Steel Mill Audit Savings **Kaeser Hybrid Dryers** **Chillers Save Energy & Water**

April 2010

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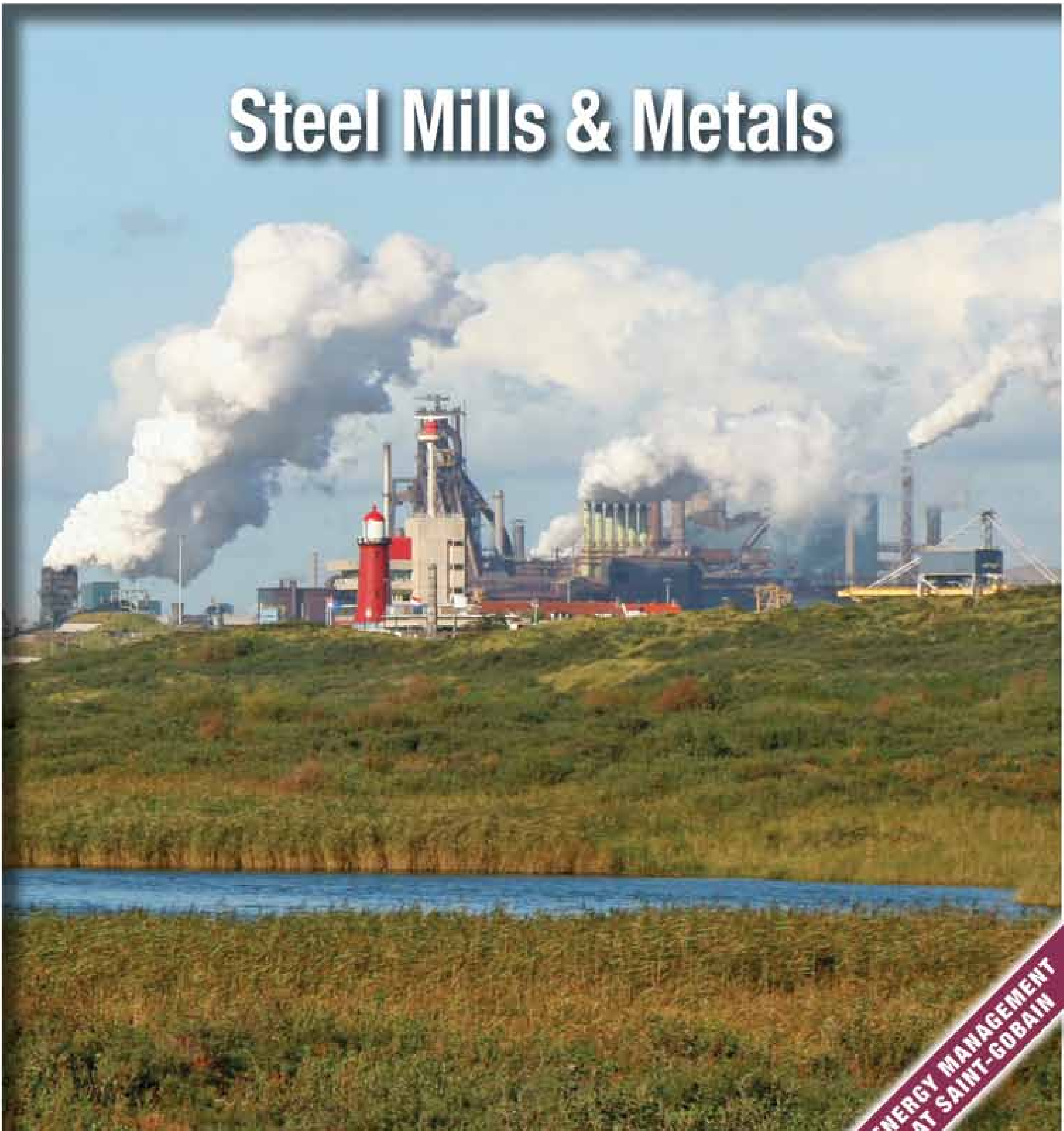

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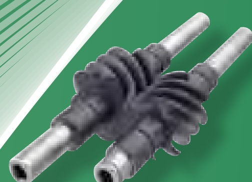

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SUSTAINABLE MANUFACTURING FEATURES

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FROM THE EDITOR

Steel Mills and Metals

This edition illustrates the vigorous work that is taking place in the mills to reduce energy costs and to conserve water. Perhaps nowhere is the exciting growth in sustainability and energy management more evident than in the steel and aluminum mills in North America. According to the American Iron and Steel Institute, the United States steel industry has reduced its energy intensity per ton of steel shipped by approximately 31% comparing 2008 to 1990. What is more, greenhouse gas emissions per ton of steel shipped have been reduced by nearly 45% since 1975. The final fact that caught my attention is that steel is the most recycled material in the world — including more than 82 million tons in the U.S. in 2008 alone. More steel is recycled annually than all other materials, including aluminum, glass and paper combined.

[1]www.steel.org
[2]www.sustainable-steel.org

A major steel mill complex upgraded their compressed air system in a story provided to us by Chuck Gerbe from the Total Equipment Company. The results were that they eliminated $500,000 in annual rental compressor costs, reduced cooling-water costs by $500,000 per year, and reduced their energy costs by $135,000 per year.

We continue our series of interview articles with Brad Runda, Manager-Energy for Saint-Gobain Corporation. Mr. Runda was able to announce that Saint-Gobain had just been named a 2010 ENERGY STAR Partner of the Year by the U.S. Environmental Protection Agency for the second year in a row. A leader in energy management, Saint-Gobain has realized energy-use reduction equated to the amount of energy we would require to make about 1.1 billion glass containers, or enough fiberglass insulation for over 250,000 typical homes! The savings are equivalent to a reduction in carbon dioxide emissions of about 140,000 metric tons.

Hybrid compressed air dryers are presented in an article by David Phillips of Kaeser Compressors as a very energy-efficient technology. Combining refrigerated dryer and heated desiccant dryer technology into one package significantly reduces the energy cost required to produce a -40 °F dew point.

Further examples of how steel mills can save energy and water are provided in articles using materials provided by Hank Van Ormer, Motivair Corporation and WIKA Instruments. Improvements in air-cooled air compressor technology (which can replace water-cooled compressors) and the adoption of chillers, which recirculate water for processes (rather than use city water once-thru), can create huge reductions in water consumption. This is exciting to see.

We hope you enjoy this edition, and thank you for your support and for investing in Industrial Energy Savings. BP

ROD SMITH
Editor
rod@airbestpractices.com

Saint-Gobain has just been named a 2010 ENERGY STAR Partner of the Year by the U.S. Environmental Protection Agency.

SUSTAINABLE MANUFACTURING NEWS

American Iron and Steel Institute, Nucor, ArcelorMittal

SOURCED FROM THE WEB

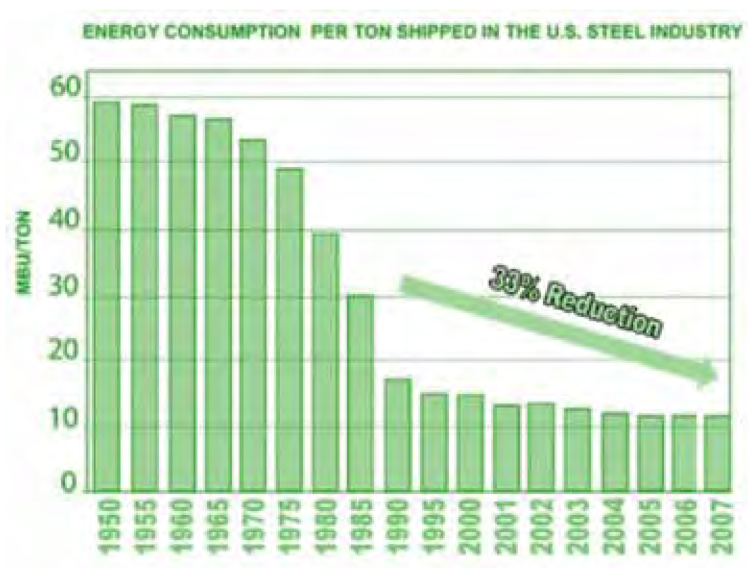
By using steel scrap, rather than natural resources, steelmakers reduce annual energy consumption by an amount that would power 20 million households for one year.

American Iron and Steel Institute

The United States steel industry has reduced its energy intensity per ton of steel shipped by 31% since 1990. Since 2002, energy intensity is down 15%. Because of the close relationship between energy use and greenhouse gas emissions, the industry's aggregate CO² emissions per ton of steel shipped were reduced by a comparable amount during the same period.

According to EPA's national greenhouse gas emissions report for 2004, the American Iron and Steel Institute represented 16.3% of the industrial process emissions yet were only 0.7% of the total U.S. emissions.

The steel industry is working to develop new, advanced steel products and applications that will yield even greater energy benefits. For example, the UltraLight Steel Auto Body-Advanced Vehicle Concepts (ULSAB-AVC) received the Stars for Energy Efficiency award from the Alliance to Save Energy for its significant advances in solutions for vehicle energy efficiency through new lightweight Advanced High-Strength Steel (AHSS) applications.



The steel industry has established a Climate VISION commitment to improve its energy efficiency by 10% by 2012, with 2002 as a basis. The industry has already achieved that reduction in just four years. If every individual and segment of the U.S. economy had achieved the same energy improvements as the steel industry, the U.S. would exceed Kyoto accords.

A large portion of the energy consumption is represented by coal. However, as steelmakers continue to use steel scrap to make new steel, they are conserving natural resources and reducing this energy consumption. By using steel scrap, rather than natural resources, steelmakers reduce annual energy consumption by an amount that would power 20 million households for one year.

The steel industry continues to search for new ways of improving the energy efficiency for its operations. In 2003, AISI joined Climate VISION, a voluntary program administered by the U.S. Department of Energy (DOE) to reduce GHG intensity (the ratio of emissions to economic outputs). Because of the close relationship between energy use and GHG emissions, the steel industry has set energy targets and is actively funding research of energy-efficient technologies to help achieve this goal.

Source: www.steel.org, www.sustainable-steel.org

American Iron and Steel Institute

SUSTAINABLE MANUFACTURING NEWS

American Iron and Steel Institute, Nucor, ArcelorMittal

It all starts with recycling. By cleaning up our land of scrap steel, we are able to reduce mining waste by 97%, air pollution by 86% and water pollution by 76%.

Nucor

As the name implies, NUCOR MINI MILLS are small. However, their small footprint on the land is just one benefit to their very environmentally friendly nature.

For starters, a mini mill's electric arc furnace requires much less in the way of natural resources. In fact, compared to the traditional blast furnace process, every ton of steel made the mini mill way eliminates the need for:

- 2,500 pounds of iron ore
- 1,400 pounds of coal
- 120 pounds of limestone
- 1,705 kilowatt hours of electricity.

Take the 22 million tons of steel Nucor made in 2007. That's enough electricity saved to power over 6.5 million homes for a year.

	PARTICULATE MATTER LBS PER TON	SULFUR OXIDES LBS PER TON	NITROGEN OXIDES LBS PER TON	CARBON MONOXIDE LBS PER TON	VOLATILE ORGANIC COMPOUNDS LBS PER TON
BLAST FURNACE MILL	39.8	5.0	0.4	44.0	1.4
RECYCLING MINI MILL	0.3	0.7	0.1	4.0	0.4

Criteria Pollutants Comparison

Air Pollutants Way Down

While conservation of natural resources is by itself an environmental benefit, it pales in comparison to the benefits brought about by the reduction of criteria pollutants released into the atmosphere. (Think about all of that coal we no longer need to burn.) Compared to the blast furnace, the mini mills' arc furnace releases 86 pounds less of pollutants into the air for every ton of steel made. In a year's time, that has the effect of reducing particulate matter emissions by over 2 million tons.

It's a win-win situation.

It all starts with recycling. By cleaning up our land of scrap steel, we are able to reduce mining waste by 97%, air pollution by 86% and water pollution by 76%.

Source: www.nucor.com

SUSTAINABLE MANUFACTURING NEWS

American Iron and Steel Institute, Nucor, ArcelorMittal

ArcelorMittal

Leaner and Cleaner

Steel-making is an energy-intensive process, and in 2007 alone we used around 22.3 gigajoules per metric ton of liquid steel produced, which added up to a worldwide total of 2,565 petajoules. With such large numbers at stake, energy efficiency is crucial to us, both for environmental reasons and as a way of reducing our costs.

In the four years up to 2012, we will be spending US$ 500 million on making the whole company more energy efficient, and we believe we could potentially save up to 2 million British thermal units per metric ton of liquid steel. This is around a 10% improvement overall.

The new Group policy was launched in May 2008 and aims to make greater energy efficiency a key element in all of our decision-making relating to procurement, equipment and technology, as well as encouraging positive changes in individual behavior.

We have a Group-wide energy management system that sets out our overall objectives, identifies best practice, and provides a practical framework for assessing capital investment and technological upgrades.

A dedicated team has analyzed the potential for improvements in 22 of our major plants. In most cases these will come from gas reallocation and optimization. For example, in Krivih Rih, Ukraine, 12 key action points were identified and nine have already been completed. These included the more efficient regulation of the power used in the plant burners and the re-use of gas generated by the steel-making process. We are also looking at reducing the amount of coke used in our blast furnaces, which will further help cut our CO^2 emissions.

In 2008 and 2009, ArcelorMittal received the ‘Energy Star’ Partner of the Year designation for its energy efficiency achievements in the U.S. — and remains the only steel manufacturer to receive this honor. Over the past three years, our U.S. operations have accomplished a 4.1% improvement in energy intensity, equivalent to $131 million of annualized savings.

Source: www.arcelormittal.com

In 2008 and 2009, ArcelorMittal received the ‘Energy Star’ Partner of the Year designation for its energy efficiency achievements in the U.S. — and remains the only steel manufacturer to receive this honor.

32 Companies Join DOE Save Energy Now LEADER Program

DOE has joined forces with 32 industrial companies to launch the Save Energy Now LEADER Program, which will provide technical assistance and resources to companies that pledge significant improvements in industrial energy efficiency. The 32 charter member companies from a broad spectrum of the United States industrial sector signed a voluntary pledge on December 2 to reduce their industrial energy intensity by 25% over the next decade. The industrial sector accounts for more than 18 million jobs in the U.S., but it also consumes nearly 30% of the energy used nationwide and produces 27% of the country's carbon emissions.

The charter member companies agreed to establish energy use and energy intensity baselines and develop an energy management plan over the next 12 months. As indicated by the special "LEADER" designation, these companies are more than just first actors on the path to greater energy efficiency; they are serving as role models on an ongoing basis for others in the industrial sector. In return, the companies will receive access to select DOE resources, as well as national recognition for their energy management achievements. The companies signing the pledge include such industry heavyweights as 3M, AT&T, Ingersoll Rand, Bridgestone, Dow Chemical Company, Honeywell, Intel, Mohawk Industries and Sherwin-Williams. For a complete list, visit www.energy.gov/news.

The LEADER program is a new component of the existing and successful Save Energy Now initiative, through which companies partner with DOE to conduct energy audits and assessments that identify the opportunities for energy and cost savings in the companies' operations. Participating businesses also have access to the tools and training they need to implement those recommendations. Since 2006, more than 2,000 plants received energy assessments through Save Energy Now, identifying opportunities for $1.3 billion in cost savings, 119 trillion British thermal units of natural gas savings and carbon dioxide reductions totaling 11.2 million metric tons. BP

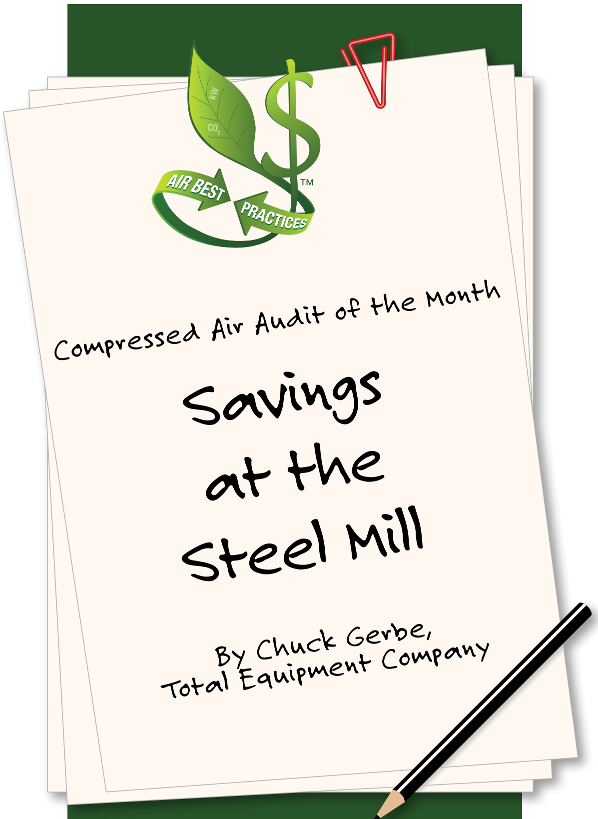
Source: www1.eere.energy.gov/industry

The 32 charter member companies from a broad spectrum of the United States industrial sector signed a voluntary pledge on December 2 to reduce their industrial energy intensity by 25% over the next decade.

THE SYSTEM ASSESSMENT OF THE MONTH

Savings at the Steel Mill

BY CHUCK GERBE, TOTAL EQUIPMENT COMPANY



April System Assessment of the Month

Where:	Eastern United States
Industry:	Steel
Issues:	High Maintenance and Rental Costs
Audit Type:	Supply and Demand Side

System Assessment Win/Win Results*

Reduction in Compressed Air Use:	3,200 scfm
Annual Energy Savings:	$135,000
Annual Cooling-Water Savings ($):	$500,000
Annual Cooling-Water Savings (gal):	154 million gallons
Annual Rental Cost Reduction:	$500,000

*Annual energy consumption

The Steel Mill

This major mill complex upgraded their compressed air system and thereby eliminated $500,000 in annual rental compressor costs, reduced annual cooling-water costs by $500,000, and reduced electrical energy costs by $135,000 per year.

The company produces flat-rolled carbon, stainless and electrical steel products, as well as carbon and stainless tubular steel products, for automotive, appliance, construction and manufacturing markets.

The company's steel operations consist of numerous steelmaking and finishing plants that produce flat-rolled carbon steels, including premium quality coated, cold-rolled and hot-rolled products, and specialty stainless and electrical steels that are sold in slab, hot band and sheet and strip form. This company operates the first steel plant in the United States to receive ISO 14001 environmental certification.

This system assessment case study was done at a major mill complex, situated on 1,300 acres with 3.5 million square feet of buildings. The mill produces stainless and electrical steel. Melting takes place in three electric arc furnaces that feed an argon-oxygen decarburization unit for refining molten metal. These units feed two double-strand continuous casters. The complex also includes a hot rolling mill, annealing and pickling units and two fully automated tandem cold rolling mills. The mill also has various intermediate and finishing operations for both stainless and electrical steels.

The Compressed Air System

Since the plants original construction until 1992, virtually all of the compressed air was supplied by as many as 16 water-cooled, double-acting, reciprocating air compressors. At the time of the plant construction, reciprocating-technology was the only industrial compressor technology available.

Chuck Gerbe, Vice President, Total Equipment Company

While these compressors were efficient and provided many years of reliable service, it became apparent that the system needed to be upgraded.

The compressors used "once thru" city water for cooling and had a large impact on the plants total water cost. The combined water-cooling requirement was as much as 154 million gallons per year.

In addition, these compressors had many wearing parts, including valves, un-loaders, packing, rings etc. The man-hours to operate and maintain these compressors increased with every year of age.

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THE SYSTEM ASSESSMENT OF THE MONTH

Savings at the Steel Mill

Ingersoll Rand Centac® 800 hp 3 stage Oil-Free Centrifugal Compressor

Closed Loop Non-Evaporative Cooler

Closed Loop Dual Pump Station and Controller

Also, the compression cylinders were continuously injected with lubricant that eventually made it into the plant piping system. This created potential environment issues as well as quality issues. The total consumption of oil exceeded 1,500 gallons annually.

Compressed Air System Upgrade Objectives and Strategy

The Total Equipment Company was invited to participate in an assessment of the "Main Plant" and offer a long-term solution to address the mills' needs. The Main Plant is the original and primary facility that uses the greatest amount of compressed air. The melt shop and caster were to be addressed separately.

The comprehensive system assessment included an analysis of supply-side system components and measuring the demand profiles of key end users of compressed air. Total Equipment Company interviewed personnel at the mill as well and was able to create a summary of objectives with strategy recommendations.

The system upgrade objectives were summarized as follows:

1. Reduce maintenance and energy costs.
2. Reduce/eliminate water costs.
3. Reduce environmental impact of oil.
4. Reduce/eliminate rental compressor costs approaching $500k/year.
5. Improve reliability/quality of compressed air.
6. Reduce parts inventory requirements.
7. Improve diagnostic/predictive measurements for maintenance.

The strategy devised to meet the objectives was:

1. Switch to centrifugal compressors.
2. Install closed loop cooling systems.
3. Install compressed air dryers.
4. Install blowers for low-pressure air users in the mill.

Centrifugal Air Compressors

The steel mill installed two 800 horsepower and one 700 hp compressor to displace all the reciprocating compressors. Oil-free centrifugal Centac® compressors were chosen. While different ratings were used, the primary spare parts (bearings, seals, pinions, filters) remained the same.

Centrifugal compressor technology is very simple and uses only a few moving parts (bull-gear, pinion, impeller). Using advanced hydro-dynamic bearing technology assures many years of reliable service.

Centrifugal compressors are oil-free and completely eliminated the oil consumption and carryover problem. Oil is now only used in a sealed environment to lubricate the bearings and gears.

Closed Loop Coolers

Each centrifugal air compressor was connected to a closed loop (non-evaporative) cooling system. In order to meet the cooling needs during high-temperature summer days, a plate and frame supplemental cooler was employed. This cooler uses a very small amount of city water to provide supplemental cooling when the temperature exceeded 80 °F. Based on ASHRAE standards, this was predicted to be less than 100 hours per year.

Capital appropriations estimated the water savings to be over 154 million gallons per year at a savings of over $500,000 per year.

Dryers

Each of the three primary plant air compressors were installed with air-cooled refrigerated compressed air dryers. These dryers were capable of reducing the dew point of the compressed air down to 35 °F. This eliminated as much as 1,500 gallons per day of water that otherwise would have entered the plant piping system.

Blowers

The steel mill had previously used 100 psig compressed air for many low-pressure applications (air wipes, blow-offs, etc). It was determined that the plant could reduce their compressed air system energy consumption by as much as 596 kW by switching these processes over to low-pressure blowers without any sacrifice to process or quality.

Ingersoll Rand Variable Capacity Refrigerated Dryer and Receiver

Ingersoll Rand Centac® Dual Inlet Filter Assemblies

The goal is to have each department start and maintain an on-going assessment of their compressed air practices and further reduce costs.

THE SYSTEM ASSESSMENT OF THE MONTH

Savings at the Steel Mill

This company operates the first steel plant in the United States to receive ISO 14001 environmental certification.

Verification of Results

After the compressed air system had been upgraded and some time had passed, Total Equipment Company returned to do a post-audit verification of results. The good news was that all of the original goals of the steel mill were either met or exceeded.

1. Reduce maintenance costs.
   - **a.** Parts and labor costs for maintenance and operations were significantly reduced.
   - **b.** Capital appropriations estimate of $150,000 per year savings was exceeded.
2. Reduce energy costs.
   - **a.** Air compressors totaling 800 hp were removed from the system by introducing low-pressure blowers.
   - **b.** Annual energy savings of over $135,000 per year.
3. Reduce/eliminate water costs.
   - **a.** Water consumption was reduced by 154 million gallons per year (a 98% reduction).
   - **b.** Water costs were reduced by approximately $475,000 per year.
4. Reduce environmental impact.
   - **a.** Oil carryover eliminated.
5. Improve reliability and air quality.
   - **a.** Compressor uptime has exceeded 99.99%.
   - **b.** Air is now oil free and dry.
   - **c.** Annual rental compressor costs of $500,000 were eliminated.
6. Reduce parts inventory requirements.
   - **a.** Single set of spares supports all three air compressors.
7. Improve diagnostic/predictive measurements for maintenance.
   - **a.** Each compressor has continuous advanced temperature, pressure and vibration measurement.

Future Plans

Long-term, additional goals for this compressed air system include adding flow meters for departmental measurement of compressed usage. This will help the steel mill assess the compressed air costs of each department. The goal is to have each department start and maintain an on-going assessment of their compressed air practices and further reduce costs. In addition, the mill seeks to "link" all three Centac units for additional energy optimization.

The Maintenance Building still uses two small, Ingersoll Rand, water-cooled, double-acting, reciprocating compressors. The Total Equipment Company has recently been contracted to conduct an Ingersoll Rand "Intellisurvey" on this system to determine potential savings on this system. The air demand in this system is much lower than the main plant and it is anticipated that a high efficiency, variable speed, air-cooled, Ingersoll Rand Nirvana class compressor will be the solution for this system. BP

For more information please contact Chuck Gerbe, Total Equipment Company,
email: Chuck.Gerbe@totalequipment.com, tel: 412-269-0999, www.totalequipment.com

For more articles like this, please visit www.airbestpractices.com/industries/metals

THE ENERGY MANAGER

Energy Management at Saint-Gobain

BY ROD SMITH, COMPRESSED AIR BEST PRACTICES®

Brad Runda, Manager-Energy, Saint-Gobain Corporation

Compressed Air Best Practices® interviewed Mr. Brad Runda, Manager-Energy, Saint-Gobain Corporation.

Congratulations on Saint-Gobain being named a 2010 ENERGY STAR Partner of the Year by the United States Environmental Protection Agency. This is the second year in a row you've won the award. Why was this award received?

Thank you! We were honored to win this award. The EPA award recognizes businesses that demonstrate their commitment to environmental protection through superior energy management that integrates the use of Energy Star tools and resources. It recognizes our commitment to, and success in, achieving superior energy management as well as our active participation in the ENERGY STAR program. Saint-Gobain is truly committed, from the top down, to improving energy efficiency that leads to reductions in greenhouse gas emissions. Our CEO truly supports the effort. He sees the value from both a cost savings perspective and an environmental perspective.

Saint-Gobain is proud to be the first and only manufacturer of glass containers or fiberglass insulation to ever receive this award. In 2008 and 2009, Saint-Gobain's North American energy-use reduction equated to the amount of energy we would require to make nearly over 1.1 billion glass containers, or enough fiberglass insulation for over 250,000 typical homes! The savings are equivalent to a reduction in carbon dioxide emissions of about 140,000 metric tons.

What specific actions at Saint-Gobain were recognized by ENERGY STAR for this award?

The key Saint-Gobain energy management accomplishments recognized by ENERGY STAR for 2010 award were the following:

- Accomplishing a 2.2 % reduction in energy intensity in spite of the economic downturn
- Expanding the company's network of energy champions to impact 98% of its energy consumption
- Improving the company's energy culture and in-house resources, evidenced by an increased number of facility energy assessments conducted internally by company teams
- Contributing to EPA's completion of the ENERGY STAR energy performance indicator for container glass plants by extensively testing the tool
- Leading the glass container industry by encouraging executives in the industry to take advantage of ENERGY STAR resources to help them improve energy performance in their companies
- Working within its Energy Value Chain to promote energy management with ENERGY STAR, both upstream and downstream of the company

THE ENERGY MANAGER

Energy Management at Saint-Gobain

Saint-Gobain is a leading supplier of glass containers

How is Energy Management structured at Saint-Gobain?

Saint-Gobain pursues energy reductions in three primary areas: buildings, transportation and manufacturing facilities. My role is to focus on manufacturing and buildings. We have over 140 manufacturing facilities in Canada and the U.S. and over 150 sites that are involved in building materials distribution. Another person in the company focuses on transportation.

I work at the Saint-Gobain corporate level. I champion efforts for culture change around energy efficiency. I manage and oversee the overall energy efficiency efforts of the company. I help coordinate projects, work with third parties, and am responsible for the agreements reached with the energy management supplier base. I work with the dozens of people in the business units who have responsibility for energy management. Internal selling is an important part of what I do.

We have four main divisions: Construction Products (CertainTeed), Containers, Innovative Materials and Building Materials Distribution (Norandex). Each division contains Energy Champions who are responsible for energy efficiency within their respective business units. The divisions have an executive-level sponsor. I will work with the sponsors and Energy Champions to understand and help accomplish their goals. Yearly plans are made by each division and we track our progress with metrics and monthly and quarterly conference calls.

Saint-Gobain is a leading supplier of ceiling panels

Some divisions, like Containers, are more energy intensive due to the nature of the process. They correspondingly have a larger staff of Energy Champions than other divisions. Our goal is for every plant to have an Energy Team that coordinates with the respective Energy Champion to identify, prioritize and execute energy efficiency projects. I sometimes help the plants directly on specific projects.

How does Saint-Gobain communicate the results of energy management?

It is critical to have a communications strategy. Our strategy focuses on letting our own employees know what we are accomplishing with energy efficiency and with ENERGY STAR. We have a strong level of support from our internal communications people — both at the corporate level and in the business units.

We publish success stories and energy-related articles in the weekly "North American Business Report," our company e-newsletter. The articles communicate internal actions and programs where we have saved energy and announce which of our own products have received the ENERGY STAR rating.

Saint-Gobain is a leading supplier of home construction materials

Our energy program grows as people help promote it. We try to raise awareness that leads to participation in the efforts, causing people to think about it and practice it. It has the effect of changing the culture of the business you work in. We want an internal culture of energy awareness within the company.

What advice would you offer to Energy Managers starting a program?

Senior management support is essential. It really helps things along when the CEO comes out with a commitment to the energy program. I recommend becoming an ENERGY STAR partner company and being active within the ENERGY STAR program. It is important to network with people and see what they are doing with energy management both inside and outside of your own industry.

This is the big advantage of being connected to the ENERGY STAR program. It's a nice network of folks willing to share ideas. Networking is particularly important if you are just getting started with energy management.

There are a whole host of ideas and resources provided through ENERGY STAR, including how to get started. Don't be afraid to ask questions of people who have "been there and done that." People involved are usually willing to share ideas.

How did you get involved with the energy management program at Saint-Gobain?

I have been working at Saint-Gobain for over nine years. My first position within Saint-Gobain was the Energy Manager for the Containers division. Earlier in my career, I worked in the key accounts group of a utility company. Part of my job was to help key account customers reduce their energy consumption. That was when I got "hooked" on reducing energy consumption.

When I first started in the Energy Manager position covering Saint-Gobain North America, I knew one thing — we had to hit the ground running. We wanted to save money and energy during year one of the program. The challenge was that we have over 150 plants in North America — with dozens of unique processes. Developing the network of Energy Champions and Energy Teams was a big key to success. We couldn't afford to get caught up in over-analysis, so we asked a lot of basic questions and then established reasonable goals for energy savings. We push hard to identify low-cost and no-cost ideas we can implement quickly. Compressed air is an area that always presents opportunity, so we targeted compressed air system assessments. We knew there was low-hanging fruit there, capable of delivering results during year one of the program.

What metrics are used to measure results?

Performance metrics are based upon our goal, which is to reduce the energy consumption per unit of product produced at Saint-Gobain. We use metrics like "btu's per ton" and "kWh per ton." At the plant level, these are readily understood metrics that lead to cost savings and also to good discussions. There are a lot of things that come out of that.

An external metric we use is the ENERGY STAR Energy Performance Indicator for Glass Containers. That is a measure that we use to benchmark our performance against. How many mmbtu's does it take to make a ton of glass? We know how many it takes for all of our furnaces and we try to benchmark against all our plants across the globe.

What specific energy efficiency projects do you focus on?

There is always a concern about the integrity of the process. People that run plants are paid to produce profitably, and we are very conscious about understanding the processes and making sure that energy efficiency projects don't hurt our capabilities to produce. On the contrary, they should enhance our ability to produce. I always remind our plant managers that I've never done an energy efficiency project (like lighting, compressed air, drives, etc.) that hasn't helped their processes.

THE ENERGY MANAGER

Energy Management at Saint-Gobain

Saint-Gobain is a leading supplier of insulation

Things really do depend upon specific processes at specific plants. We have conducted a lot of Energy Kaizen events. We also focus on low-cost initiatives. The most common projects involve primarily lighting, compressed air, and combustion efficiency (natural gas).

As an example, in our glass related processes, the biggest energy consumer is the melter. It's a large furnace made out of thick refractory material, covered in insulation. You put raw materials and recycled glass in it to melt the glass at 2,800 °F. You have losses in the walls and the exhaust. We focus a lot on this opportunity. The glass businesses are also a significant user of compressed air and we have spent a lot of time on these systems.

How important is compressed air as an energy source at Saint-Gobain?

It depends upon the process, but it's safe to say that compressed air plays a critical role in most of our processes. Without compressed air, we simply can't make most of our products. For example, if you want to form a glass container, you need a substantial amount of compressed air. Compressed air is a vital and expensive utility and we definitely want to manage it properly. We use all types of air compressors throughout the company.

How has Saint-Gobain gone about optimizing compressed air systems? What has the process been, and please describe some overall results.

Our process begins, in each facility, with a system assessment. We really like to work with a credible, unbiased company to do the assessments. When you perform compressed air assessments you have to look at the supply and demand sides at the same time. You can't focus on one side and not the other. Leaks are a great example. You can fix all the leaks in the plant and not save any energy. If your compressor goes into blowoff — what have you saved? Nothing. You have to go back to air compressors and make sure they aren't in blowoff. Once you've done that, you've accomplished the savings.

Being able to measure various parts of the system is key. A thorough compressed air system assessment will provide measurements of not only energy consumption (kW, kWh), but will also measure how much cfm is being used (on a per-unit basis) in the production processes.

> "There are a whole host of ideas and resources provided through ENERGY STAR, including how to get started. Don't be afraid to ask questions of people who have 'been there and done that.' People involved are usually willing to share ideas."
>
> — Brad Runda, Manager-Energy, Saint-Gobain Corporation

Please describe some specific actions taken with compressed air systems.

We have had good success with central monitoring and control systems in compressor rooms where you have multiple air compressors. Some have thousands of horsepower of connected load. These centralized control systems can help improve the process — not just reduce energy costs. They can help reduce downtime, make repairs during planned vs. emergency events, and also avoid the use of emergency back-up rental air compressors.

A good measurement and control system can also provide better quality compressed air. A good control system helps to avoid pressure swings. We have found that control systems help save energy but more importantly, improve the consistency and quality of the compressed air. Managing dew point is another example. This translates into process improvements in our plants.

We have had good experiences with all the optimization opportunity-areas with compressed air systems. We have focused on fixing compressed air leaks and then make sure our compressor controls can capitalize on the reduced artificial demand. A leak management system is important to maintain. We operate all makes and types of air compressors; rotary screws, centrifugals, and recips. They all have unique issues. Piping/storage is also a common opportunity that we typically see. Last, but not least, is new compressor technology. When you have older/bigger centrifugals, you can find savings by purchasing newer air compressor technology.

I wouldn't say, however, that there are any huge movements or major step changes in air compressor technology. Often incentives help decide the technology we implement. Local utility incentives can lead us to move to a VFD rotary screw air compressor to replace an existing screw due to a payback improved by the utility incentive.

How do you optimize compressed air dryers and filters?

We do the math on compressed air dryers. We like the heat of compression-type dryers and have some installed when those dew points are required. They aren't inexpensive though, so the numbers don't always work. We will put them in where we have good utility incentives. In other places refrigerated dryers make the most sense. One thing I look for when buying a refrigerated air dryer is to only consume energy when I need to. I'm a particular proponent of cycling refrigerated air dryers.

The issue with compressed air filters is to maintain them on a timely basis. We've been guilty of cranking up plant pressure due to untimely filter maintenance. The timely execution of filter maintenance programs is very important to protect air quality and system pressure. BP

Thank you very much for your insights.

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

For more articles like this, please visit www.airbestpractices.com/energy-manager

THE TECHNOLOGY PROVIDER

Hybrid Refrigerated/Desiccant Compressed Air Dryers

BY DAVID PHILLIPS, KAESER COMPRESSORS

David Phillips, Product Manager, Clean Air Treatment, Kaeser Compressors

Introduction

Desiccant dryers are commonly used to bring the pressure dew point well below freezing (commonly -40 °F) in order to prevent moisture from precipitating in the compressed air system and production equipment. In most cases, the need is actually seasonal and a refrigerated dryer is perfectly capable of meeting air quality needs for most of the year — and with much lower operating and maintenance costs. It is possible to install separate refrigerated and desiccant dryers in a series for these applications. Better still are combination or "hybrid" dryer systems that combine dryer technologies into a high-performing dryer with even lower operating costs.

These hybrid dryers first incorporate a refrigerated dryer to condense and remove the majority of the water vapor in the compressed air stream. Refrigeration is a very inexpensive method for dehydrating compressed air. Routing compressed air through a refrigeration system prior to treating it with a desiccant dryer significantly reduces the cost to produce a -40 °F dew point. Refrigeration will typically remove 85% to 88% of the total amount of water vapor. The desiccant dryer is then challenged with only the remaining 12% to 15% of the total water removal.

The hybrid arrangement also significantly reduces both operating and maintenance costs compared to any other dryer types equally capable of producing -40 °F dew points. The combination system also permits the refrigerated dryer to be operated independently. As the vast majority of compressed air applications simply require the water vapor remaining in the air after treatment to remain in the vapor state, a refrigerated dryer provides adequate drying during warmer months. The desiccant drying is needed only during cooler seasons. Turning off the desiccant dryer in warmer months creates significant operating and maintenance cost savings.

How a Hybrid Drying System Operates:

Compressed air that has been through a compressor's aftercooler (typically about 100 °F) enters the refrigerated dryer and passes through the primary side of the air-to-air heat exchanger (A/A HX) **(1)** where its temperature is reduced to about 70 °F. This change in temperature condenses a significant amount of the water vapor. Some oil vapor will also be condensed in the A/A HX.

The mixture of 70 °F saturated compressed air and liquid water then enters the air-to-refrigerant heat exchanger (A/R HX) **(2)** where the temperature is further reduced to about 38 °F, condensing more water vapor to liquid and more oil vapor to aerosols.

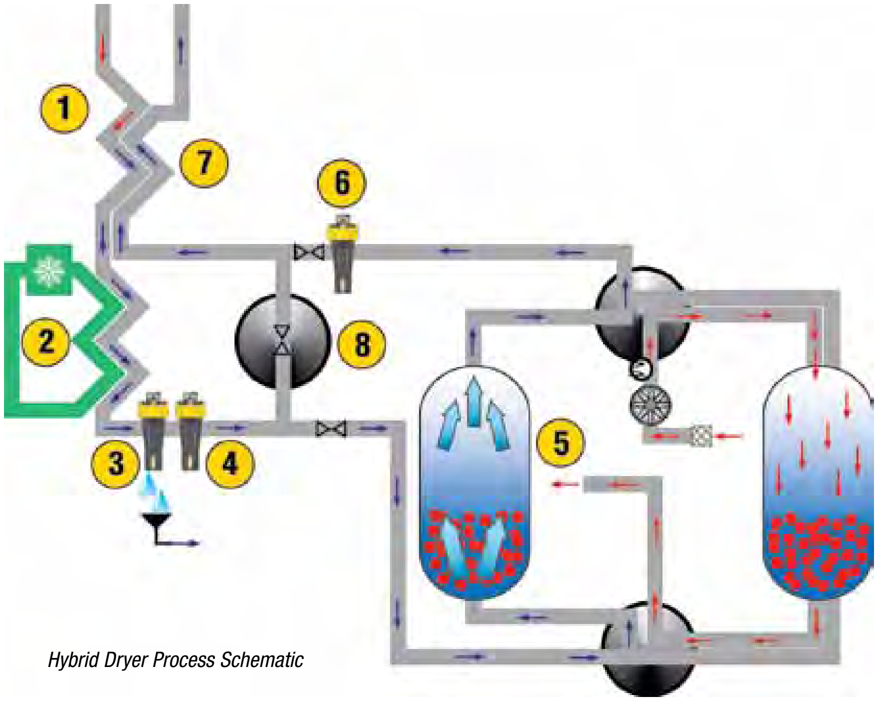
Next, the mixture of 38 °F saturated compressed air, liquid water and oil aerosols enters the refrigerated dryer's separator **(3)** where the liquid water and newly formed oil droplets are removed from the compressed air stream. The separator element also captures solid particles three micron and larger.

The cold saturated air continues through an oil coalescing filter, **(4)** further reducing oil aerosol concentration to .01 PPMw. Particles .01 micron and larger are captured.

The cold, saturated, oil-free and particle-free compressed air is now passed through a bed of heated activated alumina desiccant **(5)** where its dew point is reduced to -40 °F.

After leaving the desiccant, the cold, dry, oil-free air stream passes through a one micron particulate filter **(6)** to capture any desiccant fines swept out of the desiccant bed by the compressed air flow.

The final step is to route the cold, dry, oil-free and particle-free compressed air back through the secondary side of the A/A HX **(7)**. This locks in the dew point but warms outgoing compressed air back up to 85 °F and cools the incoming air as described in **(1)**.



Hybrid Dryer Process Schematic

THE TECHNOLOGY PROVIDER

Hybrid Refrigerated/Desiccant Compressed Air Dryers

In warmer months when conditions do not necessitate lower dew point, the desiccant dryer and its after filter may be easily valved off **(8)** so that only the refrigeration dryer will operate. The air will still flow through the moisture separator **(3)** and the cold coalescing filter **(4)**, and back through the A/A HX **(7)**. In addition to significant energy savings from turning off the desiccant dryer, additional energy savings are achieved as the pressure drop across the clean air treatment system is reduced while the desiccant dryer is bypassed.

Performance Advantages:

The hybrid dryer produces a consistent outlet dew point and air temperature. There are no spikes at anytime during the drying or regeneration cycle. In fact, it will deliver outlet dew points exceeding the -40 °F design when ambient conditions are less taxing than design conditions. It is not uncommon for combination systems to produce dew points in the range of -80 °F during wintertime operation in cold climates. A hybrid dryer can achieve the following ISO 8573.1 classes:

- Moisture: +40 to -40 °F pressure dew point
  Class 4 or 2
- Solids: .01 micron (exceeds Class 1)
- Oil aerosols: .01 PPMw/w (exceeds Class 2)

Energy Cost Advantages:

Hybrid dryers will consume significantly less power than other types of desiccant dryers. At rated conditions and producing a -40 °F dew point for seven months per year with a 38 °F dew point for the remaining five months, a combination system consumes:

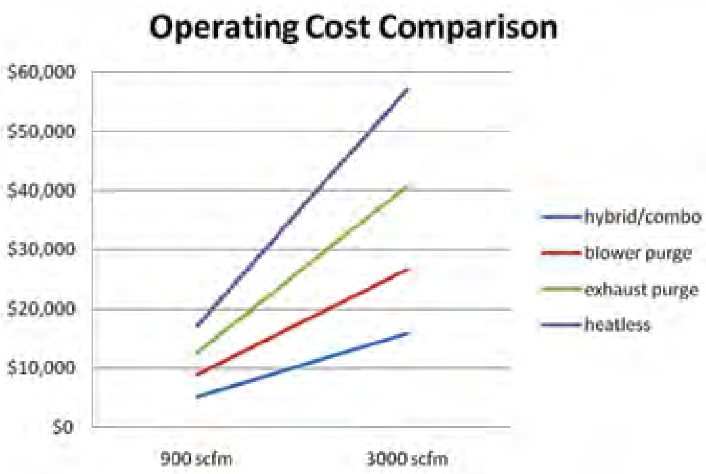
- 48% less power than a blower purge dryer.
- 54% less power than a heated purge dryer.
- 64% less power than a heatless dryer.

Higher Tolerance to Elevated Inlet Air Temperatures

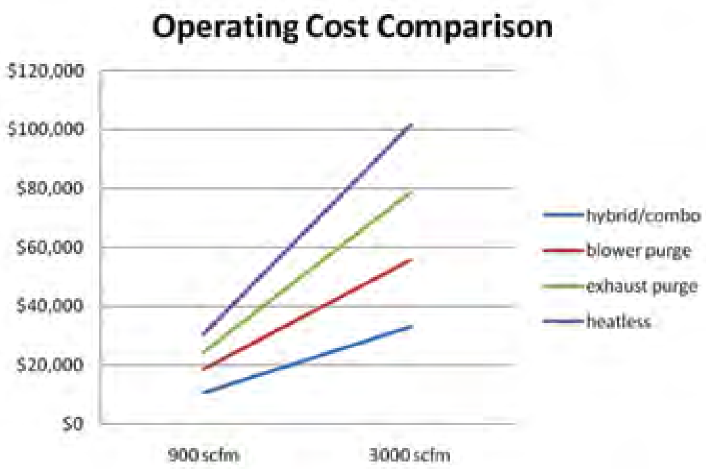
Hybrid dryers significantly outperform desiccant dryers when inlet temperatures are above rated conditions. Whether due to higher ambient temperatures or inadequate compressor maintenance, the capacity of heated desiccant dryers can be severely impaired as the inlet air temperature rises. A rise of only 5 °F above the rated inlet air temperature (100 °F to 105 °F) results in a 13% decrease of their inlet flow capacity (i.e., a 1,000 scfm dryer becomes an 870 scfm dryer). With a 10 °F rise, heated dryers lose 26% of their rated capacity, and at 20 °F above the rated inlet air temperature the capacity loss is 45% (a 1,000 scfm dryer becomes a 550 scfm dryer)!

Hybrid dryers are not so affected by inlet temperature rising above the rated condition. It is the refrigerated dryer, rather than the desiccant dryer, that will be most challenged by a rising inlet air temperature, and the effect is much less pronounced on a refrigerated dryer.

A 5 °F rise of inlet air to a refrigerated dryer will result in only a slight elevation of the outlet dew point. Theoretically the dew point would rise to 41 °F, and this is still a very tolerable condition for the combination system's blower purge dryer. Any loss in performance may be imperceptible. An inlet temperature rise of 10 °F would have a discernable impact; however, the refrigerated dryer would lose only 18% of its rated capacity compared to the 26% loss a heated dryer would have.



Assume 8,760 hours of operation at $0.07/kWh.



Assumes 8,760 hours of operation at $0.15/kWh.

Maintenance and Service Advantages:

Lower desiccant replacement costs

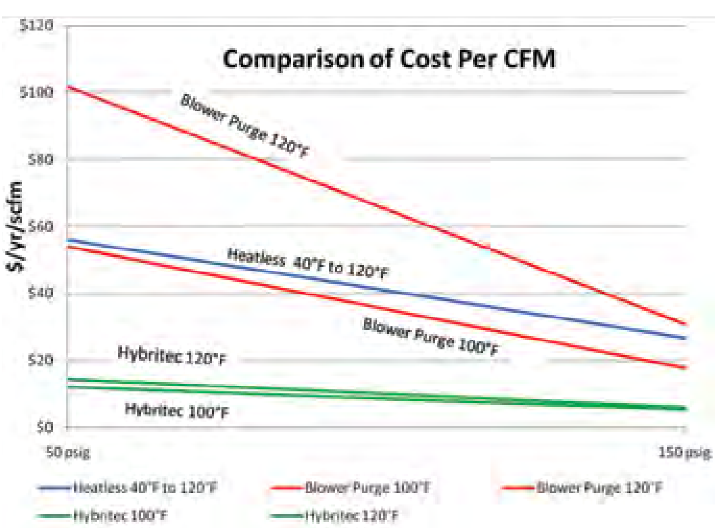
Since the refrigeration component removes 85% of the moisture, the desiccant beds, heater and blower can be sized much smaller for a hybrid dryer than a stand-alone desiccant dryer. Consequently, the cost of desiccant replacement is much lower. For example, a 1,500 scfm heated exhaust purge or blower purge dryer requires 2,520 lbs of desiccant, and a similar capacity heatless dryer holds 2,060 lbs. By contrast, a hybrid dryer only needs 1,560 lbs of desiccant for the same flow.

In addition, the service intervals for the desiccant in a hybrid dryer are less frequent:

- Heated dryers — replace desiccant every two years
- Heatless dryers — replace desiccant every three to five years
- Hybrid dryer — replace desiccant every five to seven years

The longer desiccant service in combination systems results from several factors:

1. It is not used all year long.
2. Less thermal cycling — the desiccant beds in hybrid systems are heated and cooled half as often as other heated dryer types. The desiccant is regenerated every eight hours in hybrid systems where regeneration every four is typical of other heated dryer types.
3. Magnitude of thermal cycling is reduced — the regeneration temperature for blower purge dryers in hybrid dryers is only 230 °F to 250 °F, compared to a typical regeneration temperature of 400 °F to 425 °F in other heated dryers. Therefore the temperature change of the desiccant during regeneration is only about 200 °F (40 °F inlet to 240 °F) compared with a temperature change of 300 °F (100 °F to 400 °F) in traditional dryers.
4. Hybrid systems have slower, controlled depressurization of the desiccant tower in preparation for regeneration. The tower is depressurized over a period of several minutes rather than seconds as with heatless desiccant dryers. This eliminates high air velocities in the desiccant beds that cause desiccant to breakdown. And it occurs far less frequently than heated or heatless dryers.



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Hybrid Refrigerated/Desiccant Compressed Air Dryers

Combining smaller desiccant beds with less frequent service intervals yields much lower average annual desiccant replacement costs for the hybrid unit:

Average Desiccant Replacement Quantity

- Heated: 2,520 lb x 1 change/2 years = 1,260 lb/yr
- Heatless: 2,060 lb x 1 change/5 years = 412 lb/yr
- Hybrid: 1,560 lb x 1 change/7 years = 223 lb/yr

Reduced tower switching and valve cycling

The hybrid dryer's 16-hour cycle (eight hours drying, eight hours regenerating) greatly reduces valve cycles. Heated dryers typically operate on an eight-hour cycle, so they have double the valve actuation cycles than in a hybrid system. The valves in a hybrid system cycle 99% less than a typical heatless dryer, which commonly cycle every five minutes. The result is less wear and longer valve life in the hybrid dryer.

Other maintenance benefits

Routine maintenance for the blower purge dryer, such as filter element replacement, valve rebuilds, even desiccant replacement, can be performed without having to schedule air system downtime.

The need to stock routine maintenance items (such as filter elements, valve rebuild kits and replacement desiccant) is eliminated along with the associated administrative costs of those functions, as well as keeping warehouse space free for other uses.

Why not just by two dryers?

Some energy-wise users have invested in both refrigerated and desiccant dryers, running them separately in accordance with the season. This definitely presents energy savings compared to running a desiccant dryer all year long, but it does not achieve the benefits of the hybrid dryer.

- Cost of purchasing and installing two separate dryers is higher
- Inlet air to the desiccant dryer is not pre-cooled or cold filtered, so the performance is lower
- The desiccant dryer must be sized for full-flow, so the user will not realize all of the maintenance benefits

Total Cost Comparison

As illustrated in the operating cost comparisons above, the larger the system, the greater the difference in savings. The total cost comparison (including purchase price, operating and maintenance) shows a similar pattern. Even with purchase costs included, the hybrid dryer achieves a very fast payback of capital invested:

- In a 900 scfm system, the break-even point with the next best alternative is 3.2 years
- In a 1,500 scfm system, the break-even point with the next best alternative is 1.5 years
- In a 5,000 scfm system, the hybrid dryer costs dip below the next best alternative in just 10 months

Conclusion

A combination refrigerated/desiccant compressed air dryer is a flexible drying system capable of consistently high performance and reliability with low operating and maintenance costs that quickly returns the difference of the initial purchase price, and then goes on to provide years of significant operations and maintenance savings. BP

To download a complete copy of the white paper on hybrid dryers, please visit www.kaeser.com/combodryers

For more information, contact David Phillips, Product Manager, Clean Air Treatment, Kaeser Compressors, tel: 540-834-4510, email: david.phillips@kaeser.com, www.kaeser.com

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COMPRESSED AIR DRYERS

BY THE COMPRESSED AIR CHALLENGE®

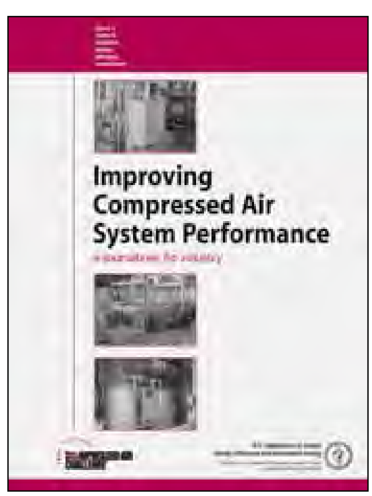
Compressed air dryers are important items to consider when evaluating the efficiency of a typical compressed air system. One of the keys to optimal system operation is ensuring the air is only dried to the level required by the actual needs of the facility.

"In selecting dryers, always consider the required dew point and the initial price compared to total operating costs," says William Scales, co-author of CAC's Best Practices Manual and a certified Advanced Level instructor. "Higher quality air usually requires additional equipment and can lead to increased capital investment and possibly higher operating costs."

For example, using standard uncontrolled heatless desiccant dryers may cost three to four times more than using a similarly sized refrigerated dryer.

"Significant energy can be saved if the plant is operating desiccant dryers when a properly designed refrigerated dryer installation would provide adequate air treatment. Even if desiccant dryers are needed, many plants that require -40 °F or better dew point are using the low initial cost heatless dryer, technology which is the most expensive to operate," says Jan Zuercher, Director of Air Systems for Quincy Compressor, and a certified CAC Fundamentals Instructor. "There are more energy efficient desiccant dryer technologies available today that offer excellent payback opportunities."

Attendees of the *Compressed Air Challenge Fundamentals and Advanced* training learn about the types of air dryers and the differing characteristics that affect system performance. The *Compressed Air Challenge* also has a number of resources available to those who are interested in learning more about compressed air dryers. The following is an excerpt from CAC's "*Improving Compressed Air System Performance: A Sourcebook for Industry*."



Compressed air system performance is typically enhanced by the use of dryers, but since they require added capital and operating costs (including energy), drying should only be performed to the degree that it is needed for the proper functioning of the equipment and the end use.

COMPRESSED AIR DRYERS

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Compressed air system performance is typically enhanced by the use of dryers, but since they require added capital and operating costs (including energy), drying should only be performed to the degree that it is needed for the proper functioning of the equipment and the end use.

Single-tower, chemical deliquescent dryers use little energy, but provide a pressure dew point suppression of 15 to 50 °F below the dryer inlet temperature, depending on the desiccant selected. They are not suitable for some systems that have high drying needs. The approximate power requirement, including pressure drop through the dryer and any associated filtration, but excluding the cost of replacement desiccant, is approximately 0.2 kW/100 cfm.

Refrigerant-type dryers are the most common and provide a pressure dew point of 35 to 39 °F, which is acceptable for many applications. In addition to the pressure drop across the dryer (usually 3 to 5 psid), the energy to run the refrigerant compressor must be considered. Some refrigerant-type dryers have the ability to cycle on and off based on air flow, which may save energy. The power requirement, including the effect of pressure drop through the dryer, is 0.79 kW/100 cfm.

On larger dryers, cylinder head unloading is available (single- and two-step) and offers improved part-load performance over conventional refrigerated dryers. Cylinder head unloaders enable discreet steps of control of the refrigerant compressor, just as unloaders enable capacity control of reciprocating air compressors.

Twin-tower, desiccant-type dryers are the most effective in the removal of moisture from the air and typically are rated at a pressure dew point of –40 °F. In a pressure-swing regenerative dryer, the purge air requirement can range from 10 to 18% of the dryer's rating, depending on the type of dryer. This energy loss, in addition to the pressure drop across the dryer, must be considered. The heated-type requires less purge air for regeneration, as heaters are used to heat the desiccant bed or the purge air. The heater energy must also be considered against the reduction in the amount of purge air, in addition to the pressure drop. Approximate power requirement, including pressure drop through the dryer, is 2.0 to 3.0 kW/100 cfm. Excellent savings can be gained with these types of dryers, if partially loaded, using dew point controls.

CAC Qualified Instructor Profile

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William Scales, president of Scales Air Compressor Corporation, is an internationally recognized expert in compressed air systems. Over the last 40 years, he has visited more than 5,000 facilities and audited hundreds of compressed air systems throughout the world for a wide variety of industrial companies. He is a Qualified Instructor for the Compressed Air Challenge® (CAC) Fundamentals and Advanced Management training and was a member of the core group that developed this training. Bill is the co-author of the Compressed Air Challenge 325-page "Best Practices for Compressed Air Systems" and a CAC Instructor of both Fundamentals and Advanced Management Systems.

Heat-of-compression dryers are regenerative desiccant dryers, which use the heat generated during compression to accomplish desiccant regeneration. One type has a rotating desiccant drum in a single pressure vessel divided into two separate air streams. Most of the air discharged from the air compressor passes through an air aftercooler, where the air is cooled and condensed moisture is separated and drained. The cooled air stream, saturated with moisture, passes through the drying section of the desiccant bed, where it is dried and exits from the dryer. A portion of the hot air taken directly from the air compressor at its discharge, prior to the aftercooler, flows through the opposite side of the dryer to regenerate the desiccant bed. The hot air, after being used for regeneration, passes through a regeneration cooler before being combined with the main air stream by means of an ejector nozzle before entering the dryer. This means that there is no loss of purge air. Drying and regeneration cycles are continuous as long as the air compressor is in operation.

This type of dryer requires air from the compressor at sufficiently high temperatures to accomplish regeneration. For this reason, it is used almost exclusively with centrifugal or lubricant-free rotary screw compressors. There is no reduction of air capacity with this type of dryer, but an entrainment-type nozzle has to be used for the purge air. The twin-tower, heat-of-compression dryer operation is similar to other twin-tower, heat-activated, regenerative desiccant dryers. The difference is that the desiccant in the saturated tower is regenerated by means of the heat of compression in all of the hot air leaving the discharge of the air compressor. The total air flow then passes through the air aftercooler before entering the drying tower. Towers are cycled as for other regenerative desiccant-type dryers. The total power requirement, including pressure drop and compressor operating cost, is approximately 0.8 kW/100 cfm.

COMPRESSED AIR DRYERS

> "There are more energy efficient desiccant dryer technologies available today that offer excellent payback opportunities."
>
> — Jan Zuercher, Director of Air Systems for Quincy Compressor, and a certified CAC Fundamentals Instructor.

Membrane-type dryers can achieve dew points of 40 °F, but lower dew points to -40 °F can be achieved at the expense of additional purge air loss.

Advantages of membrane dryers include:

- Low installation cost
- Can be installed outdoors
- Can be used in hazardous atmospheres
- No moving parts

Disadvantages of membrane dryers include:

- Limited to low-capacity systems
- High purge air loss (15 to 20%) to achieve required pressure dew points
- Membrane may be fouled by oil or other contaminants, and a coalescing filter is recommended before the dryer

The total power requirement, including pressure drop and compressor operating cost, is approximately 3 to 4 kW/100 cfm.

Dryer Selection

The selection of a compressed air dryer should be based upon the required pressure dew point and the estimated cost of operation. Where a pressure dew point of less than 35 °F is required, a refrigerant-type dryer cannot be used. The required pressure dew point for the application at each point-of-use eliminates certain types of dryers. Because dryer ratings are based upon saturated air at inlet, the geographical location is not a concern. The dryer has a lower load in areas of lower relative humidity, but the pressure dew point is not affected. Typically, the pressure drop through a compressed air dryer is 3 to 5 psi and should be taken into account in system requirements. Compressed air should be dried only where necessary and only to the pressure dew point required.

CAC Qualified Instructor Profile

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Quincy Compressor is a leading supplier of air compressors, vacuum pumps, air treatment, energy saving systems products and compressed air analysis services. Jan is a Licensed Professional Engineer with 29 years of compressor industry experience. He has held Director of Engineering positions for several major compressor manufacturers and completed compressed air audits over a wide cross section of industries. He has been awarded multiple patents for energy efficient compressor auditing and control systems. Jan is a Department of Energy Air Master + Certified Auditor, and a CAC Certified Compressed Air Challenge Instructor. He has authored several articles published in trade magazines on Compressed Air Energy Savings Opportunities.

Maintenance

"Treatment equipment, including automatic drain traps, must be properly maintained to retain top quality results from air dryers and filters," says Scales. "Often dryers are subjected to inlet or ambient air temperatures that exceed design specifications and will not produce the desired dew point or may even shut down. Sometimes, either water-cooled or air-cooled condensers have not been maintained causing the dryer to fail. There are occasions where the pressure drop across dryers or filters has not been addressed and the compressor discharge pressure has been increased leading to increased energy consumption."

Dryer Part Load Efficiency

An important item to note when assessing air dryer performance is the part load efficiency of air dryers. Often air dryers are subject to part loaded conditions where the inlet flow, temperature and pressure result in lower than rated moisture loading. Some types of dryers turn down their energy consumption in relation to this reduced moisture loading to save operating costs. Some assistance in determining the turn down of a refrigerated air dryer can be found in reviewing the CAGI dryer data sheets, a sample of which is listed at **http://www.cagi.org/pdfs/refdata.pdf**. BP

For more articles like this, please visit www.airbestpractices.com/technology/air-treatment

NEED MORE INFORMATION?

Try our "*Best Practices for Compressed Air Systems*." This 325-page manual is available at our **bookstore**, or visit **www.compressedairchallenge.org**

Please check the Compressed Air Challenge (CAC) website, **www.compressedairchallenge.org**, for the announcement of the second series of *Fundamentals of Compressed Air Systems WE* (web-based) training, scheduled to begin in early summer 2010. Led by Frank Moskowitz and Tom Taranto, this web-based version of the popular *Fundamentals of Compressed Air Systems* training uses an interactive format that enables the instructor to diagram examples, give pop quizzes and answer students' questions in real time.

If you have additional questions about the new web-based training or other CAC training opportunities, please contact the CAC at **info@compressedairchallenge.org** or by calling 301-751-0115.

THE SYSTEM ASSESSMENT

Aluminum Mill Reconfigures Compressed Air System

BY HANK VAN ORMER, AIR POWER USA

This aluminum mill spends $369,000 annually in energy costs to operate their compressed air system. This system assessment recommends actions reducing annual energy costs by $120,000 and improving productivity and quality by delivering clean, dry compressed air.

Supply-Side System Background

There are three "compressor rooms" providing compressed air to the mill: the Hot Mill Room, the Remelt Room and the Cold Mill room. This aluminum mill has grown over time but now has no expansion plans in the foreseeable future. The rooms have a mix of centrifugal and three-stage XLE reciprocating compressors. Some of the air compressors were installed in 1973, and the most recent significant compressed air system project (with new air compressors) was done in 1987.

Compressed air drying is performed by both desiccant dryers (blower purge and heatless) and by refrigerated dryers. Some of the dryers and piping cause short cycling by the air compressors. Today's dryers deliver -40 ºF dew point air from some and +40 ºF dew point air from others. The end result is a wet system, while still spending $43,000/year in dryer-related electrical energy costs.

The mill operates 8,760 hours per year. The mill is located in the "Rust Belt" and the power rate is $.0325/kWh. Plant personnel, however, inform that significant rate increases are expected in the future.

Today, we have over 12,600 scfm of capacity on-line and while we were monitoring had 10,500 scfm capacity running. The plant was taking 6,300 to 6,500 scfm due to the "choked flow" out of each compressor room.

Operating under this situation, the system entry pressure fluctuated from below 80 psig to almost 100 psig — average fluctuation 12–13 psig. This is caused by the restrictive piping first causing pressure drop, then overdriven pressure during recovery with very short cycles.

The compressors are not loading or unloading in response to system needs but in response to false signals generated in the small, turbulent piping. In all probability, 7,000 scfm is probably all the air that can be jammed through this piping and still hold reasonable, if erratic, pressures.

The Overall Action Plan

We intend to create two compressor supply areas capable of flowing up to 10,000 scfm to the plant in a smooth, efficient manner. One room, the existing Hot Mill, will provide oil-free compressed air with two 3,600 scfm class, 3-stage centrifugal compressors and new 4,400 scfm heat-of-compression compressed air dryers.

The second room will be the existing Remelt Room, in which the three existing 150HP XLE reciprocating, lubricated compressors will be augmented by one more XLE moved from the Hot Mill for a total of four units (total scfm 2,930 to 3,112 depending on configuration of fourth unit).

The existing Cold Mill room will need some piping reconfiguration if it is to be used at all. We view these units as emergency backup.

With these modifications, today's demand will be satisfied better with a $94,776 reduction in electrical energy cost. We will also be running fewer units with a commensurate reduction in maintenance and repair costs. Your records can quantify this.

The quality of air will be improved as all of the air going to the system will be -40 °F pressure dew point class. The system will be dry after the "run in" period.

The electrical energy cost to dry the compressed air will be reduced by $26,000 per year for a total compressed air system annual electrical energy savings of $120,000 per year.

Reliability — the new configuration will support a 7,000 scfm demand with "N + 1" reliability or a "firm 7,000 scfm supply." There is enough backup that if the largest single unit is down for service or repair, additional air supply will not be needed to run.

Specific Actions Required in the Hot Mill Room

The Main Action Item

Move the 200HP XLE to the Remelt Mill. Our testing discovered that the piping system in the Hot Mill Room was creating a high backpressure on the Centac and reducing its outlet air flow. The high backpressure was created by the high-velocity crossing-tee connection of the Centac and XLE air compressors. This crossing-tee created significant flow resistance and backpressure, which in a centrifugal mass flow compressor shows up as reduced flow (not increased power as in a positive displacement compressor). The plant personnel were amazed to see that the actual measured flow to the dryers in the Hot Mill Room was 800 scfm more when we turned the XLE compressor off and ran the Centac alone!

The numbers below show what we measured during our test:

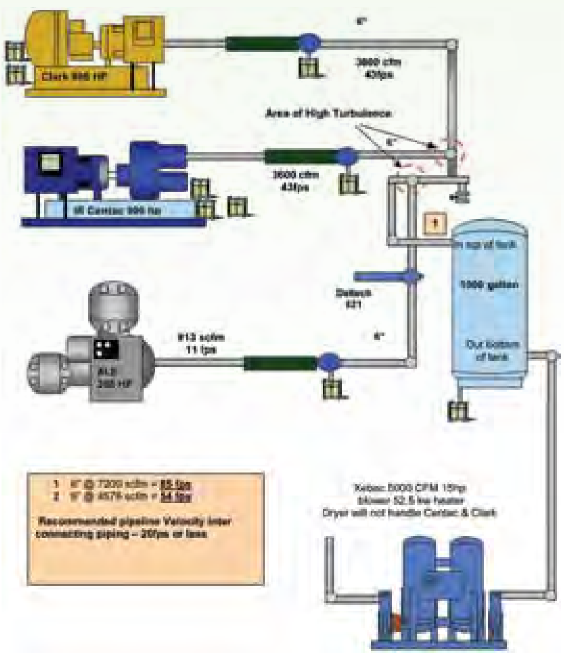
		APPARENT FLOW
Centac full load	625 kW	3600 scfm
XLE at 50% load	97 kW	457
TOTAL	**722 KW**	**4057**
Actual measured flow to the dryer		**3,100 SCFM**
Net performance 3,100 scfm/722 kW =		**4.29 SCFM PER KW**

After the shutdown of the XLE, we now have:

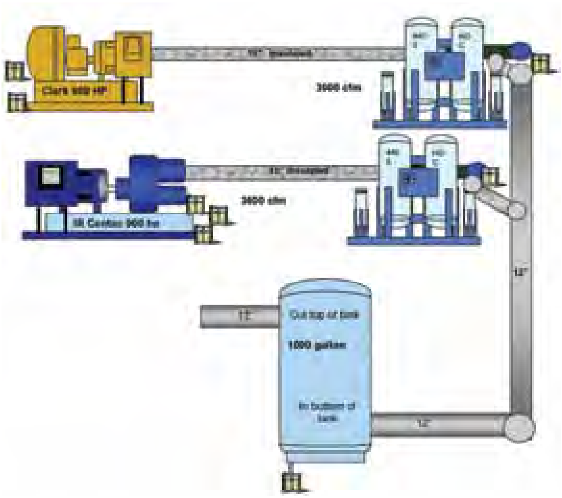
		APPARENT FLOW
Centac full load	625 kW	3600 scfm
XLE – 0% flow	OFF	-0-
TOTAL	**625 KW**	**3600 SCFM**
Actual measured flow to the dryer		**3,900 SCFM**
Net performance 3,100 scfm/625 kW =		**6.24 SCFM PER KW**

ALUMINUM MILL RECONFIGURES COMPRESSED AIR SYSTEM

Hot Mill Room Before Reconfiguration



Hot Mill Room After Reconfiguration



Other Action Items

- Move blower purge desiccant dryer to Remelt Mill where it will replace the refrigerated dryer
- Remove old piping from dryer to receiver to system and replace with 12" stainless steel, Schedule 10 piping with pre-mounted valve connections
- Install one new, 4,400 scfm rated, heat of compression dryer each for the Ingersoll-Rand Centac and Clark centrifugal
  - The dryers will have their own aftercooler rated for 4,000 scfm. The existing aftercoolers will not be needed. They may be used on the back-up compressors in the Cold Mill Room, where they will be oversized
  - The pipe from the compressor to the dryer should be 104 stainless steel, Schedule 10 and insulated to retain heat and support dryer performance

Specific Actions Required in the Remelt Mill Room

- Reconfigure piping to eliminate current small, high-turbulent pipe with new main header
- Rotate and reorient #2 150HP XLE mount on Amber booth inertia base. Cut back top of old foundation and follow instruction
- Install 200 HP XLE from Hot Mill alongside #2 oriented as shown in schematic. Install on similar Amber booth inertia base
- Reconnect #1 and #3 150HP XLE's to header as shown
- Install blower purge desiccant dryer (from Hot Mill) with current filters as shown in schematic. Eliminate the refrigerated dryer
- Install new 2,200-gallon vertical air receiver (in bottom/out top) as shown in schematic
- Install mist eliminator pre-filter ahead of existing pre-filter as shown
- Add dew point demand controller
- Add central control system to keep all units at full load except one at part load — all others off
- 4" line to shop appears to just feed leaks. Air pressure as we go forward will be too low for effective tool use. We understand the shop has it own air compressor. Check to be sure shop compressor is adequate or acquire one — shut off this 4" line

Specific Actions Required in the Cold Mill Room

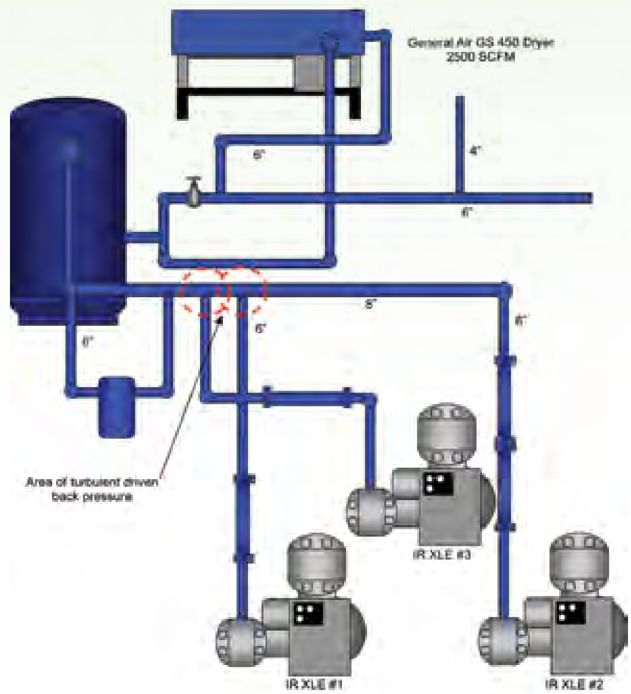
In order to run these two units together effectively, even in backup, some basic modifications are required.

- Correct the aftercooler problem. It may be possible to use coolers from the centrifugals in Hot Mill
- Be sure dryer is OK. If not, it may be possible to use the refrigerated dryer from the Remelt Mill
- Increase line size from compressor discharge to header from 3" to a minimum of 4"
- Connect to header with directional angle entry rather than tee and crossing tee
- Change header size from compressors to dryer and system from 6" to 8"

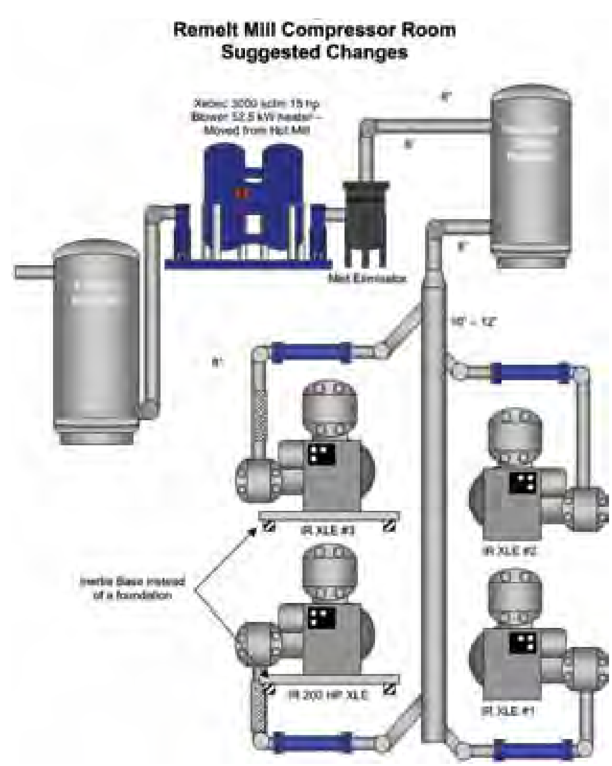
General Piping Considerations (applies to all rooms involved):

- Our sketches are schematics and are not intended to be used as engineering drawings to which to build. Follow good piping practice and all applicable codes
- We have specified stainless steel, Schedule 10 main piping for several reasons:
  - Black iron pipe requires Schedule 40 and is heavier
  - Black iron pipe has gone up in cost and stainless steel is much closer in price
  - All compressed air condensate is very acidic — in an oil-free application (Hot Mill), it is very aggressive without the presence of oil, which is normally basic to neutralize it. Stainless steel will resist this best. Black iron pipe, unless coated, etc., will rust internally and self-contaminate
- Stainless steel pipe can be welded or installed with victaulic fittings with viton seals. It generally should not be threaded for compressed air because it will tend to leak
- Use long Ells, not 90º turns, and 45º directional angle entry, not tee's. NO "dead head" or counter flow. Observe pipe sizes called for here
- Install zero loss, automatic condensate drains on all risers before dryer. Also, install on aftercooler separators, receivers, etc.

Hot Mill Room Before Reconfiguration



Hot Mill Room After Reconfiguration



ALUMINUM MILL RECONFIGURES COMPRESSED AIR SYSTEM

This aluminum mill's annual electrical energy cost reduction will now be about $120,000 per year.

Summary

After the piping and equipment have been reconfigured in the Hot Mill and Remelt Mill, the aluminum mill will now have:

- Air available to the system in a smooth flow pattern with an average 2–3 psig pressure loss compared to the current 11–15 loss today. This will stabilize production line pressure significantly
- Dry air instead of wet air
- Annual electrical energy cost reduction of about $120,000 per year
- Fewer compressors on-line to produce the air, lowering the overall maintenance and repair costs
- Firm air capacity of 7,000 scfm with redundant back-up air, even with the system's largest single compressor down for maintenance or repair. This will enhance reliability but also enable proper scheduled maintenance of the equipment. BP

For more information, please contact Hank Van Ormer, Air Power USA, Tel: 740-862-4112, email: hank@airpowerusainc.com, www.airpowerusainc.com.

For more articles like this, please visit www.airbestpractices.com/system-assessments/piping-storage

COMPRESSED AIR
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Working Together for Compressed Air Best Practices

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

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

- **Compressed Air Users — Focus Industry**
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  - B. Audit case studies and "Best Practice" recommendations
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SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Chillers Save on Energy and Water Consumption

BY ROD SMITH, COMPRESSED AIR BEST PRACTICES®

Industrial plants are major consumers of water. Water is used in many processes. Sustainability projects focus on reducing the consumption of water and the energy costs associated with cooling water so it may be used effectively. This month, we received case studies from Motivair Corporation and from WIKA Instrument Corporation providing examples on how to use chillers to reduce energy costs and water consumption.

Part 1: Motivair Free-Cooling Chiller Saves Energy at a Tube Mill

The extensive water-cooled hydraulics and product quenching system at the tube mill requires year-round cooling. The optimum cooling water temperature is around 70 °F — too low for any type of cooling tower or dry cooler (radiator) system. The entire hydraulic/product quenching cooling system is fed from two plate & frame heat exchangers inside the plant on a closed loop recirculating system. The cooling water feeding these exchangers needed to be approximately 10 °F lower, in order to ensure the correct temperature of 70 °F to the process. 60 °F was specified as the required year-round water temperature from the chiller, returning to the chiller at 70 °F.

The tube mill planned to install a nominal 100-ton refrigeration water chiller to handle the cooling load. Mechanical (refrigeration) cooling is significantly more expensive to operate than radiators or cooling towers, but there was no other alternative for guaranteed year-round water at this location.

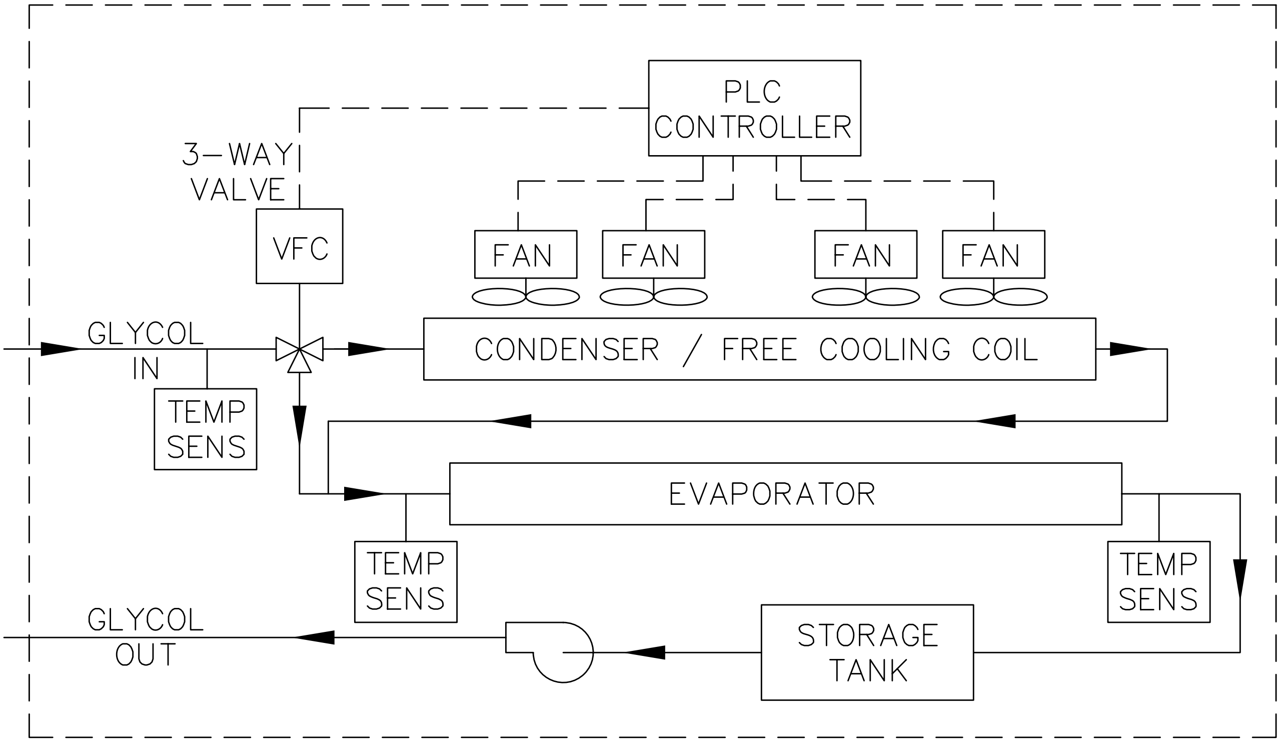
Sustainability projects focus on reducing the consumption of water and the energy costs associated with cooling water so it may be used effectively.

The tube mill researched the possibilities and settled on a Motivair Free Cooling chiller. Free Cooling chillers are outdoor, packaged, air-cooled chillers with integrated free cooling coils, motorized 3-way valve and custom PLC controls. The design allows year-round cooling applications to reduce energy costs by taking advantage of low ambient temperatures. Therefore, these chillers are best applied in the central and northern states of the United States, Canada and Europe.

When the outdoor ambient is lower than the return chilled water, the 3-way valve diverts the water through the free cooling coils positioned across the face of the air-cooled condenser coils. The condenser airflow, which is common to both coils, pre-cools the water before it enters the chiller evaporator, reducing the cooling load. As the ambient temperature falls, the pre-cooling effect is increased and the refrigeration compressors are unloaded or switched off.

Motivair Free-Cooling Chiller Installed at a Steel Tube Mill

The Free Cooling chiller design allows year-round cooling applications to reduce energy costs by taking advantage of low ambient temperatures.



Motivair Free-Cooling Chiller Process Diagram

CHILLERS SAVE ON ENERGY AND WATER CONSUMPTION

Hydraulic Hose Glycol Connections to the Integrated Free-Cooling Coils

A typical design provides 50% free cooling when the ambient air is 10 °F below the supply chilled water temperature and 100% free cooling with a 20 °F differential. The entire operation is completely automatic and provides a seamless transition in and out of free cooling with no temperature spikes. Since the chiller is required to operate outdoors, a glycol solution is mandatory to prevent freezing throughout the winter months.

These chillers can be applied to any industrial process that requires year-round cooling, including hydraulics, plastic molding, chemical, food and pharmaceutical production. The power savings are significant and easily justify the added expense of a free cooling system. A secondary, but significant, advantage is the refrigeration compressors are not required to operate in low ambient conditions — the worst operating condition for any refrigeration compressor. The elimination of low ambient operation reduces nuisance downtime in winter and extends the equipment life through reduced operating hours and optimized running conditions.

Free Cooling chillers can be applied to any industrial process that requires year-round cooling, including hydraulics, plastic molding, chemical, food and pharmaceutical production. The power savings are significant and easily justify the added expense of a free cooling system.

Given the annual temperature range in this area, the savings were readily apparent. Whenever the outside air temperature falls below 70 °F, the return chilled glycol solution is automatically diverted through the integrated Free Cooling coils of the chiller. These coils are located across the inlet-air side of the air-cooled condensers and use the condenser fans to pre-cool the return glycol. As the ambient temperature falls, the pre-cooling increases — until at approximately 20 °F below the supply glycol temperature — and the chiller operates entirely without compressors.

From historical 30-year weather data, the area experiences approximately 500 hours per year at 50–55 °F (25% free cooling); 1,052 hours at 41–50 °F (50% free cooling) and 3,484 hours below 41 °F (100% free cooling). The total installed refrigeration compressor power in the chiller is 112 kW. At a power cost of $0.07/kWh, the power savings for the tube mill were calculated to be approximately $32,412 per year, compared to the same capacity chiller without free cooling. The payback period for the free cooling option was less than the first year of operation.

Free cooling chiller savings are increased in colder climates and when higher chilled water temperatures are used. When both of these parameters are optimized the energy savings are increased proportionally.

Chillers Reduced Water Consumption at WIKA

Part 2: WIKA Plant in Georgia Reduces Water Consumption

WIKA Instrument Corporation (WIKA) has further reduced water consumption at its Lawrenceville, Georgia, pressure and temperature instrumentation manufacturing facility from 70 to 78% from May 2007 to December 2009.

In May 2007, a typical workday's daily water usage was 60,305 gallons per day and a monthly usage per thousand pieces produced was 641 gallons. In December 2009, a typical workday's water usage was 13,194 gallons per day and a monthly usage per thousand pieces produced was 193 gallons.

In 2007, an interdepartmental project team identified and implemented water reduction methods to conserve water, and in return, save the company money. The return on investment on these implementations was realized in less than one year's time. The amount of water saved annually resulted in 10.5 million gallons — enough to fill more than 16 Olympic-sized swimming pools.

In 2007, an interdepartmental project team identified and implemented water reduction methods to conserve water, and in return, save the company money. The return on investment on these implementations was realized in less than one year's time.

— WIKA Instrument Corporation

CHILLERS SAVE ON ENERGY AND WATER CONSUMPTION

Calculating the individual monthly savings compared to our "before" usages indicated we saved $39,000 on water bills in the first year.

— WIKA Instrument Corporation

The most dramatic solution implemented was the installation of ten (10) industrial "chillers." Before the chillers were installed, water was used to cool the fixtures and transformer. This water was used once and sent to the sewer. The chillers reduce our water consumption because they recirculate water, which cools the facility's 15 resistance and conductive soldering stations. The cooling temperature has to be 72 °F constant. The installation of the chillers allowed us to establish a closed loop system by regulating the temperature of recirculated water. WIKA also installed a "chiller" on another component in its factory that cools water from a washing operation.

WIKA Instruments manufactures pressure and temperature instruments at its Lawrenceville, Georgia, facility

The industrial chiller used was a Koolant Kooler, model #JT500. The ROI was determined based on the cost of incoming water and the amount of water we saved. Calculating the individual monthly savings compared to our "before" usages indicated we saved $39,000 on water bills in the first year. We purchased 10 chillers at $2,900, totaling $29,000. The simple ROI was therefore less than one year. BP

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

For Motivair Free-Cooling Chillers, contact: Graham Whitmore, tel: 716-689-0222, email: gwhitmore@motivaircorp.com, www.motivaircorp.com.

For WIKA Instruments, contact: Melissa Smith, tel: 678-739-2571, email: msmith@wika.com, www.wika.com.

For more articles like this, please visit www.airbestpractices.com/sustainability-projects/water-conservation

RESOURCES FOR ENERGY ENGINEERS

INDUSTRY NEWS

FS-Elliott Company Makes Significant Organizational Changes

FS-ELLIOTT CO., LLC announced important organizational changes to support the company's strategic objectives. Bringing a stronger emphasis to FS-Elliott's sales efforts, Mr. Al Giglia joins the company as Vice President of World Wide Sales. Al brings with him 29 years of experience with industrial machinery and products for global markets, as well as a broad range of functional experience. In his new role, Mr. Giglia will ensure that FS-Elliott establishes and maintains a leadership position in its target market segments.

Mr. Michael Gibala has accepted a new position as Director of Global Services to lead the development of a more independent and focused Global Services business. Mr. Gibala assumes this new role with more than 10 years of sales, marketing and service experience in the energy and rotating equipment industries.

Mr. Donald Ravicchio will be taking the new position as Vice President of Marketing. Mr. Ravicchio has more than 35 years of experience in the marketing and sales function of rotating machinery and is committed to continuing the work begun by Mr. Michael Gibala to build a strong and responsive marketing department.

We expect these organizational changes to sharpen our focus on growing key areas of our business and to ensure we achieve the highest levels of customer satisfaction.

For more information, contact Andrea N. Muchko, FS-Elliott Co., LLC tel: 724-387-3221, amuchko@fs-elliott.com, www.fs-elliott.com.

PRODUCT PICKS

Wind-Propelled Generator

Teseo is introducing a wind-propelled generator with a horizontal rotation axis, consisting of a spindle running on ball bearings, that supports three aluminum blades and is connected to the shaft of an air compressor.

The wind-propelled generator is mounted on top of a high aluminum framework by means of a swiveling arm. The generated compressed air is carried through pipes to a reservoir at the base of the supporting framework, and then is stored in large pressure vessels.

This innovative solution uses clean energy from a renewable source at zero cost. The unit is based on very simple and cost-effective equipment. The generator is independent of wind direction and produces energy even at low wind speeds.

Wind generator with twisted aluminum blades: 3 blades
Outer generator diameter: 4 meters
Opposed piston compressor: 2 pistons
Wind generator orientation: 1 self-directing vane
Maximum safety speed: 16 m/sec.
Height of supporting aluminum structure: 7 m
Compressor air volume intake: 374 cubic cm/revolution
Maximum compressed air pressure:11 bar
Air volume generated at 4m/sec. wind speed: 2,300 liters/hour
Air volume generated at 8m/sec. wind speed: 4,600 liters/hour
Air volume generated at 12m/sec. wind speed: 6,900 liters/hour

TESEO
sales@teseoair.com
www.teseoair.com

RESOURCES FOR ENERGY ENGINEERS

PRODUCT PICKS

Next Generation Compressed Air Filtration

Hankison, an SPX brand, announced the release of the new Next Generation Filter. The NGF Series features five element grades, covering flows 20 to 1,500 scfm (34–2,549 nm3/h). The filters are tested and rated to challenging ISO 12500 standards, delivering certifiable performance in accordance to ISO 8573.1: 2009 Air Quality Standards. Pressure drop has been reduced by nearly 50%, reducing overall cost of ownership. Patented Venturi-Wave™ elements, with color-coded end caps, promote low resistance to flow and optimal air distribution throughout the element.

Hankison — An SPX Brand
Jay.francis@spx.com
www.hankisonintl.com

New Variable Speed Compressors

CompAir announced a new line of variable speed rotary screw compressors from 50 horsepower to 180 hp (37 kW to 132 kW). The L37RS, L45RS, L75RS, L90RS and L132RS compressors have incorporated the latest in variable speed technology, producing exceptional kW/100 cfm performance across a wide turn-down range. All models operate from 75 to 190 psig at the touch of a button and are fully enclosed, delivering excellent noise performance while maintaining serviceability. The result is a compressor package that delivers significant energy savings and ultimately lower overall operating costs.

CompAir
Tel: 800-692-9868
www.compairusa.com

Direct Drive Rotary Screw Compressors

Kaeser Compressors announced the DSD direct drive series rotary screw compressors. Models are available in flows from 424–1,024 cfm and pressures to 217 psig. The units feature the optimized Sigma Profile airend, patent-pending Sigma Control system and the latest one-to-one direct drive technology. DSD units are true direct drive compressors with an oversized airend connected directly to the motor via a maintenance-free coupling for maximum efficiency. Remote grease fittings for the drive and fan motor also increase bearing life — adding to longevity and durability. Kaeser's unique cooling air flow design significantly reduces noise levels and provides superior cooling. Plus, all units are fitted with a redesigned, high-efficiency separator system for extremely low oil carry over.

The DSD units are part of the CAGI Certified Performance Verification Program — an independent, third party laboratory confirms the reported compressor performance — offering an additional level of comfort for end-users who want the very best in compressor efficiency.

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

LITERATURE & SERVICES PICKS

The Compressed Air System Solution Series©

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

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

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

The cost of the book is $195.99. To order the book, make a check or PO out to: Air's a Gas, Inc., 3728 Berenstain Drive, St. Augustine, FL 32092, or call 904-940-6940, fax 904-940-6941 or e-mail: airsagas@aol.com. A portion of the proceeds from this book will be donated to selected children's charities.

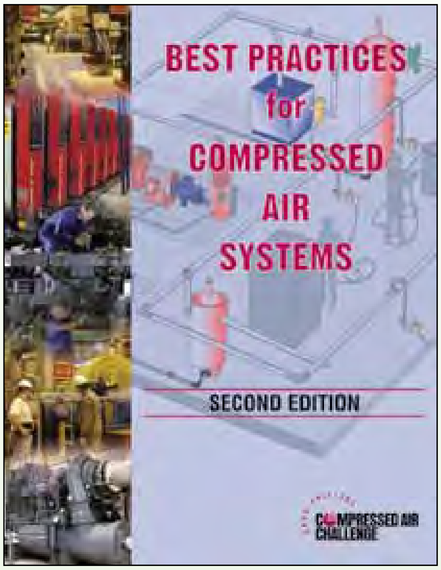
New Edition of "Best Practices for Compressed Air Systems®" from the Compressed Air Challenge®

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

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

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

Compressed Air Challenge®
www.compressedairchallenge.org



WALL STREET WATCH

BY COMPRESSED AIR BEST PRACTICES®

The intent of this column is to provide industry watchers with publicly held information, on publicly held companies, involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information gathered in this column was at the close of the trading day of March 22, 2010.

JANUARY 22, 2010 PRICE PERFORMANCE	SYMBOL	OPEN PRICE	1 MONTH	6 MONTHS	12 MONTHS	DIVIDEND (ANNUAL YIELD)
Parker-Hannifin	PH	$65.55	$59.18	$54.72	$32.06	1.54%
Ingersoll Rand	IR	$35.61	$33.43	$31.69	$14.31	1.12%
Gardner Denver	GDI	$45.27	$43.77	$34.73	$20.11	0.44%
United Technologies	UTX	$72.61	$68.84	$62.47	$41.36	2.32%
Donaldson	DCI	$45.35	$40.94	$36.20	$25.30	1.06%
SPX Corp	SPW	$60.94	$60.69	$62.99	$50.51	1.65%

United Technologies Announces 2009 Fourth-Quarter Earnings

United Technologies Corp. (NYSE:UTX) reported fourth quarter 2009 earnings per share of $1.15 and net income attributable to common shareowners of $1.1 billion, down 7% and 6%, respectively, over the year-ago quarter.

Consolidated revenues for the quarter of $14.1 billion were 5% below prior year, including 6 points of organic decline and 1 point of net divestitures, offset by 3 points of favorable foreign currency translation. Segment operating margin at 13.7% was 110 basis points higher than prior year. Cash flow from operations was $1.5 billion, including $637 million of global pension contributions. Capital expenditures were $325 million in the quarter.

Full year earnings per share of $4.12 and net income attributable to common shareowners of $3.8 billion declined 16 and 18%, respectively, from 2008 results. Revenues of $52.9 billion were 11% below prior year, including organic decline (7 points), adverse foreign currency translation (3 points) and net divestitures (1 point). Cash flow from operations was $5.4 billion and capital expenditures were $826 million.

"UTC closed the year with solid performance in the face of continuing difficult end markets," said Louis Chênevert, UTC Chairman & Chief Executive Officer. "Relentless focus on costs across the business contributed to strong margin expansion in the quarter. Strong working capital performance led full year cash flow from operations less capital expenditures to be 118% of net income attributable to common shareowners, including $1.3 billion of global pension contributions."

"Year over year order rates have remained stable, although at low levels, and we saw increases in some Asian economies, notably China," Chênevert continued. "While order rates will keep pressure on our top line, particularly in the first half of 2010, we anticipate that benefits from structural cost actions will allow us to deliver earnings growth of 7% to 13% with 2010 earnings per share of $4.40 to $4.65.

"We expect our usual standard of cash flow from operations less capital expenditures equal to or exceeding net income attributable to common shareowners in 2010. Our acquisition placeholder is $3 billion, including the GE Security transaction, and share repurchase is expected to be $1.5 billion," Chênevert added.

Share repurchase in the quarter was $320 million and totaled $1.1 billion for the year. Acquisition spending was $703 million for the year with $146 million in the fourth quarter.

SPX Announces 2009 Fourth-Quarter Earnings

SPX Corporation (NYSE:SPW) reported results for the fourth quarter and year ended December 31, 2009:

Fourth-Quarter Highlights:

Revenues decreased 12.1% to $1.32 billion from $1.51 billion in the year-ago quarter. Organic revenues* declined 16.7%, while completed acquisitions and the impact of currency fluctuations increased reported revenues by 0.4% and 4.2%, respectively.

Segment income and margins were $168.6 million and 12.7%, compared with $226.6 million and 15.0% in the year-ago quarter.

Net cash from continuing operations was $225.9 million, compared with $257.7 million in the year-ago quarter. Free cash flow from continuing operations during the quarter was $192.8 million, compared with $217.6 million in the year-ago quarter.

Full Year 2009 Highlights:

Revenues decreased 16.9% to $4.85 billion from $5.84 billion in 2008. Organic revenues declined 14.5%, while completed acquisitions and currency fluctuations impacted reported revenues by 0.2% and 2.6%, respectively.

Segment income and margins were $587.1 million and 12.1%, compared with $800.3 million and 13.7% in 2008.

Net cash from continuing operations was $461.6 million, compared with $407 million in 2008. Free cash flow from continuing operations was $368.8 million, compared with $290.6 million in 2008. The increase in cash flow was due primarily to improved working capital performance and lower capital expenditures, which more than offset lower earnings and increased spending on restructuring.

"The challenges of the global recession resulted in weaker market demand in 2009. Faced with these challenges, we focused our efforts on operating execution, reducing our cost base and maintaining strong liquidity, while at the same time continuing to invest in new product development and global expansion," said Christopher J. Kearney, Chairman, President and Chief Executive Officer of SPX. "We believe these actions have us better positioned for growth when economic conditions improve and our markets recover.

"Our primary technologies today support three critical components of modern societies: electricity; processed foods and beverages; and vehicle service," Kearney added. "Our focus on these end markets, particularly in emerging regions of the world, has been key to our success in recent years, and we believe the fundamental drivers behind the continued expansion of these markets point toward positive long-term growth for SPX moving forward."

WALL STREET WATCH

SPX Financial Highlights — Continuing Operations

Flow Technology Revenues for the fourth quarter of 2009 were $437.9 million compared to $479.1 million in the fourth quarter of 2008, a decrease of $41.2 million, or 8.6%. Organic revenues declined 14.5%, driven by softness across all of the segment's key end markets.

Segment income was $62.7 million, or 14.3% of revenues, in the fourth quarter of 2009 compared to $71.2 million, or 14.9% of revenues, in the fourth quarter of 2008.

Test and Measurement Revenues for the fourth quarter of 2009 were $219.2 million compared to $250.3 million in the fourth quarter of 2008, a decrease of $31.1 million, or 12.4%. Organic revenues declined 16.7%, driven primarily by the continued difficulties being experienced by vehicle manufacturers and their dealer service networks.

Segment income was $19.4 million, or 8.9% of revenues, in the fourth quarter of 2009 compared to $18 million, or 7.2% of revenues, in the fourth quarter of 2008.

Thermal Equipment and Services Revenues for the fourth quarter of 2009 were $488.2 million compared to $497.1 million in the fourth quarter of 2008, a decrease of $8.9 million, or 1.8%. Organic revenues declined 7.7% in the quarter, driven primarily by project timing for cooling systems and lower demand for seasonal heating products.

Segment income was $63 million, or 12.9% of revenues, in the fourth quarter of 2009 compared to $70 million, or 14.1% of revenues, in the fourth quarter of 2008.

Industrial Products and Services Revenues for the fourth quarter of 2009 were $178.8 million compared to $279.3 million in the fourth quarter of 2008, a decrease of $100.5 million, or 36%.

Segment income was $23.5 million, or 13.1% of revenues, in the fourth quarter of 2009 compared to $67.4 million, or 24.1% of revenues, in the fourth quarter of 2008. BP

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