: 419-526-7207, www.AirVantagepump.com/sandpiper/

Mark McCourt — *Director of Innovation, IDEX AODD*

Mark McCourt is director of Innovation at IDEX AODD, Inc., where he is responsible for new product development, product engineering, and quality and after sales support.

In 2007, McCourt started at IDEX AODD where he was introduced to the pumping industry. Previously he held several positions most recently, engineering division manager, within the factory automation industry at Parker Hannifin's Actuator Division.

McCourt received his bachelor's degree in mechanical engineering from The University of Akron and his master's of business administration from Baldwin Wallace College. He has technical training for electromechanical programming, FEA and project management.

McCourt has several patents pending for the new technological breakthroughs for AODD pumps. He is a member of the Hydraulics Institute, the Project Management Institute and the Product Development and Management Association. McCourt resides in Akron, Ohio.

Dean Thornberry — *Director, Product Commercialization, IDEX AODD*

Dean Thornberry is director, product commercialization at IDEX AODD, Inc, where he is responsible for providing manufacturing leadership, oversight, and direction for new product development.

In November of 2008, Thornberry started at IDEX AODD where he was introduced to the pumping industry. His previous experience includes more than 16 years in marketing and sales of consumer goods, and commercial products within various markets.

Thornberry has been awarded with the Best New Product award at the International Hardware Show in Chicago in 2004 and Best New Innovative Product from the National Home Builder's Show in Las Vegas in 2005.

Thornberry received his bachelor's degree in advertising and communications from the Ohio State University in 1993. He resides in Pickerington, Ohio with his family.

A VIEW FROM CANADA

Tembec Sawmill and Pneu-Logic Stabilize Pressure

BY ROD SMITH, COMPRESSED AIR BEST PRACTICES®

Modern Sawmills: Fast Production with Zero Waste

When some people think of a sawmill, visions come to mind of rough and tough men felling trees with handsaws. Horses then pull carts of logs laboriously to the mill, where steam or diesel powers the sawmill. I personally always throw Paul Bunyan and Babe (the blue ox) into the image as well!

Pushing the old stereotypes aside, one might be amazed at what goes on behind the walls of a modern sawmill. Production levels are staggering, with logs being turned into lumber at the rate of about one log every two seconds. According to Jon Pritchard, P. Eng., Manager Wood Products Engineering at Tembec, "The average large-sized sawmill in British Columbia puts out about 150–250 million board-feet per year. That can equal up to 2,500 rail cars of lumber per year, per mill."

In a modern sawmill, nothing is wasted. Computers scan each log to accurately set the saws and cutter-heads. This ensures the last board-foot of lumber is squeezed out of each log. Portions of the log that are unsuited for lumber production are chipped for further processing elsewhere into pulp and paper. Even the sawdust is used — it is sent to other plants for processing into panel products such as Medium Density Fiberboard (MDF) or processed into fuel pellets for heating or power generation.

"As speeds in sawmills have increased, the criticalness of the availability of compressed air at a constant pressure, has correspondingly increased."

— Jon Pritchard, Manager Wood Products Engineering, Tembec

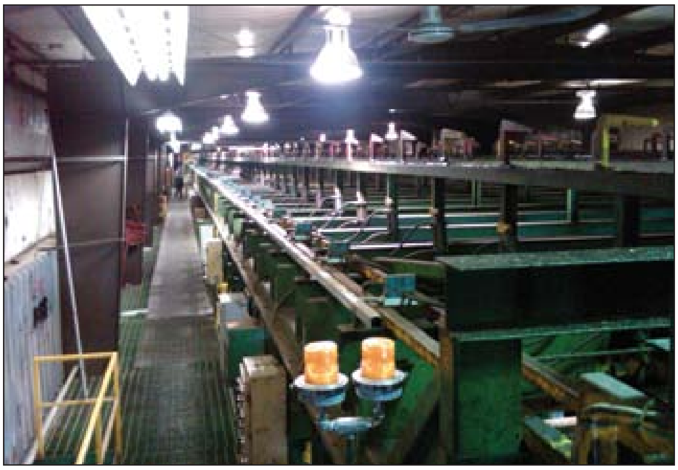
Stable Compressed Air Pressure Supports Increases in Production Speed

"Compressed air plays a big role in automating many processes in a sawmill", says Mr. Pritchard. Compressed air is used to move material in the sawmill — whether it be logs weighing several thousand pounds or small sticks placed between tiers of piled lumber. Compressed air is used to control the movement of logs as they are fed past cutter-heads and through saws. Compressed air is used as blow-off to keep photocells clear of flying sawdust and as a mixer for saw coolant (where a mixture of water, oil and compressed air is fed to lubricate guided circular saws).

Sawmills, unlike many other process industries, do not typically use any "instrument air" because the sawmilling process does not lend itself to that style of control.

A VIEW FROM CANADA:

Tembec Sawmill and Pneu-Logic Stabilize Pressure



Each lumber sorter bin is equipped with a bin-diverter air cylinder that is 4" bore x 4" stroke.

The cant optimizer infeed table positions the cant by means of air-raised positioning pins.

The cant optimizer outfeed rolls are controlled by air cylinders that are 6" bore x 8" stroke.

"The majority of compressed air usage in a sawmill, though, is in air cylinders — typically from 4–10" bore by 4"–36" strokes", according to Mr. Pritchard. In nearly all cases, air cylinders are controlled by automatic control and must be timed correctly to do their work properly — for example, to sweep a log off of a conveyor at just the right time to drop it into another conveyor. Air cylinders are also used to clamp feed-rolls onto a log that is to be held accurately for passing through a saw. Air cylinder timing is highly sensitive to air pressure fluctuations and whether volume is available to completely cycle the cylinder at exactly the required time. Mr. Pritchard continued, "As speeds in sawmills have increased, the criticalness of the availability of compressed air at a constant pressure has correspondingly increased."

End Uses: Pneumatic Cylinders Used in the Sawmill

Pneumatic air cylinders are found all over the sawmill and are critical to most production processes. Mr. Pritchard, of Tembec, was kind enough to provide us with detailed descriptions of many of the uses of air cylinders throughout the sawmill.

Bin diverter cylinders on the lumber sorter

The lumber sorter has 70 bins where lumber is sorted into each bin by size and length. Each sorter bin is equipped with a bin-diverter cylinder that is 4" bore x 4" stroke. This sorter operates at about 100 pieces per minute and a bin-diverter cylinder must cycle fully for each piece sorted.

Cant Optimizer Infeed Table and Outfeed

This machine center is called a "cant optimizer". This is a juxtaposition of sawmilling jargon from two eras: the word "cant" is from the days of horse logging describing a log with two opposite flat faces sawn on it. "Optimizer", a modern sawmill term, means a machine center that has computer sensors designed to measure the log, cant or lumber and decide the optimum way to cut it for maximum value. This two-sided cant needs to have two more sides sawn on it before it can be finally cut into lumber. The process of selecting just exactly where to place the two extra flat faces on the cant is done by the "cant optimizer".

The cant has been scanned upstream by a computerized laser scanner and the locations for the optimized flat faces have been computed. The cant optimizer infeed table positions the cant by means of air-raised positioning pins — one of which can be seen in the foreground of the photo as the tallest pin visible. This pin is moved sideways by hydraulic servo cylinders to precisely position the cant over the transport chain, which is roughly centered under the cant. Once the cant is positioned, the feed table lowers slightly (on air cylinders) placing the cant in contact with the transport chain. The overhead air-powered press-rolls also lower to hold the cant against the transport chain and it moves through the chipping heads in the background. There is a 200 hp motor on each chipping head.

The final outfeed roll, behind the cant optimizer chipping heads, as a cant is passing through the process. These rolls are controlled by 6" bore, 8" stroke air cylinders.

Cut-off Saw Station "Log Kicker"

There is a belt out-feed, from a cut-off saw station, where the incoming tree-length logs are cut to standard lumber lengths of 20 feet and shorter. Once the logs are cut, they are moved into position to be fed through the next step in the process, which is to debark them. The "log kicker" pushes the moving log off of the belt at just the correct time to land on a "transfer deck" — another conveyor which moves the logs transversely. The air cylinder used is an 8" bore x 12" stroke air cylinder.

Debarker "Log Kicker"

This application at the debarker is similar to the cut-off saw station. This particular "log kicker" sweeps logs off of a belt that receives the debarked log from the debarker and deposits them in a "log bin" in preparation for being turned into lumber. This kicker is an 8" bore x 12" stroke air cylinder. The debarkers operate at about 300 to 400 feet per minute, depending upon the size of log they debark, and the "log kicker" must cycle 10–20 times per minute.

Hold-down Rolls on the Double-length Canter Infeed

Another air cylinder application is on the hold-down rolls on the infeed of the "double-length canter". It is a machine that has a log infeed that is roughly "two log lengths long" — therefore the "double length" designation. What is happening here is that the log is carried on a wide chain (with cradles attached) transporting the log towards the chipping heads. As the log proceeds down this double-length infeed, the overhead rolls sequence down to hold it firmly onto the chain without disturbance. They then lift gently off the log before they would "fall" off the end of the log as it passes by. The log is passed by computer controlled log scanners which sense the diameter of the log every inch or so down the length of the log and also sense if the log is straight or curved. This information is processed (as in the cant optimizer) to decide the best way to cut the log for maximum lumber recovery. The speed of this infeed system is about 600 feet per minute. Air cylinders are responsible to ensure that every one of the dozen or so overhead hold-down rolls sets down gently and the lifts off precisely (off of each log). About 20 logs per minute are processed through this machine.

The "log kicker", at the cut-off saw station, uses air cylinders that are 8" bore x 12" stroke.

The debarker "log kicker" uses air cylinders that are 8" bore x 12" stroke and cycle 10 to 20 times per minute.

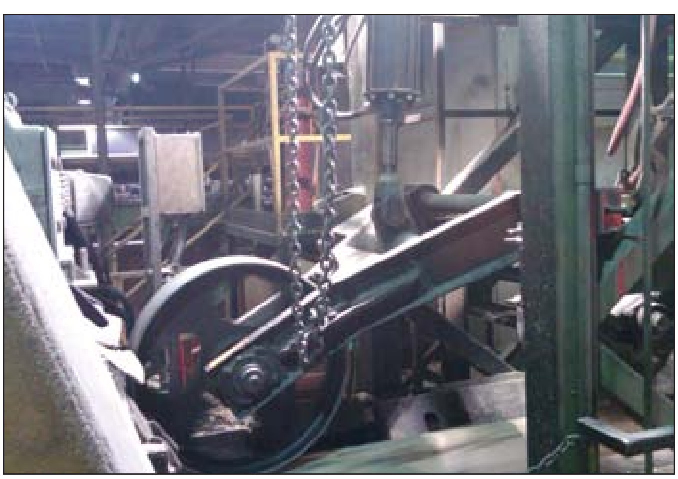
Air cylinders on the hold-down rolls of the double-length canter infeed.

A VIEW FROM CANADA:

Tembec Sawmill and Pneu-Logic Stabilize Pressure

The rubber tires and overhead metal roll, of this machine center, are all air-controlled.

A double-piston, 6" bore cylinder impales a "sharp chain" to the logs.



The ugly roll, just downstream of the thumper roll, is controlled by a 6" bore air cylinder.

The Live Fence on the Sawmill Trimmers

The live fence is a device associated with the sawmill trimmers, where the sawn lumber undergoes a trimming operation to cut any defect off the ends of the lumber and trim it to normal lengths such as 8',10', 12' up to 20'. This process is automated, with scanning systems looking for lumber defects and deciding the precise location to trim the lumber. The live fence automatically positions each board "endwise" so that it is properly positioned when it passes through the trim-saws. One design of live fence uses a set of three, 4" bore "stacked air cylinders" to achieve 8" of motion in 1" increments with combinations of cylinders with 1", 2" and 4" strokes. The cylinders have meter-out flow controls. It is important to achieve accurate speed control of the cylinders without operating them too fast. The boards travel through the trimmer at 100 boards per minute, and this set of stacked cylinders must follow at that same rate.

Outfeed of a Machine Center

The outfeed of a machine center that chips the first two faces on a log, making a 2-sided cant. The log is carried on a unique chain that has a spiked top (called a "sharp chain") which aggressively holds the log. Additionally, the cant must be supported on the sides and top as it travels out of the machine. The rubber tires and overhead metal roll are all air-controlled.

The Thumper Roll

This device is used to ensure that the logs are impaled onto the "sharp chain", described in the prior machine center. It is a double-piston, 6" bore cylinder that is connected to a very heavy overhead feed roller. The roller is swung down onto the leading end of the log as it passes by the roller, hitting the log hard enough that it is impaled onto the sharp chain. The double piston arrangement is so that the roll does not come down so hard on small logs. One section of the cylinder extends when a small log approaches, reducing the total stroke of the cylinder to minimize damage to the log.

The Ugly Roll

The ugly roll is just downstream of the thumper roll, noted in 8, above, and is situated to stabilize the log just as it enters the chipping heads. It is controlled by a 6" bore air cylinder.

Typical Sawmill Compressed Air Systems

Most modern sawmills are all-electric and are generally fed with power substations in the 2–10 MVA size. According to Mr. Pritchard, "Compressed air is the largest single user of power in the sawmill. A typical large BC sawmill will have 600–1,000 horsepower of installed air compressors." Most installed air compressors are oil-flooded rotary screw compressors. Mr. Pritchard commented, "These air compressors are rugged and reliable, but not very efficient at part load."

Sawmills are generally poorly heated, and since the logs processed through the plant are brought in from the outdoors, they can be very cold. When compressed air meets freezing cold, bad things happen with the water in the compressed air — it freezes. Mr. Pritchard stated, "Even in temperatures above freezing, the large volumes of air expanding through air valves into an air cylinder will result in problems with frozen air valves and poor air cylinder performance." For this reason, the first level of sophistication in sawmills, before energy efficiency, was the installation of air dryers to improve the immunity of the air system to freezing ambient temperatures. The type of dryer usually employed in British Columbia sawmills is the dessicant-type compressed air dryer that can deliver compressed air dried to -40 ˚F pressure dew-points.

Description of Tembec's Canal Flats Sawmill Compressor System

The Canal Flats sawmill was built in 1971 and saw various forms of upgrading over the years. Its compressed air system started with four oil-flooded rotary screw air compressors and existed with few changes until the early 1990's. Air energy efficiency was not an issue — all compressors ran on their own, with modulating valves controlling each compressors' output. Things started to change, in the early 1990's when the local power utility, BC Hydro, sponsored compressed air efficiency seminars. The air compressors were converted to on-off operation and a PLC was employed to implement a rudimentary form of sequencing control with the air compressors.

A dessicant-type air dryer was installed to address the freezing moisture issues but the claims of the manufacturer were believed and the system had to be scrapped after three years of substandard operation. A new externally-heated, twin tower, desiccant dryer was installed in 1999 along with a very large pre-filter. The plant specifications of less than 2 psi pressure drop across the dryer and filter were easily met the second time 'round.

This was the scenario that the Canal Flats compressor room was in when the BC Hydro "e-Points" program arrived at Tembec to push towards further compressor house efficiency. The compressor house consisted of:

- Four very old 150 hp oil-flooded rotary screw compressors
- One 100 hp oil-flooded screw compressor
- All five air compressors had the modulating valve systems removed and ran either fully loaded, unloaded and blown down, or shut off
- The previously-mentioned rudimentary PLC system
- One externally-heated twin tower desiccant dryer with dewpoint control and inlet filter
- Water-cooled air compressor aftercooler to ensure the compressed air was below 70 ˚F before introduction to the dryer
- Compressor oil coolers arranged to provide building heat to the sawmill during the winter and water-cooling during the summer

The rudimentary PLC control allowed large pressure swings in the plant, from a plant-stopping low of 75 psi to a power-wasting 120 psi. Plant personnel were unsure of how to handle this issue, but the traditional approach of adding more compressors was one of the options discussed.

Tembec

Tembec is a leading integrated forest products company, with operations in North America and France. With sales of approximately $2 billion and 4,300 employees, it operates over 30 pulp, paper and wood product-manufacturing units, and produces specialty chemicals from by-products of its pulping process. Tembec markets its products worldwide and has sales offices in Canada, the United States, the United Kingdom, Switzerland, China, Korea, Japan, and Chile. The company also manages forest lands in four Canadian provinces in accordance with sustainable development principles and has committed to obtaining Forest Stewardship Council (FSC) certification for all forests under its care.

Source: www.tembec.com

A VIEW FROM CANADA:

Tembec Sawmill and Pneu-Logic Stabilize Pressure

The Project To Save Energy Begins with Pneu-Logic

With help from the local provincial power utility, BC Hydro, the Tembec team focused on the goal to eliminate the large fluctuations in air pressure while running the air compressors in a way that would reduce the energy costs of the system. Pneu-Logic, a compressed air management system company, was brought in to help meet the goals of the project.

The first thing Pneu-Logic recommended was a slight but important change to the scope of work. One thing that had been overlooked was the opportunity to operate the plant at a lower pressure than previously considered, and segregate the compressors into base load units, that operated at the lower pressure, and trim units that provided energy storage air for the demand controller. This change, which was cost neutral to the original scope, paved the way for further significant energy reductions.

Air Receiver and Demand Controller

The Canal Flats project began by fabricating a demand controller and purchasing a 10,000 gallon upright air receiver to act as a trim receiver. "We knew the demand controller would level out the pressure swings in the mill," said Pritchard. He continued, "One way of looking at the demand controller and the large storage tank is that the combination of the two represent an computer controllable, source of air instantly available if there is a sudden demand for extra airflow into the plant." This ability to deliver compressed air instantly, and at high volumes, for short periods of time is what makes a demand controller successful. A normal air compressor cannot react quickly to a sudden increase in demand because it must reload, if it is already running, and so the reaction to a demand event can take 15–30 seconds for oil-flooded rotary screw compressors.

Managing the Whole System

The Pneu-Logic PL-4000 compressor sequencing control system was selected to manage the whole system. The PL-4000 acts as a back-up for the demand controller by intelligently controlling both the operation and use of the demand controller, the air receiver and the air compressors.

"We invested in the installation of the demand controller and the piping setup to allow any compressor to be set as the baseload and trim compressors," said Mr. Pritchard. This required a fair bit of additional piping. "The Pneu-Logic controller required a fair bit of wiring since we added nearly 40 sensors in each compressor room." The sensors were installed to monitor pressures, temperatures, flows and wattage drawn by the compressor motors.

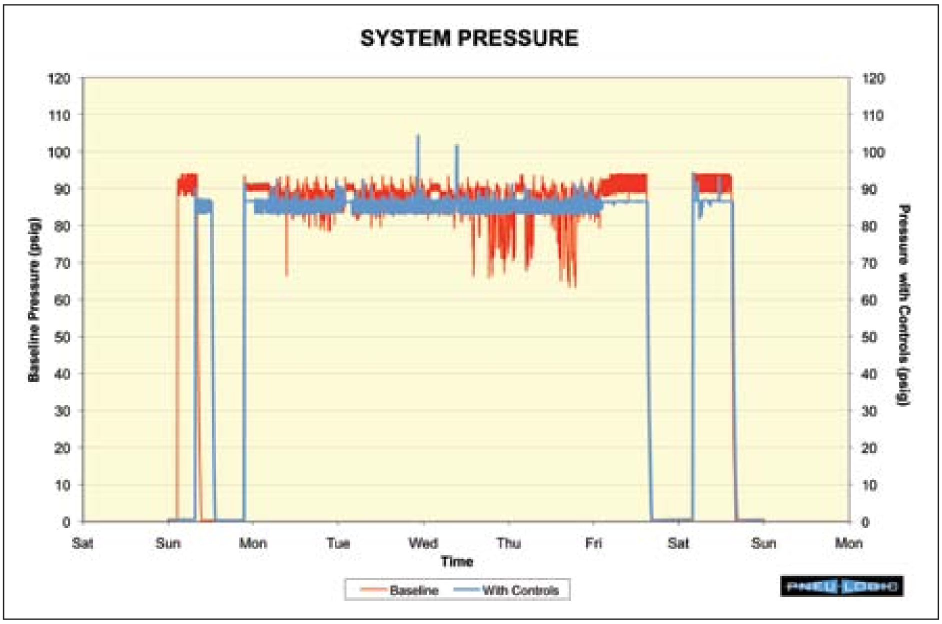
Pneu-Logic was easily able to customize its controller to use and display the additional instrumentation that Tembec wanted to install. The sheer volume of data available was at risk of providing information overload, but Pneu-Logic arranged it to provide metrics that could be measured, tracked and reported. "For example, we didn't know how many kilowatts were being used before and now we can look at each compressor to see how it runs loaded and unloaded," said Pritchard. "Screw compressors tend to draw a lot of horsepower when they are idling, and, unfortunately, we have some compressors that are

Dusty Smith, P.E., (Director of Engineering at Pneu-Logic), stands in front of an air receiver installed to help deliver large volumes of compressed air instantly to meet sudden process demands.

The Pneu-Logic PL-4000 Compressor Sequencing Control System, being programmed by Eric Bessey, P.E, (Chief Project Engineer at Pneu-Logic), manages data from over 40 sensors in each compressor room at Tembec.

A VIEW FROM CANADA:

Tembec Sawmill and Pneu-Logic Stabilize Pressure



particularly bad for high idling horsepower. The Pneu-Logic system allows us to monitor each compressor and tune it individually for minimum unloaded horsepower, and then periodically check that the adjustment has not been lost. That's a really important advantage, especially for our maintenance team. And it keeps stable compressed air at the mill at all times."

"The Pneu-logic equipment holds the air pressure rock steady at our target pressure of 86 psi. We used to see pressure fluctuate all over the map," said Pritchard. "At less than about 75 psi, machinery would malfunction. At lunchtime it would sometimes reach 120 psi, which was a waste of power. A lot of the air used in a sawmill is by large air cylinders that are PLC controlled, and if the air pressure is different than what you've set the cylinder up for, the machine is either too slow or too fast. Productivity is aided by stabilizing the air pressure so cylinders operate as expected. We have chosen 86 psi as a starting point because there is a lot of historical data suggesting that we all want 100 psi to run a mill, but will accept 90 psi. Now we have full control of the pressure and will step it down in small increments over time as our confidence increases that we can really run properly at lower pressures."

> "The system used to draw about 500 kilowatts on a steady basis and now we see that the system drops to about 350 kW for significant periods of time. There is a 20% reduction in energy use in the compressor room."
>
> — Jon Pritchard, Manager Wood Products Engineering, Tembec

Conclusion

Pneumatic air cylinders play a major role in allowing a modern sawmill to produce at the high-speed production rates required. Stable air pressure is critical to allow the air cylinders to respond in a timely manner and avoid any production delays. Tembec's Canal Flats sawmill worked together with BC Hydro and Pneu-Logic to eliminate pressure swings and to reduce their energy costs associated with compressed air. "There is no question there is a reduction in energy costs — even since the beginning of October 2008 — when the system went on line," said Pritchard, "The system used to draw about 500 kilowatts on a steady basis and now we see that the system drops to about 350 kW for significant periods of time. There is a 20% reduction in energy use in the compressor room. And, most importantly, we expect payback of this equipment in our case to exceed our initial estimates."

Pritchard concluded, "I'm very happy that we chose Pneu-Logic as our system partner with this project. I was able to work closely with their engineering team, ***particularly Mr. Eric Bessey and Mr. Dusty Smith,*** to work out details and ensure our plants received what they needed. They did a very good job for us. There is no moss growing on those engineers." BP

For more information contact Rod Smith, Compressed Air Best Practices® Magazine, tel: 412-980-9901, email: rod@airbestpractices.com, www.airbestpractices.com

THE SYSTEM ASSESSMENT

Tolko's Paper Mill and Saw Mill Save $215,000 per year

BY RON MARSHALL, MANITOBA HYDRO

Power Smart® efficiency measures for compressed air systems at Tolko's paper mill and sawmill at The Pas are saving the company more than $125,000 a year.

The measures were introduced based on the findings of compressed air system audits of both mills. They were also inspired by two Manitoba Hydro sponsored seminars on compressed air, which Tolko staff attended in 1995.

"As a result of the seminars and audits, we took a systems approach to solving our problems," says Darryl Sorochuk, Assistant Superintendent of Steam and Recovery for the paper mill.

"The result was a series of system refinements, from fixing air leaks to installing air storage, which let us turn off compressors instead of adding new ones."

Paper Mill

Steel Strapper—In the paper mill, a critical user of air proved to be a steel strapping machine that prepares paper rolls for shipment. At the downstream end of the compressed air distribution system, the strapper needed constant pressure but not high volume to work properly.

To keep pressure up at the strapper, the air system was operated at excessively high pressure. But even the higher pressure dipped when large volume air users came on. Tolko solved this critical use problem by installing a dedicated storage tank to serve the strapper. The strategy allowed a reduction in overall system pressure.

Air leaks and open drains were accounting for about 35% of total air usage.

As Sorochuk points out, "For each additional psi, we were losing about one per cent more air through leaks, including open drains that we used to purge water from our lines."

Air leaks were tracked down with an ultrasonic detector and repaired. Open drains were closed, or automatic traps were installed to expel water, with no of loss of air.

Air Dryer—One of the air audits turned up a major problem with a small desiccant dryer. Because of a malfunction in its control system, the dryer was consuming 15 times more purge air than necessary to regenerate its desiccant. The malfunction was easily corrected, for major savings.

Shutting Down a Compressor— Before the seminars and audits, the paper mill ran four, 200 hp reciprocating compressors, backed by a spare rental diesel compressor. Following efficiency measures, one of the 200 hp compressors was turned off and the rental unit retired.

THE SYSTEM ASSESSMENT

Tolko's Paper Mill and Saw Mill Save $215,000 per year

Sawmill

Moisture and Pressure Problems—The sawmill, in a building separate from the paper mill, had its own compressed air system and own set of problems. Excessive moisture in the lines fouled critical machinery and froze during cold weather. Air pressure underwent major swings, from 110 to 60 psi and back, sometimes in seconds.

A decision had been made earlier to buy a standard heatless desiccant dryer to produce cleaner, dryer air to run the sawmill. Eric Scheffers, Project Superintendent, contacted Manitoba Hydro for help in sizing the dryer.

"Manitoba Hydro helped us confirm dryer sizing," he says. "They also ran a full system audit that showed us how to address our pressure swings in an energy efficient way."

Little Storage—The sawmill had very little air storage for an operation of its type. When large, short-duration air demands hit the system, pressure collapsed because the compressors could not keep up.

Manitoba Hydro recommended installing a 5,000-gallon storage receiver and a flow controller to stabilize pressure. The storage receiver and controller eliminated pressure fluctuations. The receiver now protects the dryer against overload by storing clean dry air for large, short-duration demands. The flow controller further lowers the dewpoint of the dry air through the drop in pressure across it.

The system now runs without moisture problems, at 85 psi.

Efficient Dryer—On Hydro's recommendation, the sawmill installed a heated blower-type desiccant dryer with an energy management system. Instead of drawing 225 cfm of compressed air to regenerate the desiccant, the new dryer uses an internal heater and ambient air. It also regenerates the desiccant only when necessary, not on a fixed cycle as in a standard dryer. This lets the sawmill stretch a normal four-hour drying cycle into 60 hours during low load periods, for additional savings.

Compressed Air Team

One of the most important steps that Tolko took, based on the seminars' recommendations, was to organize a compressed air team. The team meets regularly to discuss concerns and improvements to the company's compressed air systems.

"The team ensures that all departments have a say in compressed air management," says team member Peter Rowbotham, Mechanical Project Engineer.

"We learned that we needed to keep everyone involved in making overall system refinements. It pays off in lower energy consumption."

He adds that they are also using some of the concepts they learned at the seminars to reduce their water consumption — a major expense.

Significant Savings

Ron Marshall, a Manitoba Hydro Industrial Systems Officer who performed one of the system audits, says: "System improvements at the paper mill and the sawmill save Tolko over $125,000 a year in avoided compressed air operating costs. They have also greatly improved air system quality and pressure."

Total annual electrical savings are an estimated 1,100,000 kWh and 200 kVA peak.

Project costs totalled $125,000, for a simple payback of one year.

"Tolko has proven they can solve process problems in an energy efficient way," says Marshall.

"Process improvements can sometimes be more important to a company than energy savings."

Plans for the paper mill include adding air compressor controls, more storage, and an expander.

For the sawmill, Tolko is thinking of adding compressor controls, addressing leaks, and applying measures to smooth out peak demands.

At both locations, Tolko may install high efficiency specialty nozzles to optimize cleaning and blowing operations. BP

PERSONAL PRODUCTIVITY

Why is Positive Energy Important in the Workplace?

BY SHARI BENCH

Everything is energy. Energy is powerful enough to create your success or promote your demise. Everything you involve yourself in is a result of the energy you contribute. **How** you contribute to your professional environment is as important as **what** you contribute. You may have the experience, knowledge, skill, and a long history of success; however, if you approach a new project, a meeting, a new job, an employee, your boss, or a customer with infected/negative energy, you should also be prepared to take responsibility for the consequences.

Some experts will claim energy is neither positive nor negative, rather all energy was neutral and only has the ability to take on the form in which you give it. This couldn't be further from the truth. The reality is you do have the power to choose how you exert your own energy, but you do not always have the ability to prevent encountering others' negative energy. Sometimes it is easy to see how others affect you, but many times you may not even realize the effect others are having on you. Creating an awareness of how situations or people make you feel can help correct or deflect this negative energy.

As a leader, your energy can determine the success of a meeting, a workday or even your overall company. If you have an employee or co-worker who is struggling, have you considered how much responsibility you have in their performance?

If you have chosen the privilege and responsibility to supervise others, how are you dealing with your negative employees? Negativity is contagious. It may seem as if dealing with negative people is easier to simply ignore them. However, it's important to remember that many people are not aware of how negative energy is affecting them. Therefore, your negative employees may be consciously or sub-consciously expanding their negativity and influencing the behavior of others.

Wake up Leaders! Look in the mirror. What are you contributing to your personal and professional life? How do you protect those you are responsible for, as well as your overall company, to ensure they have the positive, working environment they deserve?

PERSONAL PRODUCTIVITY

Why is Positive Energy Important in the Workplace?

1. Begin with yourself!

There are very common questions to help evaluate the energy you may be contributing. Are you generally a positive or negative person? Do you have a high or low energy level? How do others respond to you; relaxed or tense? Do you find yourself being judgmental of others or open and accepting of diversity and new ideas? Do you harbor anger rather than letting these feeling go? Do you feel mostly happy or sad and frustrated? Are you a nice person?

2. Observe Energy

Awareness is a great advocate for improvement. As leader, you should care about creating a positive environment. As an employee concerned with your current work environment, consider you are as responsible for creating a positive environment as your boss and your co-workers. Therefore, by simply taking time over the next week to observe others, you may create a new awareness of the type of energy that is most common in your department or company.

3. Dealing with negativity

How a leader deals with energy can directly determine how well an employee performs. The majority of employees spend most of their waking day at work. Most employees want to feel good about their workplace. Identifying a negative person does not have to result in turnover. The reality is if you begin with yourself, many others will naturally follow your lead and contribute toward a positive environment. However, if you identify a negative employee who is not supporting the environment you are expecting to create, it is critical to deal with this behavior. If after giving the employee an opportunity to improve, they do not respond favorably, as a leader you cannot ignore this behavior. Allowing this employee to continue contributing negative energy will quickly infect the energy of other employees and yourself.

4. Setting Expectations

Evaluate your management style and look for ways to create a positive, supportive, and rewarding process. Reward the positive improvements and mentor the employees who are not exceeding expectations. Positive reinforcement can quickly shift energy and build momentum toward your desired results.

5. Energize your team

A typical workday can drain the energy out of your employees. Look for ways to create energy boosts throughout the day, in meetings, and throughout projects. This can be as simple as frequent short breaks, laughter, creating a very open environment where fresh ideas and creativity is rewarded.

The relationships you align in life reflect who you are. You are defined by your relationships in your personal life and most certainly within your professional career. If you find the majority of your employees are tired or your team is having difficulty with exceeding expectations and creating momentum, seriously consider evaluating the energy flowing within your company. Do not wait for others to create the positive, rewarding, motivating environment that you have had the power to create all along. A positive environment is a healthy environment. BP

About the Author:

Shari Bench is a certified trainer and author of the forthcoming book, "Five Essentials of Transformation; Change your life one thought at a time." Her many programs on leadership, career enhancement, relationships, and health and wealth break down the barriers to create incredible results. For more information, please visit www.effectivetransformation.com.

A typical workday can drain the energy out of your employees. Look for ways to create energy boosts throughout the day, in meetings, and throughout projects. This can be as simple as frequent short breaks, laughter, creating a very open environment where fresh ideas and creativity is rewarded.

THE SYSTEM ASSESSMENT

Three Energy Efficiency Measures for a Pulp & Paper Mill

(Continued from page 17.)

the compressors would not result in energy savings. The energy savings for changing the compressor elements comes from increased compression efficiency (scfm/kW) at all loads and all pressures, provided that the management system prevents the compressor from blowing-off.

EEM2 Specific Equipment Recommendations

1. Replace the compression elements of all three Centac compressors with units that are designed for optimal performance at 80 psig, with the capability to operate up to 95 psig. This can be done either by replacing the impellers and diffusers or replacing the entire air-end assembly. There are two vendors who can do this, Air Relief (Gardner Denver) proposing the former and Ingersoll-Rand proposing the latter option. However, performance was not available for the impeller replacement option.

2. Install two new flow meters, one at the discharge of Centac #1 and one for #2. Install a differential pressure transmitter for the existing orifice plate for Centac #3. Patch all three into the SCADA system.

This will result in the following staging order and control modes (flows are approximate, not all Centacs can play all roles):

STRATEGY NO.	FLOW RANGE	DESCRIPTION
1	0-2795 scfm	(1) Centac, inlet modulation & blow-off
2	2795-4283 scfm	(1) Centac, base-loaded; C4 load-unload
3	4283-5590 scfm	(2) Centacs, both inlet modulation
4	5590-7078 scfm	(2) Centacs, base-loaded, C4 load-unload
5	7078-8385 scfm	(3) Centacs, all inlet modulation
6	8385-9873 scfm	(3) Centacs, base-loaded, C4 load-unload

Energy Efficiency Measure #4 (EEM4): Reduction of Constant Blowing Compressed Air Usages

Energy savings for EEM4 are only possible if EEM1-2 has been previously implemented. EEM3 does not have to be implemented to have savings for EEM4. This measure will reduce compressed air flow only. The management system will then automatically reduce compressor power as a result. This incremental reduction in energy is attributed to EEM4.

EEM4 Source of Energy Savings

The elimination of constant compressed air flow for low velocity purposes such as cooling, diverting, and bubbling is the source of the savings. The additional power consumption required to run small blowers to do the same work is far less than the power saved due to the elimination of compressed air demands. Compressor power will be reduced because of the combined effect of the reduced flow and the previously implemented management system, which will be able to run the plant on one Centac and the 350 HP screw compressor much of the time if all these flow reductions are made.

EEM4 Specific Equipment Recommendations

See Table 2.1

Conclusion

Table 1.1 on page 36 outlines the energy savings opportunities, the costs, and the ROI of all four EEM's. The energy savings opportunity presented by EEM's 1, 2, and 4 is 4.5 million kWh/yr., worth $206,808 in energy savings per year.

LOCATION	DESCRIPTION	ESTIMATED BASELINE COMP. AIR FLOW, SCFM	NEW DEVICE	NEW DEVICE COMP. AIR FLOW, SCFM	NEW DEVICE POWER, KW
PM1 DRY END PULPER	TRIM CHUTE ASSIST	96	3.5HP REGENERATIVE BLOWER & NOZZLE	0	2.6
PM1 ON LAYBOY	AIR BAR	332	8.5HP REGENERATIVE BLOWER & AIR KNIFE	0	6.8
PM1 WRAP DISPENSER	AIR SHOWER	31	HIGH EFF COMP. AIR NOZZLES	16	0
PM2 BETWEEN 1ST & 2ND PRESS	COOL UPDRAFT	309	8.5 HP REGENERATIVE BLOWER & DUCTING	0	6.8
PM2 WASTE PULPER	LUGGER BOX	144	3.5HP REGENERATIVE BLOWER & NOZZLE	0	2.6
PM3 (ON LAYBOY??)	AIR BAR	309	8.5HP REGENERATIVE BLOWER & AIR KNIFE	0	6.8
PM3 WET END	DOCTOR OSCILLATORS	300	NEW PNEUMATIC DOCTOR OSCILLATORS	30	0
TOTAL		1761		286	26

Table 2.1 Compressed Air Demand Reduction Opportunities

THE SYSTEM ASSESSMENT

Three Energy Efficiency Measures for a Pulp & Paper Mill

The incentives in Table 1.2 are based on estimated energy savings and EEM's costs documented in this report. The ROI impact of the incentives will be to lower the estimated project ROI from 1.9 years to 1 year. The actual incentive paid will be based on the final energy savings and EEM costs documented in a post-installation inspection report (completed by Utility XYZ). In both cases, here is how the incentive is calculated:

1. Incentives for EEMs are first calculated individually as the lesser of the incentive based on demand and energy savings and 50% of EEM cost. If savings from lighting EEM's exceeds 50% of the project savings (total of EEMs), incentives for lighting EEMs are adjusted.
2. Next, the simple payback after incentive for the project (total of EEMs) is reviewed against the one year minimum. The simple payback after incentive is the EEM cost after incentive divided by the annual electric cost savings.

To be eligible for incentives, sign a Utility XYZ incentive agreement prior to signing purchase orders/contracts for installation.

The higher energy savings risk is with EEM4, because the EEM4 analysis is based on less certain numbers and the implementation might be incomplete. However, its cost is relatively low, so we strongly recommend implemention of as much of this EEM as possible, since this measure affects the entire project economics significantly. BP

For more information please contact Tim Dugan, P.E., Compression Engineering Corporation, tel: 503-520-0700, email: tim.dugan@compression-engineering.com, www.compression-engineering.com

Utility XYZ rate schedule		999
Cost of Energy	$	0.04000 /kWh
Cost of demand	$	5.00 /kW/month

EEM No.	Energy Efficiency Measure (EEM)	Include in Package?	Billing demand savings (kW/mo)	On-peak demand savings[1] (kW/mo)	Annual electric savings (kWh/yr)	Estimated annual electric cost savings: Demand Savings ($/yr)	Energy Savings ($/yr)	Total electric savings ($/yr)	EEM installed cost ($)	Simple payback before incentive (years)
1	MANAGEMENT SYSTEM	Yes	-17	-17	1,370,726	-$1,004	$54,829	$53,825	$99,150	1.8
2	RE-RATE COMPRESSOR AIR ENDS FOR 100 PSIG	Yes	169	169	912,356	$10,124	$36,494	$46,618	$180,850	3.9
3	NEW DRYERS & REDUCE PRESSURE	Yes	18	18	1,039,873	$1,097	$41,595	$42,692	$482,395	11.3
4	DEMAND REDUCTION	Yes	263	263	2,264,589	$15,780	$90,584	$106,364	$118,188	1.1
Total for EEM 1, 2 & 4			**415**	**415**	**4,547,671**	**$ 24,901**	**$ 181,907**	**$ 206,808**	**$ 398,188**	**1.93**
Total for EEM 1 - 4			**433**	**433**	**5,587,543**	**$ 25,998**	**$ 223,502**	**$ 249,499**	**$ 880,583**	**3.53**

Table 1.1 Estimated Electrical Savings and Cost Summary

Incentive Summary, Package 2, EEM1, 2, and 4

Energy incentive rate	$	0.12 /kWh annual energy savings
On-peak demand incentive rate	$	50 /avg. monthly on-peak demand savings
Incentive cap		50% of EEM installed cost

EEM No.	Energy Efficiency Measure (EEM)	Include in Package?	Utility XYZ estimated incentive calculation: Energy incentive (a)	On-peak demand incentive[1] (b)	Incentive based on savings (c=a+b)	50% EEM cost incentive cap (d)	1-year Project Payback incentive cap (e)	Estimated Utility XYZ incentive (lesser of c, d and e)	Estimated EEM installed cost after incentive	Estimated incentive as % of EEM installed cost	Customer payback after incentive (years)
1	MANAGEMENT SYSTEM	Yes	$164,487	-$836	$163,651	$49,575	*$47,654*	$47,654	$51,496	48%	1.0
2	RE-RATE COMPRESSOR AIR ENDS FOR 100 PSIG	Yes	$109,483	$8,437	$117,920	$90,425	*$86,922*	$86,922	$93,928	48%	2.0
4	DEMAND REDUCTION	Yes	$271,751	$13,150	$284,901	$59,094	*$56,805*	$56,805	$61,383	48%	0.6
Total for EEM 1, 2 & 4					**$ 566,471**	**$ 199,094**	***$ 191,380***	**$ 191,380**	**$ 206,808**	**48%**	**1.00**

MATCHING THE SUPPLY AND DEMAND IN A COMPRESSED AIR SYSTEM

BY BOB WILSON, PEMCO SERVICES FOR THE COMPRESSED AIR CHALLENGE®

Compressed air is a source of energy in support of manufacturing. It is also a very high cost component in the production of the goods and services at a plant. As such, improving the efficiency of an existing system offers a large savings opportunity. To realize the potential, the system dynamics must be understood and the supply from the compressors must always match the real system demands.

Production processes get their energy from the air stored at higher pressure in the piping distribution system. The air compressors simply replenish the air that is consumed. It is an important distinction to make. The energy input in compressing the air is supplied to the connecting pipes for delivery to the various demands throughout the facility. The energy extracted from the system to perform the required tasks actually comes from air already stored in the pipes. The inefficiencies of a plant air system are affected as much by how the air escapes the system as by how it is generated in the compressor room. Matching the supply with the demand at an optimal level requires that both generation and storage issues be addressed.

Every air system reaches a balance between the air compressor's supply into the system and the downstream demands that use the air. The energy input from compressing the air equals the energy used plus the system's inherent inefficiencies. Any more or less energy goes into or is released from storage. Every time there is a change to either side of the equation the system rebalances at a new point. **Figure 1** expresses the relationship.

Taking proactive, positive measures to control the balance point ensures the system always operates at its optimum energy level. There are two major sources of energy to draw from to accomplish this.

1. Air stored at an elevated pressure in a fixed volume vessel.
2. Reserve rotating energy of off loaded operating air compressor motors.

Air Storage: Volume alone does not equal storage. In order to replenish or release the energy of the stored air, the fixed volume must realize a change in pressure. Take, for example, a large receiver installed in a compressor room. Unless there is pressure differential

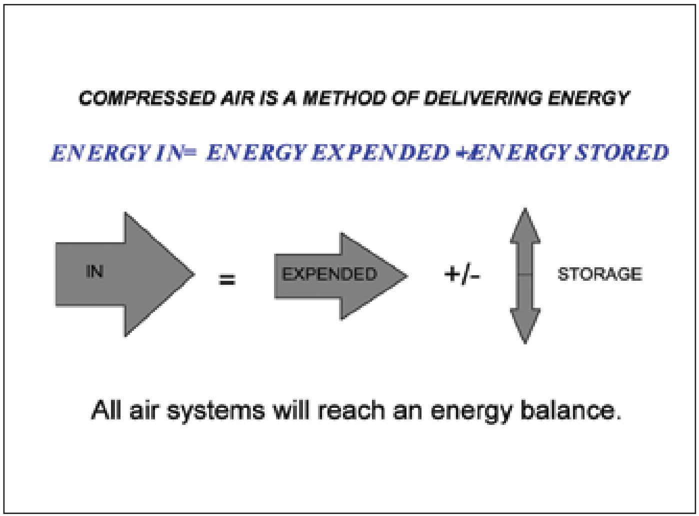


Figure 1: The Energy Balance Equation

between the tank inlet and outlet, no air will flow. It only creates a quiet zone. While adding volume increases the energy level across the entire plant air system, the usable stored energy for controlling the energy balance is zero. To create usable storage requires a change in the receiver pressure. The relationship is expressed as follows:

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

Where Vs = stored volume (cubic feet)
ΔP = change in pressure (psi)
Pa = atmospheric pressure (psia)
Vf = fixed volume (cubic feet)

The following example illustrates the importance of the volume/pressure relationship when applying storage properly. Assume the compressors are operating at full capacity and an additional 250 standard cubic feet (scf)of air is needed to satisfy the automated sequencing of the compressor network without disturbing production.

If the system pressure is allowed to degrade 15 psi over the event, the receiver size becomes:

$$Vf = (Vs \times Pa/\Delta P) \times 7.481 \text{ US gal/cf}$$
$$Vf = (250 \times 14.5/15) \times 7.481 = 1{,}870 \text{ gal.}$$

If the system pressure is only allowed to degrade 5 psi, the required receiver would be:

$$Vf = (250 \times 14.5/5) \times 7.481 = 5{,}000 \text{ gal.}$$

The 3 steps for applying storage properly are:

1. Determine the volume of air that needs to be available to sustain the system during a peak short duration event. For example, a typical system will need 20–30 seconds of supplemental flow in the event a standby compressor must start up and begin contributing air. In the previous example, the 250 scf would represent 30 seconds of flow in a compressor rated for 500 scfm. A simplified approach might be to base the air storage requirement on the largest trim compressor in the network, which is usually the worst case scenario and is often sufficient to cover all other high demand events. Be careful estimating storage using this simplified approach, however, for larger more complex systems, or systems with significant high flow events as the results can lead to improperly sizing the receivers. Engineered storage based upon measured data is usually a worthwhile investment for systems with more than 600 hp of operating air compressors.

2. Identify the minimum acceptable pressure the system can degrade to without creating a work hazard condition or serious production interruption. The minimum acceptable pressure represents the lowest pressure to which the delivered air can drop, plus some margin of safety to address pressure gradients in the system. Compressors are typically set to operate sufficiently above this level to ensure sufficient quantity of air is stored to be able to ride out the worst case scenario event without causing work interference. The maximum allowable change in storage pressure for a given system while feeding this event, therefore, will be somewhere between the lowest compressor supply pressure and the marginally adjusted minimum acceptable delivered air pressure.

MATCHING THE SUPPLY AND DEMAND IN A COMPRESSED AIR SYSTEM

3. Size the storage receiver capacity based upon the volume and pressure figures determined in steps 1 & 2. Subtract any existing compressor room receiver capacity from the storage calculation to determine the capacity of an additional receiver(s). Upsize to the nearest stock tank size. Multiple smaller receivers can be used if the new receiver size is physically too large. Receivers can also be installed in a side stream (T'd) arrangement with the main air flow path.

Pressure/Flow Control: The resultant pressure fluctuations from bringing compressors on and off line and the impact of short duration surge demands throughout the plant air system forces the system to continuously seek a rebalance point. The addition of the properly sized air storage receiver mitigates the magnitude and rate of change in system pressure but does not by itself eliminate it. System pressure must still be raised high enough to compensate for the cyclical profile. To stabilize delivered air pressure, the air release out of the receiver must be controlled.

A Pressure/Flow Controller installed downstream of the properly-sized air storage receiver(s) and upstream of the main piping header leaving the compressor room is designed for this task. It senses the pressure at its outlet and modulates the flow control valve(s) accordingly to control the air flow from the receiver to hold the pressure constant. If more air is flowing away than in, the air expands and pressure decreases. The Pressure/Flow Controller opens sufficiently to release air from storage to bring pressure back to the set point. Conversely, if more air is flowing in than out, pressure is increasing and the Pressure/Flow Controller closes to hold air back in the receiver to correct the offset. The Pressure/Flow Controller isolates the supply side from the demand side dynamics and typically stabilizes the delivered air pressure +/- 1 psi or less. **Figure 2** depicts a typical compressor room arrangement with storage and a Pressure/Flow Controller.

Stabilizing the pressure in the main distribution header eliminates the need to compensate for the fluctuating air pressure by raising the overall system pressure. The delivered air pressure from the Pressure/Flow Controller is set to more closely approach the minimum acceptable. Leaks and unregulated demands in the system consume less air when supplied at the lower pressure. **Figure 3** is a table of air flow from an orifice based upon the supply pressure and orifice size. Viewing the use points and leaks as equivalent to an orifice quantifies the savings opportunity.

DISCHARGE OF AIR THROUGH AN ORIFICE (SCFM)

	1/64"	1/32"	1/16"	1/8"	1/4"	3/8"
70 psi	.300	1.20	4.79	19.2	76.7	173
80 psi	.335	1.34	5.36	21.4	85.7	193
90 psi	.370	1.48	5.92	23.8	94.8	213
100 psi	.406	1.62	6.49	26.0	104	234
125 psi	.494	1.98	7.90	31.6	126	284

Figure 3: Air flow escaping an orifice.

Reserve Rotating Horsepower: Significant reserve energy is available from air compressor motors that are running but not fully loaded. In combination with the Pressure/Flow Controller and air storage receiver, this reserve energy can be applied in a proactive manner to maintain an optimal balance point. As the receiver pressure changes, the trim compressor loads and unloads accordingly. For systems equipped with a network control system, instrumentation of the change allows a signal to be sent to automatically sequence the operation of the compressors in the network. **Figure 4** illustrates the concept.

Running a partially loaded fixed speed compressor is inefficient and can be costly. Storage, therefore, is typically sized to allow unneeded compressors to time out and shut down. Ideally, all operating

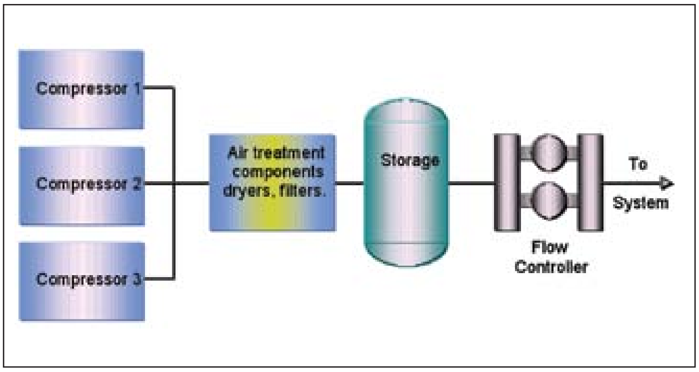


Figure 2: Typical Compressor Room Layout with Storage and a Pressure/Flow Controller. Illustration courtesy of Compressed Air Challenge®, Fundamentals of Compressed Air Systems.

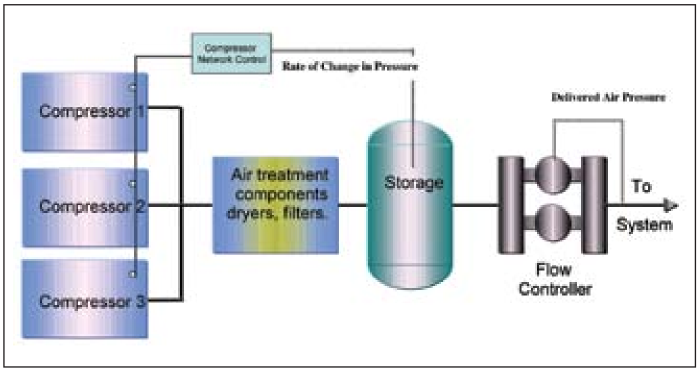


Figure 4: Matching supply to the real instantaneous demand. Illustration courtesy of Compressed Air Challenge®, Fundamentals of Compressed Air Systems.

compressors run at full load with only one compressor trimming at any given time. Substantial air storage must be applied to cover any peaks so a shut down compressor doesn't have to restart.

The advances in variable speed drive compressors (VSD) offer even greater opportunities to save energy and further enhance the overall performance of a system. Unlike a fixed speed compressor, there is no penalty for operating a VSD compressor partially loaded. Horsepower balances with the demand over the full capacity range of the compressor. A VSD compressor can be oversized to provide additional reserve energy without introducing an added operating cost burden.

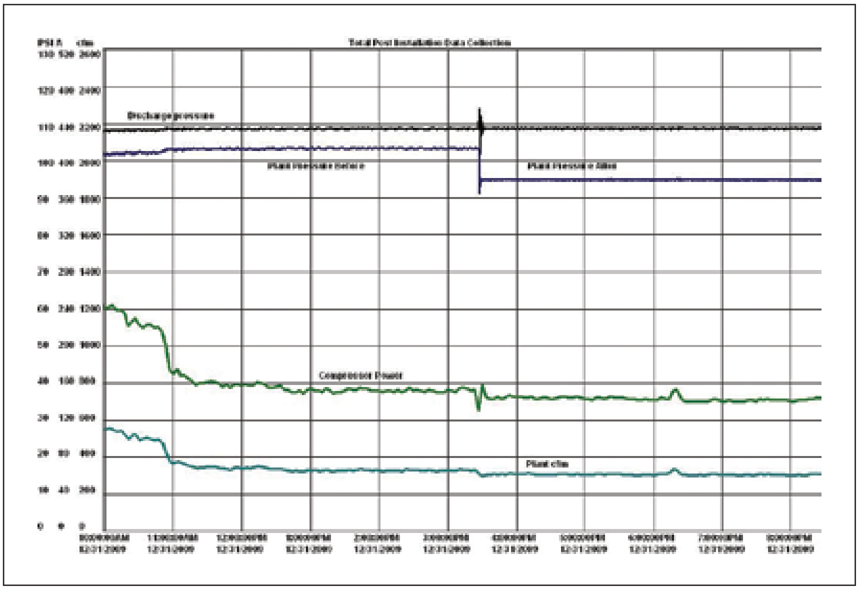


Figure 5: VSD Compressor Installation Pressure Profile

The application of a Pressure/Flow Controller with the VSD compressor(s) offers additional savings opportunities and greater stability. Without supplemental storage, a VSD compressor tends to become reactive and ends up constantly chasing the dynamic demands, stressing the compressor motor. The Pressure/Flow Controller eliminates the oscillation and allows the VSD to operate at its maximum efficiency. Additional savings of 7–10% can be realized. Figure 5 depicts the profile of a VSD compressor before and after the installation of the Pressure/Flow Controller.

Eliminate waste and the inefficient use of air: With both the supply and demand profile under control, any steps taken to reduce air consumption will positively translate back to the compressors and reduce the input energy. Leak repairs, regulating use points, and the application of high efficiency blow off devices are some cost effective measures to take. It is not uncommon to realize additional savings of 20-30% on top of the savings gained from lowering the delivered pressure and proactively controlling the compressors. BP

Find out about similar efficiency measures in CAC's "Best Practices for Compressed Air Systems". This 325 page book has excellent reference material and is available at our bookstore.

CAC® Qualified Instructor Profile

Bob Wilson
PEMCO Services
4905 34th Street S #332
St. Petersburg, FL 33711
Phone: 727-866-8118
Email: rwilson9@tampabay.rr.com

- BSME, Clarkson University
- Member in AFE.
- Compressed Air Challenge® (CAC) Fundamentals Instructor
- Qualified AIRMaster+ Specialist
- Industrial Technologies Program (ITP) Partner, EERE
- DOE Certified Energy Expert, ESA
- Collaborator, Encyclopedia of Energy Engineering and Technology
- Published Author

RESOURCES FOR ENERGY ENGINEERS

TRAINING CALENDAR

TITLE	SPONSOR(S)	LOCATION	DATE
Visit www.compressedairchallenge.org for more information.			
Fundamentals of Compressed Air Systems	Pennsylvania State University Technical Assistance Program, DOE EERE	York, PA	April 7, 2011
Fundamentals of Compressed Air Systems	Sacramento Municipal Utility District, California Energy Commission, Compressed Air Challenge, DOE EERE	Sacramento, CA	April 7, 2011
Advanced Management of Compressed Air Systems	Southern California Edison - Customer Technology Education Center, Compressed Air Challenge, DOE EERE	Irwindale, CA	April 12-13, 2011
Fundamentals of Compressed Air Systems	Clark State Community College, Edison Community College, Miami University, Southern State Community College, Wright State University, Compressed Air Challenge, DOE EERE	Dayton, OH	April 15, 2011
Fundamentals of Compressed Air Systems	Blackhawk Equipment Corp., Compressed Air Challenge, DOE EERE	Westminster, CO	April 19, 2011
Advanced Management of Compressed Air Systems	Blackhawk Equipment Corp., Compressed Air Challenge, DOE EERE	Westminster, CO	April 20-21, 2011
Fundamentals of Compressed Air Systems	Hughes Machinery, Omaha Public Power District, Atlas Copco, DRAW Professional Services, Compressed Air Challenge, DOE EERE	Omaha, NE	April 26, 2011
Advanced Management of Compressed Air Systems	Hughes Machinery, Omaha Public Power District, Atlas Copco, DRAW Professional Services, Compressed Air Challenge, DOE EERE	Omaha, NE	April 27-28, 2011
Fundamentals of Compressed Air Systems WE (web-edition)	—	Online Training	May 18, 2011
Advanced Management of Compressed Air Systems	Sacramento Municipal Utility District, California Energy Commission, Compressed Air Challenge, DOE EERE	Sacramento, CA	May 18-19, 2011
Fundamentals of Compressed Air Systems	St. Louis University, Atlas Copco, Illinois Department of Commerce and Economic Opportunity, Ameren Illinois, Ameren Missouri, Act on Energy, Association for Facilities Engineering, Compressed Air Challenge, DOE EERE	St. Louis, MO	May 24, 2011
Advanced Management of Compressed Air Systems	St. Louis University, Atlas Copco, Illinois Department of Commerce and Economic Opportunity, Ameren Illinois, Ameren Missouri, Act on Energy, Association for Facilities Engineering, Compressed Air Challenge, DOE EERE	St. Louis, MO	May 25-26, 2011
Airmaster+	Michigan Industry Energy Center, University of Michigan Industrial Assessment Center, Compressed Air Challenge, DOE EERE	Ann Arbor, MI	June 7-10, 2011
Fundamentals of Compressed Air Systems	Capitol Air Systems, Compressed Air Challenge, DOE EERE	Rocklin, CA	June 21, 2011

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

PRODUCTS

Dust Collector Pulse Timer Saves Energy

IntelliPULSE™ pulse jet timer for baghouses and dust collectors reduces energy costs and offers direct connection to PLCs with user specified field bus communications such as Devicenet, Ethernet, Modbus and Profibus. The intelligent pulse cleaning control technology is said to minimize compressed air use during filter cleaning significantly reducing energy consumption. No tuning is required. Compressed air energy savings up to 90% over continuous pulse cleaning methods and up to 40% over pulse on demand methods are reported. Compact DIN rail packaging makes for easy mounting and field service.

FilterSense
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www.filtersense.com

PRODUCTS

Hitachi Introduces Industrial AC Variable Frequency Drives

Hitachi America, Ltd., announced the introduction of the L700 Series of Industrial AC Variable Frequency Drives. The L700 significantly expands on the performance, capabilities and functions of its predecessor, the L300P. Hitachi has broadened the applicability of this series by incorporating the improved sensorless vector (SLV) control algorithm that was first developed for the SJ700 series. This allows the L700 to develop 150% torque at 0.5 Hz, ideal for a wide range of applications beyond just fans and pumps. The L700 also has a number of features built in that make the commissioning process quick and trouble-free.

Another notable upgrade in the L700 is Hitachi's EzSQ (Easy Sequence) built-in programming function, which actually provides the functionality of a PLC built into the inverter. In many cases, the need for a separate PLC can be eliminated due to this internal capability. The program is developed on a PC and then downloaded to the inverter, using the simple-to-use EzSQ software provided at no charge.

Hitachi has designed many other new and helpful features into the L700 Industrial AC Variable Frequency Drive, such as the patented micro-surge voltage suppression (to protect the motor winding insulation), advanced trip avoidance functions, configurable sink/source logic on digital inputs, built-in dynamic braking circuit in models up to 30 hp (22 kW), a built-in EMC filter in models up to 200 hp (160 kW), and much more.

The L700 also has features customers have come to expect from Hitachi Variable Frequency Drives, such as built-in RS485 Modbus/RTU communication, and options for other communications networks, such as Ethernet Modbus/TCP, DeviceNet, Profibus and LonWorks. The L700 can be configured via the front-mounted keypad or using Hitachi's ProDrive PC-based software. A true global product, the L700 carries CE, UL, cUL and c-Tick marks, and is RoHS compliant.

Hitachi America, Ltd.
Email: inverterinfo@hal.hitachi.com
www.hitachi-america.us/inverters

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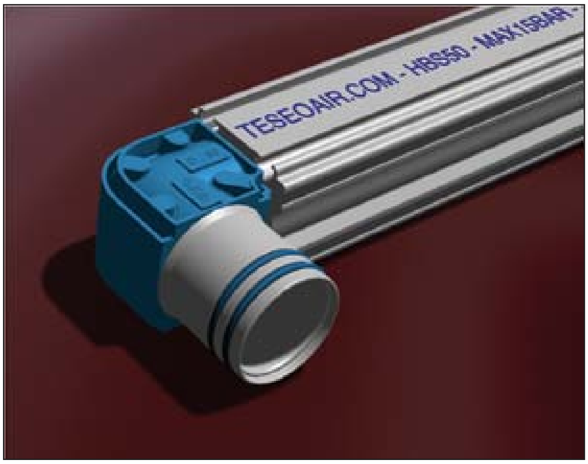

RESOURCES FOR ENERGY ENGINEERS

PRODUCTS

New Ejectors Use Less Compressed Air

Piab launches its piCOMPACT10 range, the first manifold-mounted and functional ejector system on the market based on the energy-efficient Micro COAX® technology. By working at low feed pressure and maximizing the utilization rate of the compressed air, the COAX® ejectors reduce energy consumption for manufacturers while increasing productivity and reliability. Products in the piCOMPACT10 range are ideal for pick-and-place operations where efficient handling of small, heavy parts is crucial, common for electronics, semiconductor, plastics, metal and medical applications.

Using Piab's unique Micro COAX® cartridges, the world's smallest multistage vacuum ejector, the piCOMPACT10 range provides three times more vacuum flow than similar products. This reduces energy consumption by 30-50% compared with traditional ejectors, resulting in substantial sustainability benefits as well as energy and cost savings.

By offering an increased vacuum flow, piCOMPACT10 ejectors strengthen product grip to increase pickup speed, minimize product damage and reduce waste. piCOMPACT10 also allows faster release of products from the suction cups onto the production line for efficiency gains.

Products in the new piCOMPACT10 range are smaller and lighter than conventional ejectors, reducing the total weight of vacuum handling systems. This innovative design allows vacuum systems to move more quickly to increase production capacity.

To help manufacturers achieve high levels of safety in production plants, the piCOMPACT10 vacuum ejectors use compressed air at lower pressure while still offering the same level of performance. This is ideal for handling products in the electronics industry where ejectors that work at low feed pressure are required and safety regulations are becoming stricter.

"Vacuum ejectors today are essential components for an uncounted number of general manufacturing and automation applications across a wide range of industries, with hundreds of specific product requirements. Across the board, manufacturers are seeking improved performance together with reduced total cost of ownership while always considering their impact on the environment," said Häla Washbrook, Vice President Marketing and Communication, Piab. "Energy consumption is a key consideration for manufacturers when looking to reduce costs of a complete vacuum system. Working at low pressures with efficient COAX® technology, the piCOMPACT10 range increases productivity for small product handling applications, saving money and reducing a manufacturers' carbon footprint."

The piCOMPACT10 vacuum ejectors are available in four versions to fit with a variety of systems, including those that require very low feed pressure or extra deep vacuum levels. In addition, the compact ejectors can be easily integrated into existing production lines with no modifications required, and can be quickly configured to meet individual manufacturing needs.

PIAB North America
Email: ed.mcgovern@piab.com
Tel: 781-337-7309
www.piab.com.

WALL STREET WATCH

BY COMPRESSED AIR BEST PRACTICES®

The intent of this column is to provide industry watchers with publicly held information, on publicly held companies, involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information gathered in this column was during the trading day of March 21, 2011.

DECEMBER 27, 2010 PRICE PERFORMANCE	SYMBOL	OPEN PRICE	1 MONTH	6 MONTHS	12 MONTHS	DIVIDEND (ANNUAL YIELD) 12 MONTHS
Parker-Hannifin	PH	$90.09	$91.30	$68.77	$64.53	1.44%
Ingersoll Rand	IR	$47.15	$46.94	$34.94	$34.53	0.60%
Gardner Denver	GDI	$72.94	$75.22	$53.78	$44.73	0.28%
Atlas Copco ADR	ATLCY	$22.94	$21.80	$16.22	$13.87	1.74%
United Technologies	UTX	$81.17	$84.54	$69.70	$72.66	2.12%
Donaldson	DCI	$59.11	$57.19	$45.12	$45.03	0.89%
SPX Corp	SPW	$77.01	$83.09	$61.70	$60.08	1.32%

Parker Hannifin Announces Fiscal 2nd Quarter Results

Parker Hannifin Corporation (NYSE: PH), reported record results for the fiscal 2011 second quarter ending December 31, 2010. Fiscal 2011 second quarter sales were $2.9 billion, an increase of 21.7% from $2.4 billion in the same quarter a year ago. Net income was $231.8 million an increase of 120.9% from $105.0 million in the second quarter of fiscal 2010. Earnings per diluted share for the quarter were $1.39 compared with $0.64 in last year's second quarter. Cash flow from operations for the first six months of fiscal 2011 was $408.2 million, or 7.2% of sales, compared with cash flow from operations of $606.3 million, or 13.2% of sales in the prior year period. Cash flow from operations in the first six months of fiscal 2011 included a $200 million discretionary contribution to the company's pension plan. Excluding this discretionary contribution, cash flow from operations as a percent of sales was 10.7% for the first six months of fiscal 2011.

"Demand levels remain strong across many markets, resulting in a significant increase in sales for the second quarter and increased order levels relative to the prior year period," said Chairman, CEO and President Don Washkewicz. "We were able to deliver sales increases in every segment, as total organic sales increased 22%. Order rates also increased in all segments and we are particularly pleased to see demand levels recover in our aerospace segment."

"This was another quarter that demonstrated our ability to leverage our strong revenue performance into increased operating margins and earnings. Our total segment operating margin performance was 14.0%, led by Industrial North America segment margin of 15.2% and Industrial International segment margin of 14.6%."

Segment Results

In the Industrial North America segment, second quarter sales increased 23.4% to $1.0 billion, and operating income was $159.4 million compared with $114.4 million in the same period a year ago.

WALL STREET WATCH

In the Industrial International segment, second quarter sales increased 23.1% to $1.1 billion, and operating income was $167.8 million compared with $82.6 million in the same period a year ago.

In the Aerospace segment, second quarter sales increased 14.7% to $459.6 million, and operating income was $63.6 million compared with $41.0 million in the same period a year ago.

In the Climate and Industrial Controls segment, second quarter sales increased 22.6% to $214.3 million, and operating income was $9.5 million compared with $6.1 million in the same period a year ago.

Orders

Parker reported an increase of 29% in total orders for the quarter ending December 31, 2010, compared with the same quarter a year ago. The company reported the following orders by operating segment:

- Orders increased 26% in the Industrial North America segment, compared with the same quarter a year ago
- Orders increased 29% in the Industrial International segment, compared with the same quarter a year ago
- Orders increased 37% in the Aerospace segment on a rolling 12-month average basis
- Orders increased 26% in the Climate and Industrial Controls segment, compared with the same quarter a year ago

Outlook

For fiscal 2011, the company has increased guidance for earnings from continuing operations to the range of $5.80 to $6.20 per diluted share.

Washkewicz added, "Our performance in the first half of this year has been very strong and puts us ahead of where we expected to be. Therefore, we are increasing our full year guidance for earnings per share in fiscal 2011. By executing the Win Strategy, our employees will continue to build from a position of great strength and we remain confident about our prospects for growth and profitability in the coming years."

Ingersoll Rand Announces 4th Quarter 2010 Results

Ingersoll-Rand plc (NYSE:IR), reported that total revenues increased 13% for the fourth quarter of 2010 compared with the 2009 fourth quarter; orders increased approximately 10% excluding currency; and diluted earnings per share (EPS) from continuing operations were mid-range of the prior guidance.

The company reported net earnings of $212.1 million, or EPS of $0.62, for the fourth quarter of 2010. Fourth-quarter net income included $211.1 million, or EPS of $0.62, from continuing operations, as well as $1.0 million of after-tax income from discontinued operations. This compares with net earnings for the 2009 fourth quarter of $139.4 million, or EPS of $0.42, which included EPS of $0.38 from continuing operations and $0.04 from discontinued operations.

"During the fourth quarter we made additional progress toward reaching our long-term revenue growth and earnings objectives," said Michael W. Lamach, chairman, president and chief executive officer of Ingersoll Rand. "Fourth-quarter revenues increased 13% and we leveraged these gains to improve operating earnings 38% compared with last year. In 2010 we continued to build a productivity-driven culture by integrating our business activities and improving our cost structures and overall efficiency. We improved our full-year operating margins more than 2 percentage points and increased continuing EPS by 60%. Additionally, during the year, we increased the funding of innovation to develop new products that will drive future growth."

Additional Highlights for the 2010 Fourth Quarter Revenues: The company's reported revenues increased 13% to $3,712 million, compared with revenues of $3,281 million for the 2009 fourth quarter. Total revenues excluding currency were up 14%, compared with 2009. Reported U.S. revenues were up 13%, and revenues from international operations also increased approximately 13% (up 15% excluding currency), primarily due to strong growth in Asia.

Operating Income and Margin: Operating income for the fourth quarter was $314 million, an increase of 38% compared with $227 million for the 2009 fourth quarter. The fourth-quarter operating margin was 8.4%, an increase of 1.5 percentage points compared to an operating margin of 6.9% for the same period of 2009. Higher volumes and productivity drove the

"By executing the Win Strategy, our employees will continue to build from a position of great strength and we remain confident about our prospects for growth and profitability in the coming years."

— Don Washkewicz, Chairman, CEO and President of Parker Hannifin Corporation increase in operating profits and margins. These improvements were partially offset by higher inflation.

Interest Expense and Other Income/Expense: Interest expense of $71 million for the fourth quarter of 2010 decreased compared with $76 million in the 2009 fourth quarter, due to lower year-over-year debt balances. Other income totaled $11 million and increased by $8 million for the fourth quarter of 2010 compared with the 2009 fourth quarter, primarily due to lower currency losses.

Taxes: The company had an effective tax rate of approximately 14% in the fourth quarter of 2010, which was lower than the previously forecasted rate of 20%.

Full-Year Results

Full-year 2010 net revenues were $14,079 million, and increased 7% compared with reported net revenues of $13,102 million in 2009. Operating income for 2010 totaled $1,247 million, an increase of 43% compared with $872 million in 2009. The operating margin for 2010 was 8.9% and increased 2.2 percentage points compared with 2009. The operating margin increase was primarily due to higher volume and $593 million of year-over-year productivity savings.

The company reported full-year 2010 EPS of $1.89. EPS from continuing operations was $2.23 with $(0.34) of costs from discontinued operations. Full-year continuing operations includes $80 million, or EPS of $(0.17), of restructuring charges/productivity investments and $(0.12) of costs related to a healthcare-related tax item.

The company reported full-year 2009 EPS of $1.37. EPS from continuing operations was $1.47 and EPS from discontinued operations was ($0.10).

Fourth-Quarter Business Review

The company reports the results of its businesses in four segments based on industry and market focus. The company's four segments are: Climate Solutions, which includes the Trane commercial HVAC Systems, Hussmann and Thermo King businesses; Industrial Technologies, which includes Air and Productivity Solutions and Club Car; Residential Solutions, which includes the residential HVAC and security businesses; and Security Technologies, which includes the commercial security businesses. Segment operating margins for both 2009 and 2010 include restructuring/productivity investments.

Climate Solutions delivers energy-efficient HVAC-R solutions globally and includes Trane, which provides HVAC systems and building services, parts, support and controls for commercial buildings; Hussmann, a leader in food merchandising solutions; and Thermo King, the leader in transport temperature control solutions. Reported revenues for the fourth quarter of 2010 were $2,061 million, with operating income of $147 million. Total revenues for the fourth quarter increased 16% (up 16% excluding currency), and operating earnings increased 61% compared with the fourth quarter of 2009. Bookings increased 7% year-over-year primarily due to the commercial HVAC business.

On a year-over-year basis, total commercial HVAC revenues increased 13% (up 13% excluding currency), with a 16% increase in equipment and systems revenues and a 10% increase in parts, services and solutions. Commercial revenues, excluding currency, increased in all major geographic regions, with strong year-over-year improvements in North America and Asia. Equipment revenue in North America was up more than 10%, and markets appear to be recovering after reaching a cyclical bottom. Fourth-quarter bookings were up 10% compared with the 2009 fourth quarter, with double-digit gains in Europe and Asia.

Total Thermo King refrigerated transport revenues increased 25% in the fourth quarter compared with last year, with improvements in all geographic regions. Total worldwide refrigerated trailer and truck revenues increased more than 30% compared with last year, reflecting improved activity in both the U.S. and overseas markets. Seagoing container revenues, auxiliary power units and worldwide bus revenues also increased due to improving end-market activity.

Hussmann revenues increased 16% compared with the fourth quarter of 2009 due to significant improvements in the North American display case business.

Fourth-quarter segment operating margin was 7.1%, including $9 million of restructuring/productivity investments, an increase of 2 percentage points compared with last year. Higher volumes, productivity actions and improved revenue mix offset the negative impact of higher commodity costs.

Industrial Technologies provides products, services and solutions to enhance customers' productivity, energy efficiency and operations. Products include compressed air systems, tools, fluid power products, and golf and utility vehicles. Total revenues in the fourth quarter of $692 million increased approximately 17% (up 19% excluding currency) compared with the fourth quarter of 2009. Air and Productivity revenues increased 21%, with volume increases in all major geographic regions. Revenues in the Americas increased 17% compared with 2009, as industrial and commercial markets for both air compressors and tools continued to improve. Air and Productivity Solutions revenues outside the Americas increased approximately 25% (up 28% excluding currency) compared with 2009, from strong activity in Asia. Bookings increased 22% year-over-year with substantial gains in the Americas and Asia.

WALL STREET WATCH

Club Car revenues increased slightly compared with the fourth quarter of 2009, as increased sales for both golf cars and aftermarket were partially offset by declines in utility vehicles. Bookings declined due to slowing demand in the North American golf market and more difficult year-over-year comparisons.

Fourth-quarter operating margin for Industrial Technologies of 13.1%, including $10 million of restructuring/productivity investments, increased slightly compared with 12.9% last year due to productivity, higher volumes from recovering industrial markets and improved pricing, partially offset by inflation, higher investment spending and unfavorable mix.

Residential Solutions includes the Trane and Schlage brands, which deliver safety, comfort and efficiency to homeowners throughout the Americas. Products, services and solutions include mechanical and electronic locks, HVAC systems, indoor air quality solutions and controls, and remote home management systems. Fourth-quarter revenues were $510 million, an increase of approximately 12% (up 14% excluding currency) compared with 2009. Bookings increased 22% year-over-year primarily due to substantial gains in the residential HVAC business.

Total reported residential security revenues decreased 14%. North American revenues declined 9%, primarily due to stagnant remodeling and new builder markets and inventory management actions by "big box" customers. South American revenues were down more than 40%, primarily due to significant negative currency translation.

Residential HVAC revenues increased 20% compared with 2009 with increased shipments of residential and light commercial HVAC systems. The improved sales are attributable to positive product mix in air conditioning systems and market share gains in residential air conditioning, air handlers and furnaces.

Fourth-quarter segment operating margin of 9.3% included $1 million of restructuring/productivity investments. Margins increased 1.8 percentage points compared with 7.5% recorded in 2009. The segment margin improvement was due to higher volumes and productivity gains and lower restructuring expenditures, which were partially offset by commodity price inflation and negative currency comparisons.

Security Technologies is a leading global supplier of commercial security products and services. The segment's market-leading products include mechanical and electronic security products; biometric and access-control systems; and security and time and attendance scheduling software. Fourth-quarter revenues of $448 million declined approximately 1% (flat excluding currency) compared with the fourth quarter of 2009. This decrease reflects the ongoing sluggish new building activity in the United States and in Europe, and moderate improvements in the retrofit/remodeling market. Revenues in the United States were up 2% due to improving sales of electronic locking devices. Overall segment bookings were flat both in the Americas and overseas. Fourth-quarter operating margin improved slightly to 17.9%, compared with the fourth quarter of 2009. Fourth-quarter margins included $5 million of restructuring/productivity investments. The operating margin increase was due to cost reduction from productivity gains, lower restructuring spending and improved pricing, which offset lower volumes and commodity inflation.

Balance Sheet

During the fourth quarter the company made a $201 million discretionary cash contribution to its pension fund and contributed $444 million for discretionary pension funding during the second half of 2010. Year-end debt totaled approximately $3.7 billion and the company reduced total net financing by $550 million for full-year 2010. "We are continuing our focus on generating cash flow through higher earnings and managing our balance sheet," said Lamach. "Our working capital management improved during 2010. Working capital was 2.6% of revenues in the fourth quarter of 2010 and was slightly above last year due to additional working capital requirements from higher than expected revenue growth. Available cash flow for the year totaled $874 million and the company is targeting to generate $1.1 billion of available cash flow in 2011."

2011 Outlook

"The majority of Ingersoll Rand's major end-markets continued to recover in the fourth quarter of 2010, although some challenges remain, especially in the commercial building markets in North America and Europe," said Lamach.

Fourth-quarter orders were up approximately 10%, excluding currency, compared with last year. There are sustained recoveries in the worldwide industrial and refrigerated transport markets, global parts and service activity and across most of the company's businesses in Asia. The North American commercial and residential HVAC markets are also slowly recovering after several years of declines. However, the company faces challenges as slow activity in the U.S. and European non-residential new construction markets is expected to constrain results in the commercial security business for the first half of 2011.

Revenues for full-year 2011 are expected to be in the range of $15 to $15.3 billion, an increase of 7 to 9%. Full-year 2011 EPS from continuing operations are expected to be in the range of $2.90 to $3.10. The forecast also includes a tax rate of 24% for continuing operations and an average diluted share count for full-year 2011 of 345 million shares. Available cash flow for 2011 is expected to approximate $1.1 billion, based on projected earnings and working capital requirements.

First-quarter 2011 revenues are expected to be in the range of $3.1 to $3.2 billion, which would be an increase of approximately 6 to 9% compared with the first quarter of 2010. The company also expects to capture significant additional benefits from productivity programs. However, some of these benefits will be eroded by commodity inflation which accelerated sharply in the fourth quarter of 2010. EPS from continuing operations for the first quarter are expected to be in the range of $0.25 to $0.35. The first-quarter forecast also reflects a tax rate of 24% for continuing operations and an average diluted share count of 343 million shares.

"Our internal business fundamentals and most of our external markets improved throughout 2010. We have globally recognized brands and leading market shares in all of our key businesses," said Lamach. "Our balance sheet is solid and improving, and we are generating significant cash. As the recovery of the world economy progresses, we will continue to invest in new products and innovation. Our 2010 achievements give us a high degree of confidence that we can continue to drive exceptional performance in 2011 and beyond." BP

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Advertising & Editorial: Rod Smith
rod@airbestpractices.com
Tel: 412-980-9901

Subscriptions & Administration: Patricia Smith
patricia@airbestpractices.com
Tel: 412-980-9902

A Publication of: Smith Onandia Communications LLC
217 Deer Meadow Drive
Pittsburgh, PA 15241

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Attendees can explore promising new technologies, compare energy management options, view alternative energy solutions, and learn about innovative project implementation strategies. The multi-track conference, seminars, tradeshow and workshops cover a variety of topics, many specific to the region.

West Coast EMC's California Green showcase, co-presented by the U.S. EPA's ENERGY STAR®, will also be a prominent part of the event for 2011. Here you can examine firsthand the latest green / sustainable / environmentally friendly energy technologies now available for both new design and retrofit projects. Conference presentations will facilitate your understanding of these technologies, covering such topics as green building design and retrofit; EPA's online energy measurement and tracking tool for buildings, Portfolio Manager; LEED certification and building commissioning; high performance facilities; the latest developments in renewable energy; reducing carbon emissions; transportation solutions for the future; and green/sustainable project success stories.

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