The Magazine for ENERGY EFFICIENCY in Compressed Air, Pneumatics, Blower and Vacuum Systems

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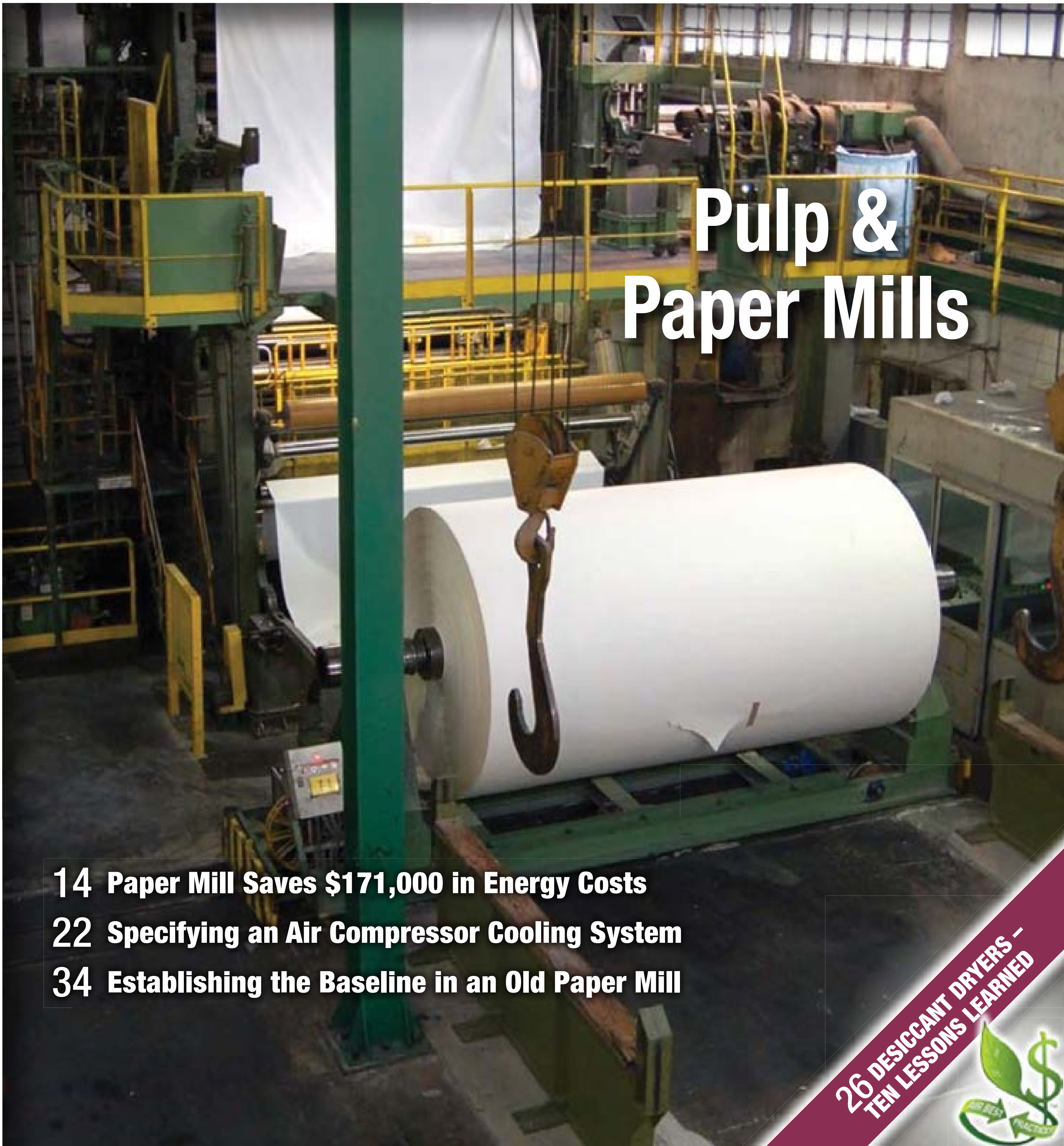
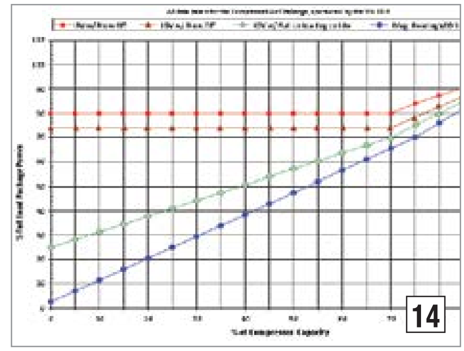
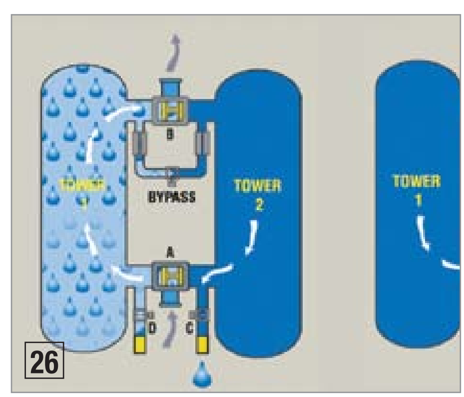


Pulp & Paper Mills

SUSTAINABLE MANUFACTURING FEATURES



COLUMNS



FROM THE EDITOR | Pulp & Paper Mills

The first system assessment article this month is titled, "Paper Plant Saves $171,000 in Energy Costs." This paper plant was built twenty years ago and spends $307,000 annually on energy to operate the compressed air system powered by two Joy three-stage centrifugal air compressors. The story is a simple example of how new air compressor and desiccant dryer technology can significantly reduce energy consumption.

Air compressors require cooling. Bruce Williams, from Hydrothrift Corporation, provides us with a solid article titled, "Specifying an Air Compressor Cooling System." What information is required to appropriately specify a correctly sized cooling system? The article reviews a sizing scenario for a 200 brake horsepower air compressor using a closed-loop cooling system.

"Desiccant Dryers-Ten Lessons Learned," is the latest contribution from Ron Marshall on behalf of the Compressed Air Challenge®. Compared to refrigerated air dryers, the cost of operation of heatless desiccant dryers is fairly expensive, therefore their use should be carefully considered. According to this article, refrigerated dryers consume about 0.8 kW per 100 cfm of dryer rating — including the compressor power required to compensate for the pressure differential across the dryer. Heatless desiccant dryers consume about 15 to 20 percent of their rating in purge air. This means 15 to 20 cfm of purge per 100 cfm dryer rating. If the compressed air is generated at an average specific power of 20 kW per 100 cfm at the compressor, the cost of the purge air is about 3 to 4 kW per 100 cfm of dryer nameplate rating. Add to this the cost for the pressure differential of the dryer and associated filters, and the cost becomes 3.5 to 4.5 kW per 100 cfm at full load. This is 4 to 6 times the cost of refrigerated dried air.

The second system assessment article reviews a paper mill spending $1.7 million annually on energy to operate their compressed air system. Veteran compressed air auditor, Hank van Ormer, provides us with an article titled, "Establishing the Baseline in an Old Paper Mill." This story provides readers with a nice example of the detail required to get a proper understanding of what is happening with the air compressors in your plant — before any changes are made or recommended.

Thank you for your support and for investing in ***Compressed Air Best Practices®***.

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INDUSTRY NEWS & SUSTAINABILITY REPORTS

Atlas Copco Compressors Adds HTE Technologies to Midwest Distributor Roster

Atlas Copco Compressors is partnering with HTE Technologies, a leading industrial products and services distributor, to offer its energy efficient compressed air system solutions to over 2,000 industrial customers across Missouri and Illinois.

"Our new partnership with HTE Technologies enables us to extend our reach and continue to satisfy the demand for energy efficient and sustainable compressed air solutions in the Midwest region," said John Brookshire, president, Atlas Copco Compressors. "This is an exciting partnership because both Atlas Copco and HTE Technologies are committed to increasing energy savings for customers."

As a result of this partnership, HTE's customer base will have access to Atlas Copco's portfolio of compressed air products and technologies and its advanced in-house and field support services, energy savings systems design and control and remote monitoring program. HTE will continue to provide its customers with compressed air system equipment engineering, installation, parts inventory and service support in their designated territory.

"We pride ourselves on understanding our customer base and providing products and services that are energy efficient, reliable, environmentally-conscious and delivered on time," said Kim Shearburn, president, HTE Technologies. "Our new partnership with Atlas Copco will allow us to consistently ensure that we exceed our customers' expectations in energy savings and service solutions with every compressed air system purchase."

HTE Technologies is headquartered in St. Louis, Mo., and includes a 12,000 sq.-ft. service, fabrication and testing center. HTE also staffs a 4,000 sq.-ft. service center and warehouse in Decatur, Ill. Its core markets include industrial manufacturing and process industries including aerospace, automotive assembly, medical, pharmaceutical, chemical, food and the energy sector.

Visit www.htetechnologies.com

Atlas Copco Compressors is part of the Compressor Technique Business Area, and its headquarters are located in Rock Hill, S.C. The company manufactures, markets, and services oil-free and oil-injected stationary

"Our new partnership with HTE Technologies enables us to extend our reach and continue to satisfy the demand for energy efficient and sustainable compressed air solutions in the Midwest regions."

— John Brookshire, president, Atlas Copco Compressors

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air compressors, air treatment equipment, and air management systems, including local manufacturing of select products. Atlas Copco Compressors has major sales, manufacturing, production, and distribution facilities located in California, Illinois, Massachusetts, North Carolina, South Carolina, and Texas.

Visit www.atlascopco.us

BOGE Opens New Plant in Germany

BOGE opened its new plant in the presence of the German Federal Minister of the Interior Dr Thomas de Maizière MdB, Saxony's Minister for Economic Affairs Sven Morlok, the Mayor of Grossenhain Burkhard Müller and other guests. In his address, the Federal Minister of the Interior, de Maizière, acknowledged the importance of medium-sized companies for the German economy as a whole: "The opening of the new BOGE production plant in my constituency is a pleasing and encouraging event for me — I feel honoured to be here. We know that a strong economy forms the basis of our prosperity. Germany's strength lies in our many small and medium-sized businesses and our successful industry. Manufacturing industries, which now also include BOGE in Grossenhain, support the overall economic growth. And the federal government will continue to reliably provide the right framework conditions for businesses."

When searching for a new production location, the choice of Germany as the country of manufacture for BOGE was never questioned: "Made in Germany" is one of our quality attributes in worldwide competition and is often a purchasing criteria for our customers", explained Director Wolf D. Meier-Scheuven at the opening of the ceremony.

From left to right: Matthias Dues, BOGE Komponenten Production Manager, Thorsten Meier, BOGE Director, German Federal Minister of the Interior Dr. Thomas de Maizière MdB, State Minister Sven Morlok, Wolf D. Meier-Scheuven, BOGE Director, Arndt Steinbach, Meißen District Administrator, Michael Rommelmann, BOGE Komponenten Director, Bodo Finger, President of the Saxony Business Association and Burkhard Müller, Mayor of Grossenhain

After careful deliberation, the choice was made in favour of Grossenhain. “Saxony lies at the centre of Europe. Our new production location puts us closer to customers in the eastern regions of Germany and in the whole of Eastern Europe, where we aim to further expand our market position.”

Sven Morlok, Saxony’s Minister for Economic Affairs Labour and Transport, extended a warm welcome to BOGE and emphasized the importance of the choice of location for the State of Saxony: “With BOGE, a renowned, international company has decided in favour of Saxony. This speaks for the Free State of Saxony as a business location. Technologically oriented companies such as BOGE, which pursue continued growth from here, secure the future viability of Saxony and make an important contribution to ensuring that the Free State remains at the forefront of business and technology, both now and in the future.”

BOGE has already invested around twelve million euros in setting up the new production plant — the largest single investment in the history of the company. In the 4,500 square metres of new production and assembly areas, BOGE is commissioning ultramodern manufacturing technologies, such as the high-tech machining centres for automated production processes. Amongst other products, the Grossenhain plant produces the core component of the company’s compressors: the BOGE effilence airend. “Due to the high number of orders, we are delighted that the entire manufacturing system in Grossenhain is now complete and we can begin production”, says Meier-Scheuven.

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14 members of staff are currently working in the production plant. By October this year, the company will have doubled the number of staff and will be operating in shifts. As in the headquarters in Bielefeld, BOGE will be training staff at the new location too: Two machinist apprenticeship positions must be filled in Grossenhain by 1 August this year. The Mayor, Burkhard Müller, also took an optimistic view of the future during the ceremony: "BOGE and Grossenhain — this partnership has great potential. I have the feeling that what belongs together has been brought together here."

BOGE KOMPRESSOREN Otto Boge GmbH & Co. KG is one of the world's leading suppliers of compressors and compressed air systems. Defying the trend within the industry, BOGE was able to increase sales again in 2013 and to start the new year with a promising situation regarding orders. "We believe that our success in Germany and abroad is primarily based on our capacity for innovation and on the high quality standards of our products", explained Meier-Scheuven. BOGE attaches particular importance to the subject of energy efficiency. For this reason, the company is constantly striving to optimize its existing portfolio and to introduce new, innovative products with the highest level of efficiency to the market. This also applies to the new plant in Grossenhain, as Meier-Scheuven affirms: "The BOGE effilence airend that we produce here far surpasses the quality standard of the previously purchased models, because it has a longer service life and is quieter and more energy efficient."

Visit www.boge.com/us

Iowa Fluid Power Named a Festo Distributor

Festo has named Iowa Fluid Power, Cedar Rapids, Iowa, its newest product distributor. Founded in 1974, Iowa Fluid Power (IFP) is a leading Midwest distributor and integrator of motion control and fluid power solutions. The company will represent the complete product offering of Festo to the IFP customer base in Iowa, Kansas, Nebraska, and Texas, as well as selected counties in western Illinois and Missouri.

"We maintain an on-the-shelf inventory of more than $5 million of hydraulics, pneumatics, electronics, and motion control components at three stocking locations in the Midwest," said Don Kaas, CEO and founder of Iowa Fluid Power. "We are excited to now include Festo's high quality, innovative products and to feature Festo as our technology partner."

In addition to IFP's highly skilled sales staff, the company employs 17 engineers. IFP's unique approach offers a greater level of

design, documentation, and state-of-the-art solutions to meet its customer's needs.

For more information on Festo, call 800-993-3786 and visit http://www.festo.com/us

Visit http://www.ifpusa.com for more information on IFP.

New Public CNG Station Opens in Orlando

Officials from the city of Orlando and state of Florida joined representatives of ampCNG, Trillium CNG and Frito-Lay North America in a ribbon-cutting ceremony at the new fast-fill compressed natural gas (CNG) station located at 2920 Silver Star Road in Orlando.

The station is located at Lewis Petroleum's Silver Star Fuelman in the Princeton Industrial Park, just two blocks from Frito-Lay North America's Orlando plant. Frito-Lay selected Trillium CNG to build natural gas infrastructure to fuel its fleet of CNG tractor-trailers.

The amp Trillium station will be open 24 hours a day, seven days a week. It will have two dual-hose dispensers, allowing two semitrailers to fuel at the same time. The station also features Trillium CNG's 10 GGE per minute fast-fill hydraulic intensifier compressor.

"We're committed to supporting Frito-Lay's North America's CNG fueling infrastructure build-out plan. This station has the added

benefit of providing 24/7 CNG fueling for heavy-duty trucking in the area due to the station's proximity to Interstate 4 and the East-West Expressway," said Mary Boettcher, president, Trillium CNG.

"This CNG station in Orlando is an important addition to our CNG network across the U.S.," said Nate Laurell, CEO of ampCNG. It connects

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southern Florida to CNG infrastructure throughout the southeast, creating an opportunity for local and regional fleets to realize the economic and environmental benefits of CNG."

About amp Trillium, LLC

Amp Trillium is a joint venture between ampCNG and Trillium CNG formed in 2012 to build a network of CNG stations across the U.S. to serve the commercial trucking industry.

About Trillium CNG

Trillium CNG is a leading provider of CNG to fleets, and also offers complete facility design, construction, operation and maintenance services. Our focus is on fueling heavy-duty fleets that require high-performance solutions. For more information, visit www.TrilliumCNG.com. Trillium CNG is a business unit of Integrys Energy Group Inc. (NYSE: TEG).

About Integrys Energy Group, Inc.

Integrys Energy Group, Inc. is a diversified energy holding company with regulated natural gas and electric utility operations (serving customers in Illinois, Michigan, Minnesota and Wisconsin), an approximate 34 percent equity ownership interest in American Transmission Co. (a federally regulated electric transmission company), and nonregulated energy operations.

For more information, visit www.integrysgroup.com

About ampCNG

ampCNG, the Chicago-based energy company focused on displacing liquid fuels with CNG, builds and owns CNG fueling stations for long-haul truck fleets and finances leases for CNG trucks. ampCNG operates the largest US renewable natural-gas plant that produces fuel from cow manure. The company is a member of the Department of Energy's National Clean Fleets Partnership tasked with reducing the nation's dependency on imported oil.

For more information, call (312) 300-6700 or visit www.ampCNG.com.

Xebec Announces New U.S. Operation and New Executives

Xebec Adsorption Inc., a provider of biogas upgrading, natural gas, field gas and hydrogen purification and filtration solutions for the clean energy and crude-derived fuels displacement markets, is pleased to announce its expansion into the US with a Houston, Texas, office and dedicated Senior Management Team.

Mr. Parag Jhonsa joins Xebec Canada as Corporate Vice President, Business Development, and President of Xebec Adsorption USA. Mr. Jhonsa brings over 20 years of experience in the energy field in operations, QHSE, business development, engineering, and project and production management. Prior to joining Xebec, Parag was President and General Manager with ProSep USA Inc. where he led the business unit that provided the oil and gas industry with custom-engineered process equipment system solutions for oil, gas, and water processing and purification. Parag holds both a Bachelor's and Master's degree in Chemical Engineering.

Mr. Gary Blizzard joins Xebec Canada as Corporate Vice President, Sales, and Vice

President, Business Development and Process Engineering for Xebec's U.S. operation. Gary has over 25 years of diverse experience in the energy industry in the areas of international business development, marketing, engineering, and project management. In his last position as Executive Vice President of Process Engineering & Product Development with ProSep, he provided strategic guidance for the worldwide process engineering team. Prior to that, Gary was Vice President, Marketing & Business Development at NATCO Group, where he provided leadership for growth in specialized gas treating technology. He holds a Bachelor of Science in Chemical Engineering from Texas A&M University and a Master of Business Administration from The University of Texas in Austin.

Building strength on strength, Xebec is also pleased to welcome **Dr. Peter Cheng** who joins Xebec Adsorption (Shanghai) Co. Ltd. as General Manager. Over the past 20 years, Dr. Cheng has held various executive positions with ABB, Ontario Power Generation, Hong Kong and China Gas Investment Limited, as well as A.T. Kearney, developing expertise in the fields of energy business development, strategic planning, and engineering and operations improvement. He holds a Ph.D. in mechanical engineering and an MBA, majoring in finance and strategy. Dr. Cheng is a professional engineer in Ontario, a qualified senior engineer in China, a member of the American Society of Mechanical Engineers, an advisor to the Enterprise Management Committee of the China Gas Association, and an expert in the category of foreign technology and economy in China.

"We are delighted to welcome these senior executives at this pivotal point in Xebec's history, as we turn the corner from right-sizing and restructuring toward sustainable profitability" stated Mr. Kurt Sorschak, Chief Executive Officer of Xebec. "Their track records for generating exceptional results will go a long way to help Xebec solidify its future as a successful and growing clean energy company".

About Xebec Adsorption Inc.

Xebec Adsorption Inc. is a global provider of clean energy solutions to corporations and governments looking to reduce their carbon footprints. With more than 1,300 customers worldwide, Xebec designs, engineers and manufactures innovative products that transform raw gases into marketable sources of clean energy mainly used as transportation fuel. Xebec's strategy is focused on establishing leadership positions in markets where demand for biogas upgrading, natural gas dehydration, liquefaction and hydrogen purification and filtration is growing. Headquartered in Montreal (QC), Xebec is a global company with two manufacturing facilities in Montreal and Shanghai, as well as a sales and distribution network in North America and Asia. Xebec trades on the TSX under the symbol XBC.

For additional information on the company and its products and services, please visit the Xebec web site at www.xebecinc.com

To read more ***Industry News*** articles, visit www.airbestpractices.com

THE COMPRESSED AIR SYSTEM ASSESSMENT

Paper Plant Saves $171,000 in Energy Costs

By Don van Ormer, Air Power USA

This paper plant currently spends an estimated $307,337 annually on energy to operate the compressed air system at its plant located in the southeastern U.S. This figure will increase as electric rates rise from their current average of 5.26 cents per kWh.

Based on the air system operating 8,760 hours per year, the group of projects recommended below could reduce these energy costs by an estimated $170,718 or 56% of current use. In addition, these projects will allow the plant to have a back-up compressor and help eliminate the rental expenditure for compressor maintenance or downtime.

Estimated costs for completing the recommended projects total $307,600. This figure represents a simple payback period of 21.6 months. Savings estimates depend, in part, upon the capabilities of the compressor capacity control system in order to translate reductions in air use into lowered electric costs. The current system is not equipped with this type of compressor unloading controls when activated. With the facility's current piping system, the new controls, turndown capability will be able to accomplish this electricity savings goal.

Current System Background

This paper plant was built approximately twenty years ago. The plant currently operates 8,760 hours per year, except for short shutdowns for maintenance. The compressors were installed at that time along with the dryers and filters. There is one main system split into two separate systems, mill air and instrument air.

The instrument air system is dried with an Airtek model TW 1500 heatless desiccant dryer while the mill air system is not dried. The Airtek dryer uses 15% of its rated flow equaling 225 scfm for regeneration of the wet tower.

Project #1: Install a New Centrifugal Air Compressor

The two air compressors are Joy models TA-18 450 hp class units producing around 2,000 scfm at 105 psig. Each one is a 3-stage, water-cooled centrifugal air compressor with inlet guide vanes (IGV) for unloading and blow-off piped to the outside. Currently both compressors are operated to meet plant

PROJECT	SAVINGS PROFILE	ENERGY AND OTHER SAVINGS			TOTAL PROJECT COST ($)
		AVG KW	KWH	SAVINGS ($)	
AIR COMPRESSOR SUPPLY					
1. Install new 450-hp, 3-stage centrifugal with IGV control; Place one existing in back-up. (after air savings projects are complete)	37% gain in efficiency	169	1,480,440	$77,781	$225,000 Estimated
CAPACITY CONTROL					
2. Lower discharge pressure on new compressor to 100 psig	This is not an energy savings project, but will allow an additional 50 scfm and 6 horsepower less.				—
AIR TREATMENT					
3. Install new 1,500 scfm rated external heated desiccant dryer to reduce the amount of purge air needed	120 scfm	49.38	432,569	$15,468	$55,800 Estimated
4. Replace 15 timer activated drains with level-actuated type	45 scfm	13.16	115,305	$5,801	$7,500
DEMAND-SIDE SYSTEM					
5. Repair 168 compressed air leaks identified by Envision Energy	556 scfm	162.6	1,424,376	$71,668	$19,300
TOTAL	**721 scfm**	**364.5**	**3,452,690**	**$170,718 per year**	**$307,600**

THE COMPRESSED AIR SYSTEM ASSESSMENT | Paper Plant Saves $171,000 in Energy Costs

COMPARISON OF CURRENT AND PROPOSED COMPRESSOR RATINGS OEM ENGINEERING DATA

MANUFACTURER	EXISTING JOY		PROPOSED CAMERON
Model	TA 18	TA 18	TA 3000 450 – 125
Unit Type	3-stage Centrifugal	3-stage Centrifugal	3-stage Centrifugal
Type of Cooling	Water	Water	Water
Full Load Nominal Published BHP	450	450	450
Full Load Pkg Horsepower (input)	554	558	445
Full Load Motor Efficiency (me)	.90	.90	.95
Full Load Rated Pressure (psig)	125	125	125
Full Load (input) kW @ rated psig: Calculated	460	463	349
Total Input FL kW	460	463	349
Full Load Flow (scfm)	1,976	1,991	1,940
Full Load Nominal Set Point (psig)	106	106	106
Type of Capacity Control	IGV OL/OL	IGV	IGV
Pressure Control Band	99-106	106	106
Turn Down Air Flow %	7.2	5	32.5
Turn Down Air Flow/% (scfm)	1,833	1,892	1,309
Turn Down Power kW / 98%	451	460	283
Idle kW	50	50	40
Full Load Specific Power (scfm/kW)	4.29	4.30	5.56
Annual Electric Cost ($/cfm) Full Load	$107.26	$107.15	$82.89

Based upon blended electric rates of $0.0526 per kWh and operating 8,760 hours per year.

demand with one near full load and the other operating on dual control. This control allows the unit to unload and come to idle. Currently both of the water-cooled after-coolers are tied together on the inlet and discharge side. The compressors draw 460 kW at full load producing 1,976 scfm for unit #1 and 1,991 scfm for unit #2.

Project #1 Summary

Replace the existing compressors with a more efficient unit. After the air savings and dryer projects are complete, install a new 450 hp, 3-stage centrifugal compressor with approximately 30% turndown to allow for efficient turndown without significant blow off. For example we used a Cameron model TA 3000, 3-stage compressor.

Electric demand of current air compressor with reduced demand	452 kW
Annual hours of operation for current unit (new conditions)	8,760 hrs/yr
Annual energy cost of current unit	$208,270 /yr
Electric demand of proposed compressor	283 kW
Annual energy cost of proposed unit	$130,399 /yr
Annual energy savings	$77,871 /yr
Estimated equipment and installation cost for new compressor	$225,000

Project #2 — Replace Heatless With a Heated Desiccant Air Dryer

Currently only the Instrument Air system is dried through an Airtek model TW 1500 heatless desiccant dryer. According to plant flow data, an average of 1,100 scfm goes to the Instrument Air system, while an average of 193 scfm with sustained peaks of 600 scfm for extended periods of time. The sustained spikes in the Instrument Air flow are between 1,400 and 1,500 scfm. During our site visit we observed the measured dewpoint of -38 ˚F; plant specification is -40 ˚F.

Project #2 Summary

Add a more efficient compressed air dryer. Install a new 1,500 scfm rated external heat dryer for the Instrument Air system. This will allow for reducing the purge air demand from 15% to 7% rated flow saving 120 scfm. With a dewpoint demand controller installed, the cycle time between the tower switch can be extended, with the possibility of not switching for several hours past the normal four hour cycle. This time period will vary depending on the moisture intake to the compressor.

Current annual operating cost of AirTek dryer	$29,003/yr
Total compressed air savings	120 scfm
Recoverable energy savings from air flow reduction	$128.90 cfm/ yr
Total annual electrical energy savings from air reduction	$15,468/yr
Electrical energy cost to operate proposed dryer	$6,220/yr

Project #3 — Replace All Timer Drains With No Air-Loss Level-Activated Drains

Dual-Timer Electronic Drains use an electronic timer to control the number of times per hour they open and the duration. In theory the frequency should be adjusted to ensure that condensate drains open fully and that the open time without water is minimized because compressed air is wasted. But in reality, cycles often aren't reset from original factory settings, resulting in condensate build-up during the summer and being set wide open during cooler weather. When they fail in "open position", they blow at a full flow rate of about 100 cfm.

THE COMPRESSED AIR SYSTEM ASSESSMENT | Paper Plant Saves $171,000 in Energy Costs

COMPARISON OF CURRENT AND PROPOSED DRYERS		
	CURRENT	PROPOSED
MANUFACTURER	AIRTEK	AIRTEK
Model	TW 1500	TWP 1500
Unit Type	Desiccant Heatless	External Heat Desiccant
Rated Flow @ 100 ºF / 100 psig / 100 scfm	1,500	1,500
Purge air scfm	225	105
Full Load Heater kW	N/A	18
Total Full Load kW	N/A	18 x .75 = 13.5
% Load w/ Dew Point Demand Control (optional)	100	100
Net Electric Demand (kW)	N/A	13.5
Net Purge Air Used	225	105
Annual $/scfm	$128.90	Calculated in compressor operating cost.
Annual purge costs	$29,003	
Annual electrical energy costs	--	$6,220
Total Annual Operating Cost ($)	$29,003	$6,220

Based upon a blended electric rate of $0.0526 per kWh and operation of 8,760 hours per year.

Consider, for example, that the usual "factory setting" is 10 minutes with a 20-second duration. Some 1,500 scfm of compressed air will generate about 63 gallons of condensate a day in average weather or 2.63 gallons per hour. Each 10-minute cycle will have 0.44 gallons to discharge. This will blow through a 1/4-inch valve at 100 psig in approximately 1.37 seconds. Compressed air will then blow for 18.63 seconds each cycle, 6 cycles per hour, which will total 111.78 seconds per hour of flow or 1.86 minutes per hour of flow. A 1/4-inch valve will pass about 100 cfm. The total flow will be 100 x 1.86 = 186 cubic feet per hour, or 186 * 60 minutes = 3.1 cu ft/min on average. This 3 cfm would translate into an energy cost of $300 per year based on a typical air flow cost of $100 per cfm per year.

The configuration and performance of the condensate drains in the plant's compressor area and in the distribution system do need to be modified. Fifteen condensate drains requiring replacement were identified.

Air flow (cfm) savings per drain (each)	3 cfm/yr
Total of number of drains	15
Total compressed air saved	45 cfm
Recoverable energy savings from air flow reduction	$128.90/ cfm yr
Total annual energy savings	$5,801 /yr
Cost per drain	$500 each
Cost of project	$7,500

> "This group of projects could reduce energy costs, at this paper mill, by an estimated $170,718 or 56% of current use."
>
> — Don van Ormer, Air Power USA

Project #4 — Compressed Air Leak Survey

Air Power recommends an ultrasonic leak locator be used to identify and quantify the compressed air leaks. We use an Ultraprobe leak detector manufactured by UE Systems.

Shutting off or valving off the air supply to leaks when the area is idle would save significant energy use from leaks. Reducing the overall system pressure would also reduce the impact of the leaks, when air to the machine cannot be shut off. Repairing the leaks can save additional energy. The savings estimates associated with a leak management program are based on the unloading controls of the compressors being able to effectively translate less air flow demand into lower cost.

With a few minor exceptions, most leaks cannot be found without the use of an ultrasonic leak detector and a trained operator. Leak locating during production time with the proper equipment is very effective and often shows leaks that are not there when idle. However, a regular program of inspecting the systems in "off hours" with "air powered up" is also a good idea. In a system such as this one, some 80 to 90% of the total leaks will be in the use of the machinery, not in the distribution system.

Some of areas surveyed in a leak study include a great deal of high background ultrasound noise that shields many of the smaller leaks. In continuing the leak management program, plant staff should perform leak detection during non-production hours in order to eliminate some of the high ultrasonic background noise.

Project #4 Summary

Implement ongoing leak identification and repair program with ultrasonic leak locators. Repair the 168 compressed air leaks identified by Envision Energy.

THE COMPRESSED AIR SYSTEM ASSESSMENT |

Paper Plant Saves $171,000 in Energy Costs

LIST OF OPEN CONDENSATE DRAINS AND DUAL-TIMER DRAINS				
QUANTITY	DRAIN LOCATION	TYPE	(CFM)	% UTILIZATION
2	Comp #1 Intercoolers	Timer	6	100
2	Comp #2 Intercoolers	Timer	6	100
2	After cooler separators	Timer	6	100
4	AirTek Prefilters	Timer	12	100
1	Mill Air Receiver	Timer	3	100
*1	Instrument Air Receiver Column G21	Timer	3	100
*1	05 West Roll-up Door Column F1	Timer	3	100
1	Instrument Air Receiver	Timer	3	100
1	Column E- 9.1	Timer	3	100
1	Column F 36	Timer	3	100
1	Column C 42	Timer	3	100
Total: 17			51 cfm	

*Not included in savings calculations

Number of leaks	168 leaks
Estimated air flow of leaks identified	927 cfm
Proposed repair rate	60%
Estimated flow rate for savings calculations	556 scfm
Recoverable savings from air flow reduction	$128.90/cfm yr
Annual electric cost savings with proposed project	$71,668 /yr
Cost of leak detection equipment	$3,500
Unit cost of leak repairs	$15,800
Total project cost	$19,300

Conclusion

This group of projects could reduce energy costs, at this paper mill, by an estimated $170,718 or 56% of current use. In addition, these projects will allow the plant to have a back-up air compressor and help eliminate the rental expenditure for compressor maintenance or downtime. Estimated costs for completing the recommended projects total $307,600. This figure represents a simple payback period of 21.6 months. BP

For more information contact Don van Ormer, Air Power USA, tel: 740-862-4112, email: don@airpowerusainc.com, www.airpowerusainc.com

To read more ***Air Compressor Technology*** articles, visit www.airbestpractices.com/technology/air-compressors

SPECIFYING AN AIR COMPRESSOR COOLING SYSTEM

By Bruce Williams, Hydrothrift Corporation

There are several pieces of information that your cooling system specialist will need in order to properly engineer and build a cooling system for your new air compressor. There are many types of air compressors and each has different requirements of the cooling system in order to operate correctly. This article will take the mystery out of some of the terms and specifications for your cooling system.

In the previous article titled, "The Six Basic Types of Liquid Cooling Systems" (July 2013 Issue of Compressed Air Best Practices® Magazine), we gave a basic description of the different types of cooling systems and how they operated. This article will outline the basics of how one of those systems is employed to operate as an air compressor cooling system. We cannot possibly cover all of the variations of the different types of compressors nor how they are employed or how the location climate affects the operation of that compressor.

One Sizing Scenario

Therefore, we will choose one air compressor at a single location to give the reader an idea of what to provide to your cooling system specialist. For example: One 175 nameplate horsepower air compressor located in Scranton, PA. The building has a central open-cooling tower with an abundance of tower water available at a maximum temperature of 85 ˚F. Power is available at 460 Volts, 3 phase, 60 Hz. There is a compressed air dryer in the system that will work properly with 100 ˚F inlet air from the air compressor.

At this point we need an air compressor data sheet to continue with the specification of the cooling system. In this example, the compressor data sheet gives us the actual maximum Brake Horse Power of the compressor to be 200 BHP. We use this information to determine the maximum heat load. Converting the brake horsepower to Btu/hr equals 509,000 Btu/hr. This is our heat load for the air compressor, if everything is operating perfectly. Normally, a margin is added to the system to reduce the effects of fouling, piping heat gain, inefficiencies in the system and condensation. For this example the customer wants us to use 30%. We simply multiply the load by 1.3 and we now have a design heat load of approximately 662,000 Btu/hr.

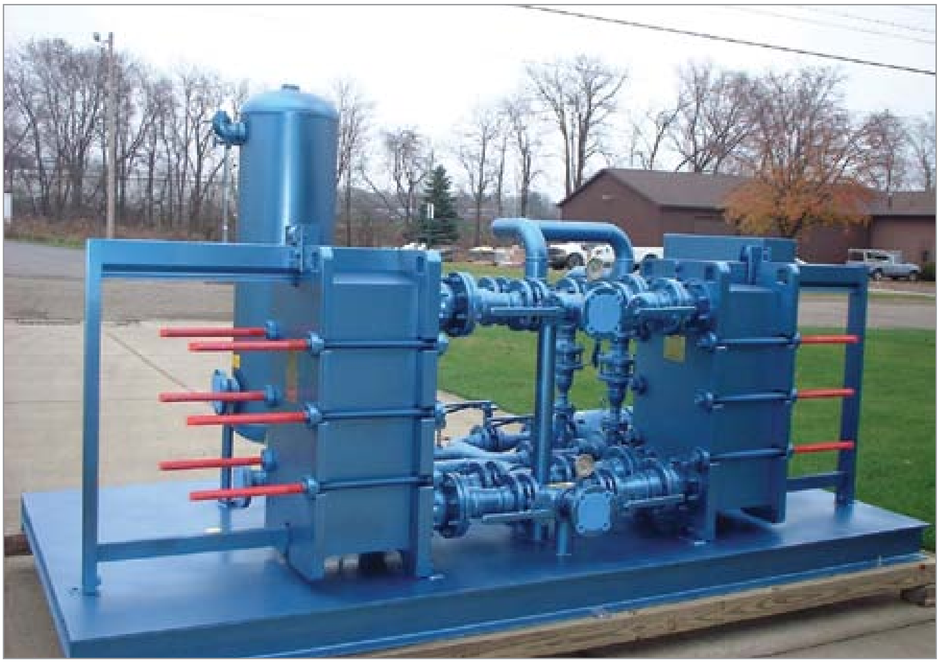
The compressor data sheet tells us that the cooling system inlet temperature approach to the outlet air temperature is 10 ˚F. This means that the outlet air temperature is regulated by the inlet cooling fluid temperature. Therefore, we need 90 ˚F coolant temperature to provide an outlet air temperature of 100 ˚F, a requirement for proper operation of the compressed air dryer. All of this can be achieved with a PCX (liquid to liquid) cooling system as discussed in our previous article.

A Closed-Loop System

The customer wants a closed-loop cooling system to prevent fouling of the heat exchangers in the air compressor from the dirty tower water. The PCX system is going to be located in a building that will remain heated and above freezing. This will allow us to use treated water on the closed loop side of the cooling system. From the data sheet we learn that the compressor can use 90 F water at a flow rate of 34 gpm, with a leaving water temperature of 120 F, and a total pressure drop across the compressor cooling circuit of 5 psid, at this flow rate. This flow rate was provided by the air compressor manufacturer based on the maximum heat load from the compressor. However, we have changed the heat load by adding a 30% margin to the load. We must now use the heat balance equation to determine the new flow for the compressor.

The heat balance equation tells us that the load equals the product of the change in temperature times the flow rate times the constant of the cooling fluid. (662,000 Btu/hr = (Delta Temperature in

SPECIFYING AN AIR COMPRESSOR COOLING SYSTEM



A PCX Closed-loop Cooling System

degrees ˚F) X (Flow Rate in gpm) X (Constant for 100% water)

In this case the constant for water is 500, our delta temp is 30 ˚F and our load is 662,000 Btu/hr. From this information we can easily derive the new flow to be a little over 44 gpm. Since we have changed the flow we will need to adjust the pressure drop across the compressor. The new pressure drop is the ratio of the new flow to the old flow squared and multiplied by the old pressure drop. Your cooling system specialist will use the new compressor pressure drop, the pressure drop across the customer engineered proposed piping, and the pressure loss in the newly

> "Selecting the correct pump is critical to successful operation of the cooling system. Special controls may be necessary to avoid water hammer effects for elevation changes over 25 feet, varying loads and long pipe runs."
>
> — Bruce Williams, Hydrothrift Corporation

proposed cooling system to determine the pump "head" required to provide the closed loop flow for the system.

Selecting the correct pump is critical to successful operation of the cooling system. Special controls may be necessary to avoid water hammer effects for elevation changes over 25 feet, varying loads and long pipe runs. Your cooling specialist will need to know the volume of the proposed engineered piping to properly engineer the expansion tank volume for expansion and contraction of the cooling fluid. In this example, treated water must contain lime scale and corrosion buffering agents and biocides to prevent rust and biological growth in the closed loop system.

Conclusion

The process of specifying a cooling system to correctly cool your air compressor is not difficult if the correct information exists to engineer the system. If the information is not available, then instruments need to be installed to measure flows, temperatures, and pressures to correctly assess the need. This is just one example of a cooling system selection process. There are other factors such as explosion-proof areas, coastal area corrosion, special power requirements and other items that will require additional engineering. If you are struggling with an existing application or have a new one, ask for help from your cooling system specialist. They have seen many applications and are familiar with many different styles of air compressors. In the end, the best cooling system is one that operates reliably and meets your needs. BP

For more information contact Bruce Williams, Hydrothrift Corporation, tel: 330-264-798, email: bwilliams@hydrothrift.com or visit www.hydrothrift.com

For more ***Cooling System*** articles, visit www.airbestpractices.com/technology/cooling-systems

DESICCANT DRYERS — TEN LESSONS LEARNED

By Ron Marshall for the Compressed Air Challenge®

KNOW PRESSURE COMPRESSED AIR CHALLENGE®

The Compressed Air Challenge training material for our Fundamentals of Compressed Air Systems seminar briefly covers a number of types of air dryers. One type of dryer seen frequently across the world is the regenerative desiccant dryer. These dryers have a number of characteristics that can affect their cost of operation and the operating of the associated compressors and can therefore affect the efficiency of the complete compressed air system.

Regenerative desiccant type dryers use a porous desiccant that adsorbs the moisture by collecting it in its myriad pores, allowing large quantities of water to be retained by a relatively small quantity of desiccant. Desiccant types include silica gel, activated alumina, and molecular sieves. In some cases, more than one desiccant type can be used for special drying applications. In most of these cases, a larger particle size (1/4" or more) is used as a buffer zone at the inlet, while

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— Ron Marshall

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a smaller particle size desiccant (1/8" to 1/4") is used for final drying. Where very low dew points are required, molecular sieve desiccant is added as the final drying agent. The most common dew point rating for these dryers is -40. While this level may be needed for sensitive processes or instrumentation, this level of dryness in not normally needed in general manufacturing unless the pipes are exposed to freezing temperatures.

Normally the desiccant is contained in two separate towers. Compressed air to be dried flows through one tower, while the desiccant in the other is being regenerated (Figure 1). Regeneration is accomplished by reducing the pressure in the tower and passing purge air through the desiccant bed. The purge air may also be heated, either within the dryer or externally, to reduce the amount of purge

DESICCANT DRYERS — TEN LESSONS LEARNED

air required. Heated purge air may also be supplied by a blower. Desiccant dryers all have a built-in regeneration cycle, which can be based upon time, dew point, bed moisture load or a combination of these.

All of these dryers have filtration on the inlet to keep water and oil from damaging and contaminating the desiccant. An additional filter on the outlet catches the desiccant dust that is generated from the constant movement of the desiccant beads against one another caused by flow of air through the dryer.

Compared to refrigerated air dryers the cost of operation of desiccant dryers is fairly expensive therefore their use should be carefully considered. Refrigerated dryers consume about 0.8 kW per 100 cfm of dryer rating including the compressor power required to compensate for the pressure differential across the dryer. Heatless desiccant dryers consume about 15 to 20 percent of their rating in purge air. This means 15 to 20 cfm of purge per 100 cfm dryer rating. If the compressed air is generated at an average specific power of 20 kW per 100 cfm at the compressor, the cost of the purge air is about 3 to 4 kW per 100 cfm of dryer nameplate rating. Add to this the cost for the pressure differential of the dryer and associated filters, and the cost becomes 3.5 to 4.5 kW per 100 cfm at full load. This is 4 to 6 times the cost of refrigerated dried air.

Over the years I have come to learn some important general lessons about desiccant dryers which I share here for the benefit of all:

Lesson 1 — Purge is based on nameplate rating

It is important to realize that the purge rating of an uncontrolled desiccant dryer is based on nameplate rating, not the amount of air flowing through it. The purge control is often simply an orifice or cracked open valve of some sort that allows a fixed flow of air from the pressurized side to the side being regenerated. The flow of air is not affected by the amount of air being dried in the air dryer unless there is some sort of dew point or moisture control. A properly sized dryer will be oversized to compensate for worst case conditions where excessive ambient and inlet temperatures are experienced at full load. Typically the average loading of the dryers is not at worst case conditions,

> "Heat regenerated desiccant dryers that are dew point controlled reduce their purge flow in proportion to moisture loading."
>
> — Ron Marshall

however, meaning a typical dryer will often be running at average flows that are lower than its nameplate rating. If, for example, the flow in a 1,000 cfm fixed cycle air dryer is only half its rating or 500 cfm, the purge flow will still be 15 to 20% of the nameplate rating or 150 to 200 cfm. This would mean the real purge would now be 30 to 40% of the average flow. At one quarter load the purge flow would be 60% to 80% of the average flow.

Lesson 2 — Sometimes the purge continues when compressor is off

If the dryer is operating on a fixed cycle with no dew point control and the associated compressor turns off for some reason, which stops the flow of compressed air through the dryer, the purge will often continue to be fed from other system compressors. This flow allows the purge cycle to continue uninterrupted, but once the desiccant has been regenerated an uncontrolled dryer will continue to consume purge air for no reason and waste significant amounts of compressed air even though there is no air flowing through it. In this case the efficiency of the dryer is very poor. If multiple dryers exist in this condition during low load periods the waste can be extreme.

Lesson 3 — Air dryers are often the biggest use of compressed air

When auditing a compressed air system it is very common to find that uncontrolled desiccant dryers represent the biggest use of compressed air in the plant. This is especially true for lightly loaded systems where the compressor and dryer are much larger than the actual average loading due to size mismatch or load characteristics. Recently an audit at a grain processing facility showed a very high flow of air when the plant was in not in production. Much effort was expended in looking for leaks and drainage only to find that the non-productive load was caused by a misadjusted heatless air dryer. Repair of the situation prevented the purchase of a larger compressor.

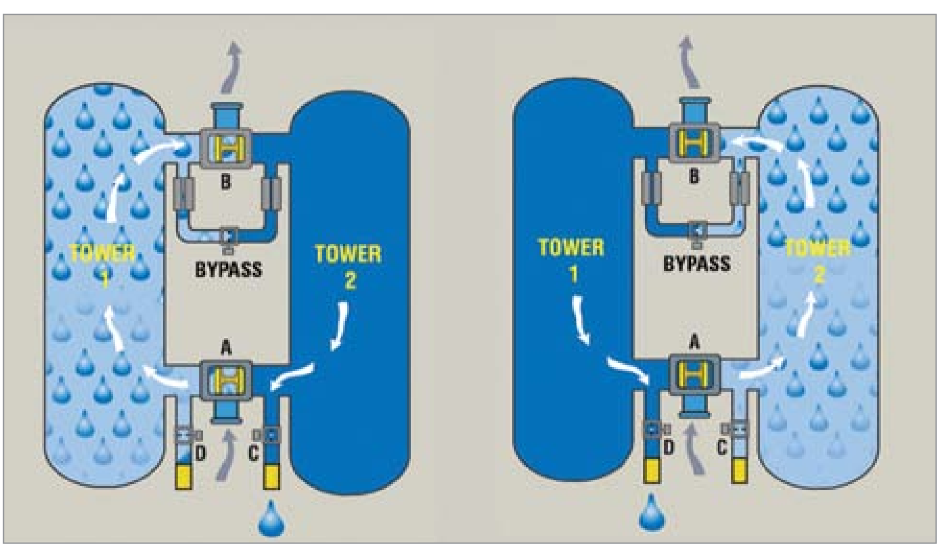

Figure 1: Operation of a heatless desiccant dryer.

DESICCANT DRYERS — TEN LESSONS LEARNED

Lesson 4 — Purge flows can change

The adjustment of the purge flow in a dryer is important. Often this is a manual adjustment that is done during a specific part of the dryer cycle. Many times the adjustment is simply the position of a ball valve based on the pressure reading on a gauge. Over time the ball valve can become misadjusted and the gauge can go out of calibration. The purge exhaust ports can plug causing a back pressure that can reduce the purge flow. Poor adjustment can lead to purge flows that are much higher than the rating of the dryer. Since there is typically no way of directly measuring the purge flow this wasteful higher flow is rarely detected. Regular testing is a good practice.

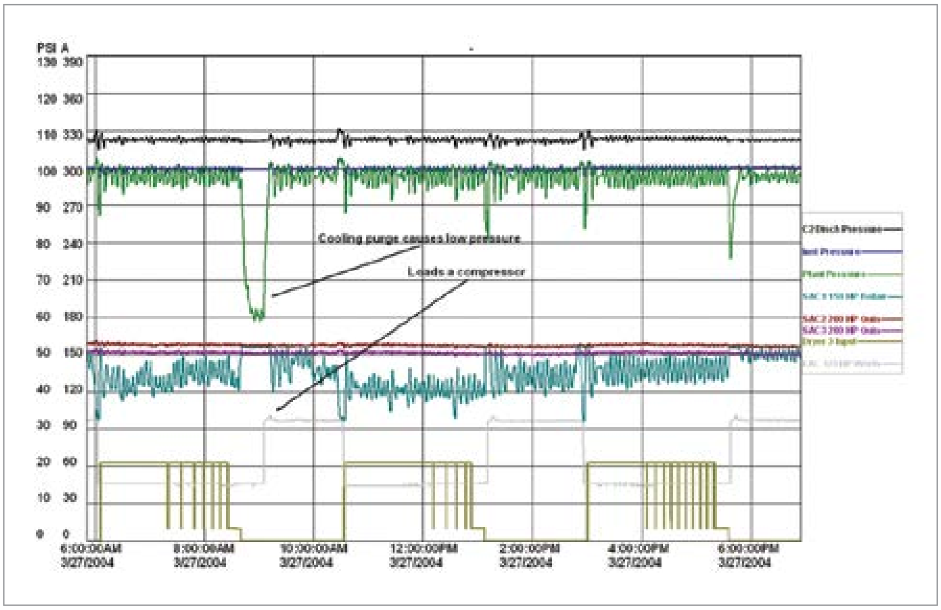

Chart 1: Cooling flow causes low pressure and an extra compressor to load

Recently, a seed cleaning plant purchased a used desiccant air dryer that used a fixed orifice style of purge flow metering. Once installed, the plant started experiencing pressure problems on a 10 minute cycle. An auditor was called in to assess the situation and found pressure dips every time the air dryer purged on its left side. Further investigation revealed that the orifice for the left side had been lost while the dryer was disassembled for transport.

Lesson 5 — Pressure effects purge

Due to numerous reasons some systems operate higher than 100 psi, sometimes much higher. If the dryer uses a fixed orifice, this higher pressure will cause the dryer to consume more that rated purge. Dryers running at higher pressures actually need less than rated purge. Manufacturers

DESICCANT DRYERS — TEN LESSONS LEARNED

can supply proper orifices for various rated pressures to reduce this wasteful flow for pressures other than 100 psi thereby saving purge cost.

Lesson 6 — Check the check valves

Some dryer designs have integrated check valves internal to the dryer. When this check valve is located downstream of the point where the purge flow is redirected to the regenerating side the air from the plant cannot get back to the dryer to maintain purge flow if the associate compressor unloads. This can have energy savings benefit if the associated compressor turns off, however, because the associated compressor now must exclusively feed the dryer purge this can cause compressor control issues. Where the dryer has a check valve and there is no large storage receiver between the compressor and the dryer a load unload compressor will rapid cycle. As soon as the compressor tries to unload the dryer will rob the compressor of its control signal, the check valve preventing back flow, and the compressor will immediately have to load up again. This can continue with the compressor inefficiently rapidly loading and unloading, even when there is no really system load on the compressor.

Lesson 7 — Dewpoint controls save

One way to ensure the purge flow stays at near 15 to 20 % of the actual dryer flow is to use dew point or loading controls on the dryer. These controls adjust the purge time of the dryer to ensure that all the desiccant is saturated before the flow of purge starts to regenerate the desiccant. This method of control sometimes has its problems as the typical designs allow the desiccant to both sides to saturate fully before the flow of purge is turned on. Since both sides need regeneration there are sometimes a cluster of multiple purge cycles that can cause additional air demand. This has prompted at least one manufacturer to put moisture probes part way up the towers to detect then the moisture front reaches a certain level, thereby leaving some active desiccant remaining to assist in the regeneration. Others simply use a watchdog timer that initiates a purge cycle every so many minutes no matter what. This type of system has limited turn down for light loads.

Of course the dew point control sensor is only as good as its calibration. At one paper plant the compressed air system operators checked and recorded the dew point value of their blower purge dryer every 2 hours. No matter what, the reading was a constant -120 ˚F, never changing. An auditor pointed out that there was water was pouring out of the dryer after-filter, yet the control said -120 ˚F. The sensor had become flooded and failed to the low reading, a test of the calibration would have prevented expensive downstream contamination of instrumentation.

Lesson 8 — Purgeless doesn't always mean purgeless

A big plus for heated blower style dryers is that they are purgeless dryers, they use heated ambient air to regenerate the desiccant, not expensive compressed air. But the desiccant in the dryer remains hot after the regeneration cycle, and hot desiccant does not dry the air. Since there isn't enough time to cool naturally in a standard four hour cycle, the desiccant is

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most often cooled using a flow of compressed air, not exactly purge, but a consumption of air just the same. Most manufacturers of this type of dryer rate this cooling flow at 2% of the nameplate rating of the dryer. In actual fact this 2% is often 8% over one hour of the 4 hour dryer cycle, which averages to 2%. This 8% can have major implications if there is not enough compressor capacity online to feed its flow.

Chart 1 shows the notching effect caused by this flow at a fertilizer plant. The flow caused low pressure in the facility every four hours unless a 125 HP compressor was kept running. This particular dryer was oversized at 4,000 cfm for future load, however, it was only drying the capacity of two 750 cfm air dryers. The cooling losses in this dryer were excessive. The dryer also had a glitch in its operating software that caused its cooling flow to operate for 1.5 to 2 hours rather than one hour if the heating cycle finished early due to low moisture load, increasing the compressed air waste even more.

Lesson 9 — Temperature and flow effects

The temperature of the inlet air affects the moisture loading on desiccant air dryers. For every 20 degrees ˚F drop in temperature the moisture content roughly reduces by half. Heatless desiccant air dryers are not affected by this reduction in moisture loading, so they don't save if the air temperatures are reduced. For very light loading this lack of moisture can actually cause heatless dryers to perform poorly. Heat regenerated dryers that are dew point controlled; on the other hand, reduce their purge flow in proportion to moisture loading. This can be used as an energy efficiency measure. In fact at least one manufacturer sells a hybrid dryer that uses this effect by placing a refrigerated air dryer on the front of the dryer and a heated desiccant style on the back end.

Lesson 10 — Filter differential costs energy

Because the desiccant is sensitive to oil and free water contamination there is usually a series of filters on the inlet and outlet of these dryers. Typically a particulate and coalescing combination is placed on the inlet and particulate on the outlet. When auditing these dryers this is a location that represents typically one of the biggest pressure differentials in the whole system. Where 5 to 7 psi exists across the dryer filter combination about 2 to 3 percent more compressor power is required to overcome this resistance.

Further to this the pressure differential can negatively affect compressor control and can cause rapid cycling of load/unload compressors, which can drive them to inefficient operating points on their curve, costing even more energy.

Selection of dual inlet filters can reduce this affect. Since pressure differential across filters varies with the square of the flow, the selection of parallel filters reduces the pressure differential to one quarter of the original value for a 75% reduction. BP

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THE COMPRESSED AIR SYSTEM ASSESSMENT

Establishing the Baseline in an Old Paper Mill

By Hank van Ormer, Air Power USA

This paper mill currently spends $1,747,000 annually on energy to operate the compressed air system at their plant located in the southwestern region of the U.S. The set of projects recommended, in this system assessment, could reduce these energy costs by $369,000 or twenty-one percent (21%). Estimated costs for completing the projects total $767,900, representing a simple payback of 25 months. More importantly, these projects will improve productivity, quality and maintenance costs — many associated with poor compressed air quality.

This pulp and paper plant runs three paper machines and is fully integrated, handling pulp production through finished product. The primary compressed air supply is handled by five 600-horsepower Elliott 3-stage, oil-free centrifugal compressors and one Atlas Copco 300 horsepower lubricated rotary screw unit. Compressed air dryers are either not present (Mill Air) or are an assortment of heatless desiccant air dryers for the Instrument Air section.

Due to space constraints, this article will show the reader the initial observations and measurements made by our team at this old paper

mill. The idea is to show the reader some of the information required to understand a large and aged compressed air system.

I. Observations on the Air Compressors

The main air system is composed of five 600 hp Elliott 3-stage centrifugal compressors. Ages range from 43 to 19 years old. There are two 1970 units, one 1980 unit, one 1988 unit, and one 1994 unit. These air compressors have been extremely durable and reliable over the years.

Additional compressed air supply comes from one of two electric motor-driven 350 hp class, two-stage, oil-free rotary screw units, which are currently being rented. There are four additional diesel engine-driven rotary screws are available for emergency use only. Normally, the plant runs on the five Elliott units and one of the two oil-free electric rentals along with the 300 hp lubricated rotary screw machine.

#1 CENTRIFUGAL (1970 UNIT)

- The water-cooled after-cooler has gotten worse since the May visit, note the high temperature rise in the water (30 ˚F) and yet the discharge air is 139 ˚F. This cooler is sized to deliver air at 10 ˚F over the entry cooling water (76 ˚F) equaling 86 ˚F. 100 ˚F is the critical temperature for air to enter any dryer to be within normal ratings.
  - Probable cause — low cooling water flow
  - Unit was in blow-off some of the time, but fully loaded most of the time

#2 CENTRIFUGAL (1970 UNIT)

- The water-cooled after-cooler on this unit is in the same situation as unit #1, except it seems to have a problem of greater magnitude.
  - Probable cause — low cooling water flow
- The second stage intercooler appears to not be cooling the air properly before going to the third stage. The inlet temperature to the third stage should be closer to 100 ˚F.
  - Probable cause: there are many things that could cause this, low cooling water flow is one of them.
- One of the intercooler drain valves is blowing water and air continually. This is not only a waste of compressed air (20 cfm = $2500/yr) but also creates a possible failure scenario. Since the water or condensate blows continuously and never seems to fully drain. We have **no idea** what the true condensate level really is. If the condensate level gets too high, water can travel to the next stage wearing or cracking the impeller and or diffuser. This may be a "cracked" or cut gate valve.
  - We also found other manual drain valves shut off. This is **very risky** for the same reason.
    - Recommendation: we suggest you install high quality, acid resistant, level activated electric or pneumatic activated automatic condensate drains on all of the Elliott inter and after cooler drains.
    - **Continued monitoring of the performance of these drains is mandatory in this State, if you are to run trouble free. This should be a highlighted part of the maintenance program.**
    - The drain issue applies to all the centrifugals.

"This paper mill currently spends $1,747,000 annually on energy. The set of projects recommended, in this system assessment, could reduce these energy costs by $369,000 or twenty-one percent."

— Hank van Ormer, Air Power USA

THE COMPRESSED AIR SYSTEM ASSESSMENT | Establishing the Baseline in an Old Paper Mill

- Unit #2 centrifugal has an intercooler gasket leak. This not only wastes air but also negatively affects efficiency.

#3 CENTRIFUGAL (1980 UNIT)

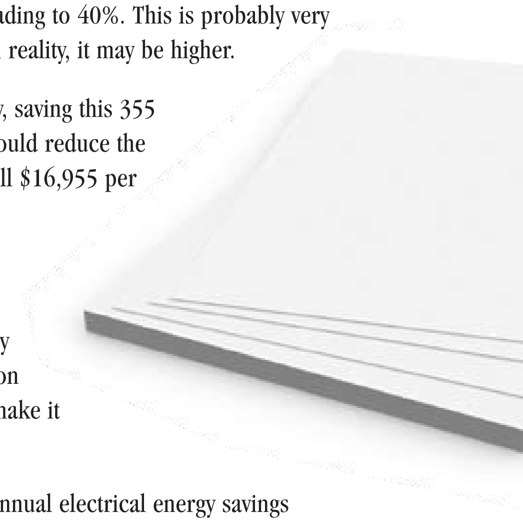
- Unit is not running at full load. It is at 90% of flow. The higher temperatures in the blow off line indicate either:
  - A Blow-off Valve (BOV) opening too soon
  - A leaking or non-seating BOV
- There is a major leak at an intercooler seal. There have been attempts to repair this with sealant — this will not work and needs to be repaired correctly.

#4 CENTRIFUGAL (1988 UNIT)

- Has a poorly performing 2nd stage intercooler. The third stage inlet temperature is 132 ˚F
- Water-cooled after-cooler separator and drains are not working at all, no water / no air. All water being condensed out is **staying in the system.**
  - See notes on automatic condensate drains under #2 Centrifugal.

#5 CENTRIFUGAL (1994 UNIT)

- Unit is pushed back into significant unload by the Atlas Copco unit #6.
  - Note: the IBV (inlet butterfly valve) is 100% open.
  - The BOV (blow off valve) is 18% open
  - The temperature of the third stage is only 143 ˚F (normally 225 – 275 ˚F). This may indicate a very low pressure at the impeller tips, as the air is moving rapidly through the BOV.
  - The temperature of the blow off line is 179 ˚F (room temperature 80 ˚F). This indicates a high volume flow of **bypassed air** to reach this temperature.
  - **Bypassed air: you paid to compress it but it does not go into the system (146 scfm).**
- This unit has 15% turndown. This means the flow should be reduced 15% (355 scfm) by the IBV closing and reducing the power draw commensurately. At the end of this travel, the BOV should begin to open. **There is no energy savings at all for the reduced flow.**
- Today the BOV is opening with the IBV at full open. Air blows off, the power is still at full load. We have estimated the unloading to 40%. This is probably very conservative and in reality, it may be higher.
- At today's efficiency, saving this 355 cfm (27.67 kW) would reduce the electrical energy bill $16,955 per year.
- Recommended Project: Repair / realign as necessary inlet control valve on # 5 centrifugal to make it operate properly.
  - 27.67 kW — Annual electrical energy savings equal $16,955/yr.



> "The strategy, of this project, will be to consolidate the air compressors into one location and reduce the use of rental compressors where possible."
>
> — Hank van Ormer, Air Power USA

COMPARISON OF CURRENT AIR COMPRESSOR RATINGS						
MANUFACTURER	UNIT #1 ELLIOTT	UNIT #2 ELLIOTT	UNIT #3 ELLIOTT	UNIT #4 ELLIOTT	UNIT #5 ELLIOTT	UNIT #6 ATLAS COPCO
Model/Year	250 DA3 (1970)	250 DA3 (1970	260 DA3 (1980)	260 DA3 (1988)	270 DA3 (1994)	GA315-100 (2000)
Unit Type	3-stage centrifugal	3-stage centrifugal	3-stage centrifugal	3-stage centrifugal	3-stage centrifugal	SS Lub Rotary Screw
Type of Cooling	Water-cooled	Water-cooled	Water-cooled	Water-cooled	Water-cooled	Water-cooled
Full Load Nominal Published BHP	600	600	600	600	600	350
Full Load Horsepower (bhp)	560	560	575	575	530	360.8
Full Load Motor Efficiency (.me) (est)	.91	.91	.93	.93	.93	.954
Full Load Pressure (psig)	.95	.95	.95	.95	.95	100
Full Load Flow (cfm)	2,500	2,500	2,640	2,640	2,600	1,695
Full Load Flow (scfm)	2,275	2,275	2,402	2,402	2,366	1,543
Full Load Nominal Set Point (psig)	95	95	95	95	95	100
Type of Capacity Control	Reg	Reg	Reg	Reg	Electronic	2-step
Pressure Control Band	95-105	95-105	96-105	95-105	95-105	100-110
Turn Down %	15%	15%	15%	5%	15%	100%
Turn Down Air Flow (scfm)	1,934	1,934	2,041	2,275	2,011	NA
Full Load (input) kW @ 95 psig: Calculated	459.1	459.1	461.24	461.24	425.14	276.5
Turn Down kW: Rated%	413.19	413.19	415.12	451.16	375.35	See chart
Idle kW (est 30%)	138	138	138.4	138.4	127.54	55 (20%)
Full Load Specific Power (scfm/kW)	**4.96**	**4.96**	**5.21**	**5.21**	**5.57**	**5.58**
Annual Electric Energy Cost ($/scfm)*	$112.60	$112.60	$107.13	$107.13	$100.27	$100.23

* All data is from OEM Engineering sheets.

** Based on blended electric rates of $0.07 per kWh and operation of 8,760 hours per year.

Summertime acfm to scfm multiplier = x .91

$$\frac{100 \times (14.5 \text{ psia} - .24 \text{ psia})}{14.5 \text{ psia}} \times \frac{520°F}{460 + 100°F} = .9132$$

*** Atlas Copco full load kW @ 95 psig = 360.8 BHP at 100 psig x .98 (95 psig) x .746 ÷ .954 ME = 276.49

THE COMPRESSED AIR SYSTEM ASSESSMENT | Establishing the Baseline in an Old Paper Mill

KEY AIR SYSTEM CHARACTERISTICS – CURRENT SYSTEM*	
MEASURE	**ALL SHIFTS**
Average air delivered from compressors	14,689 cfm
Average air to System	13,533 cfm
Avg Compressor Discharge Pressure	88 psig
Average System Pressure	80 psig
Input Electric Power	2,849.48 kW
Operating Hours of Air System	8,760 hrs
Specific Power System Air	4.75 cfm/kW System Air
Electric Cost for Air /Unit of Flow	$129.11 /cfm year
Ann'l Elec Cost for Compressed Air	$1,747,301 /year

*Based on a blended electric rate of $0.07 per kWh, 8,760 hours/year.

#6 LUBRICANT COOLED ROTARY SCREW:

- Supposed to run as a trim unit to the #5 centrifugal. Unfortunately at today's control settings and piping design, the "positive displacement" lubricant cooled rotary screw is pushing the centrifugal into **unload!** Due to the demand and piping the system pressure falls to 86 psig to 87 psig and this is reflected in the discharge pressure from the unit.
- Running a lubricant cooled rotary screw compressor at 85 psig with a standard air/oil separator and scavenge lines will ***almost always lead to significant oil carry over*** into the system (dryer).

Today this has resulted in oil getting into the two desiccant dryers, ruining the desiccant, fouling the filters and causing too high pressure drop and destroying the drying capability of the desiccant.

According to plant personnel when the dryer bypass is closed and all the air is forced through the dryer, the *pressure loss goes up significantly,* and the *pressure dew point* rises significantly.

Subsequently the dryers are run with the bypass partially open. This means most of the wet air bypasses the dryer, **putting wet air into the system.**

Recommendation — Reconfigure compressor alignment, piping receiver placement and control settings to stop the Atlas Copco screw from pushing the centrifugal into unload. Run Atlas Copco at higher pressure or modify air/oil separation system to handle lower pressure.

II. Establishing the Current System Energy Baseline

The table below reflects the energy and economic performance of the current air system. Annual plant electric costs for air production, as running today, are $1,755,788 per year. The plant runs 24 hours a day, 7 days a week, with a blended power cost of $0.07 per kWh.

Comments on Compressor Operating Energy Costs vs. Rental Units

Comments regarding the operating energy cost of the installed compressed air supply compared to the rental units (this is only energy cost — does not include maintenance, oil changes, etc. which can be frequent on diesel engines).

It should be noted, the rental units *have allowed* the plant to continue operating non-stop during periods where this old compressed air system would not have allowed production to continue.

- The **diesel** rental units have an **operating energy cost of $260.00 cfm/yr** or $416,000 per year for

"We believe the number one project in this mill, at this time, is to dry all the compressed air (both Mill Air and Instrument Air) going to the plant."

— Hank van Ormer, Air Power USA

COMPRESSOR USE PROFILE – CURRENT SYSTEM							
UNIT #	COMPRESSOR: MANUFACTURER/MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (SCFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL SCFM
All Shifts: Operating at 95 psig discharge pressure for 8,760 hours							
1	250 DA3	459.1	2,275	100%	459.1	100%	2,275
2	250 DA3	459.1	2,275	100%	459.1	100%	2,275
3	260 DA3	461.24	2,402	97%	447.4	90%	2162
4	260 DA3	461.24	2,402	100%	461.24	100%	2,402
5	270 DA3	425.14	2,366	100%	425.14	60%	1.420
6	GA315-200	276.5	1,543	100%	276.5	100%	1,543
7	Rental PTS1600E	321	1,456	100%	32	100%	1,456
				TOTAL (Actual):	**2,849.48 kW**	**13,533 acfm**	

8,760 hours/year each (1,600 cfm) with diesel fuel at $2,50 per gallon.

- The **electrical** rental units have an operating energy cost of **$123.02 cfm/year** or $196,837 for 8,760 hours/year each (1,600 cfm).
- The existing 1970 centrifugals (Units #1 and #2) are the least efficient units in the plant. Their best possible operating electric energy cost is **$112.60 cfm/yr** or $180,160 for 8,760 hours/year (1,600 cfm).
- The newer centrifugal (Unit #5) and the Atlas Copco lubricated rotary screw have operating annual energy costs of $100.27 scfm/yr and $100.23 scfm/yr or $160,368 for 8,760 hours/year.

Reviewing the compressor use profile tables shows there is a energy efficiency difference among the five Elliott units with the specific power ($/scfm/yr) getting lower as the units are newer. The improvement from the 1970 250 DA3 to the 1994 2700A3 is 11%. This is a reflection of improvements in manufacturing capabilities and basic aero improvements. New current units will probably have almost a similar improvement.

The GA315 single-stage Atlas Copco has an efficiency level equal to the newer Elliott, however, it is a lubricated compressor instead of an oil-free unit. The installed centrifugals have very limited turndown in their basic design. Newer units could also improve this. When combined with inlet guide vanes, this should be evaluated.

III. Observations on Compressed Quality and the Air Dryers

This is an old paper mill, which has been upgraded several times in the past. Like many other mills, it traditionally has had two compressed air systems:

- The Mill Air compressed air system with no drying or compressed air treatment of any kind
- The Instrument Air compressed air system with desiccant air dryers providing a -40 ˚F pressure dewpoint

THE COMPRESSED AIR SYSTEM ASSESSMENT | Establishing the Baseline in an Old Paper Mill

Compressed air is dried by a collection of various heatless twin-tower desiccant dryers rated to handle the rated load with 100 ˚F inlet air at 100 psig pressure. Of the twelve dryers in the plant, four are turned off. Of the four dryers that are shut off, one is a rental, which is too small for the application. Of the remaining eight operating dryers, two are bypassed, but rent is still being paid.

Like most other mills, compressed air quality has degenerated over the years until there are heatless desiccant dryers throughout the Mill to try and outrun the water contamination. These smaller desiccant dryers use a great deal of purge air to regenerate the desiccant beds. In today's operation, total purge air equals the full flow output from a 380 hp compressor (380 x .746 ÷ 95 x .07 x 8760) with an estimated annual cost of $182,979 per year.

INSTALLED DESICCANT COMPRESSED AIR DRYERS

MAKE	MODEL	SCFM RATING	LOCATION	PURGE AIR SCFM	KW	COMMENTS
Hankison (rental)	RDH3000	3,000	Turbine room	450	--	Hot entry air. Muffler not working.
Pall (steam)	HV9	900	Turbine room	70	--	Hot entry air. Muffler not working
Pall (steam)	HV9	900	Turbine room	OFF		
Pall	CHB1600	1,600	Kraft	240	1	Restrictive 3" pipe in and out. AmLoc purge-saver not engaged.
Pall (rental)	CHA900	900	Area 66 w/FTS1600	135		Receiving air from CHA1600. Not needed.
Pall (steam)	HV9	900	Waste recovery	OFF		
Pall	DHA1600	1,600	AC-GA315-200	240		Bypassed/AmLoc purge-saver not engaged
Pall	DHA1600	1,600	#5 Elliott	240		Bypassed/AmLoc purge-saver not engaged
Pall/Hankison (rental)	RPD900	900	#5 Elliott	OFF	No purge – too small – high pressure loss	
Pall	110DHEM	110	Turbine room	16		
Pall (steam)	HV6	600	IR type 4 need	OFF		
Pall (steam)	HV6	600	IR type 4 need	45		
TOTAL		**10,210 scfm**		**1,436 scfm**		

THE COMPRESSED AIR SYSTEM ASSESSMENT | Establishing the Baseline in an Old Paper Mill

Overall, the plant has a significant water contamination problem. Because of the high ambient temperatures and high humidity levels in the southern U.S., the untreated Mill Air is very heavily loaded with water. Many cross-ties and back-feeds, in the piping system, actually cause the saturated mill air to pollute the instrument air system. Many of the current dyers are overloaded and/or bypassed.

We believe the number one project in this mill, at this time, is to dry **all** the compressed air (both Mill Air and Instrument Air) going to the plant. The significant moisture saturation in the compressed air lines over the years has set up many negative situations.

- Rust and scale in all the west air lines is making them not only contaminated with liquid water, but also creates a smaller and rougher internal piping diameters interfering with efficient and effective distribution of compressed air.
- The heavy load of aggressive acidic water from oil-free units quickly fills the receivers, filters, standpipes, risers, etc. All over the plant area there are either drains left cracked open (significant leak); or use electric timer activated drains that waste air and don't necessarily drain fully. Some areas are left to build up and then either are drained in time or the liquid condensate goes down the compressed air line.
- The acidic condensate rots out seals, diaphragms, solenoids, etc., *greatly increasing maintenance cost and down time.*
- In order to get clean and dry compressed air, at a higher pressure, process personnel are adding significant numbers of small single-stage lubricant-cooled rotary screw compressors with accompanying heatless desiccant dryers without regard to the effect on the overall system economics. Extra air

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compressors and dryers that have been observed but not included in this report include:

- One 200 scfm rated Pall heatless dryer in Paper Mill #2 on the 2nd floor: compressed air purge equals 30 scfm
- Two new Pneumatic Products DH90 heatless dryers in Paper Mill #2): compressed air purge equals 16 scfm each
- Four 20 hp tank-mounted Gardner Denver lubricated, single-stage rotary screw compressors. Three installed at both ends of paper mill, now running 100 – 105 psig (Note: Mill air now at 88 psig or less)
- One 40 hp Gardner Denver lubricated rotary screw compressor on Line 7 tied to Mill air (air-cooled aftercooler and water-cooled aftercooler), apparently putting no air into the system

- Many if not most of your old gate valves won't fully shut off due to trash in the trough. Even a very small leak will not only allow wet air to leak past, but the water vapor itself will migrate from the wet side (saturated) to the dry side, (Frick's Law of vapor dispersion) regardless of the air flow

The plant has twelve dryers installed with eight of them operating. Three of these dryers are rental units — two rental units are currently operable and one rental unit cannot run. All of these dryers are twin tower desiccant-type dryers, which when applied correctly, will deliver a -40 ˚F pressure dewpoint or lower. Most of these are of the heatless type and require about 15% of the compressed air for purge to regenerate the wet tower. Many of these units have a purge-saving controller (called AmLoc) that is not being used. This purge-saving controller could lower the purge air volume by fifty percent (50%) if deployed.

These compressed air dryers have operated reliably and well over the years. The issue is the evolution of the plant's piping design and overall compressed air system layout has created a situation where the existing dryers are simply trying to salvage a difficult situation.

Conclusion

The important first step, in any project, is to establish a baseline. A lot of detailed information is required to understand what the existing situation is. The strategy, of this project, will be to consolidate the air compressors into one location and reduce the use of rental compressors where possible. Next, we will dry all the compressed air with an oversized cycling refrigerated dryer. Certain desiccant air dryers will still be used for Instrument Air where a -40 pressure dew point is required and these will have their purge-saving controllers activated. BP

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To read more ***Air Compressor Technology*** articles, visit www.airbestpractices.com/technology/air-compressors

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

New Parker CAMTU Microbial Compressed Air Testing Device

The Filtration and Separation Division of Parker Hannifin Corporation, the global leader in motion and control technologies, has introduced an innovative compressed air microbial detection device which allows users to quickly test for microbial contamination in compressed air that comes into contact with food and food contact surfaces.

The warm, dark, moist environment inside a compressed air system provides the perfect conditions for microbes to flourish and grow. These bacteria flow along with the air stream and begin their journey through the compressed air system. Introducing this type of microbial contamination to food products is very risky and would be considered a lack of control by the facility. It is not always apparent where the compressed air is contacting the food. Working surfaces such as counters and conveyors are obvious and manageable contact points. However, air is invisible, and leaves no visible trace where it contacts the food, food contact surfaces, or the packaging.

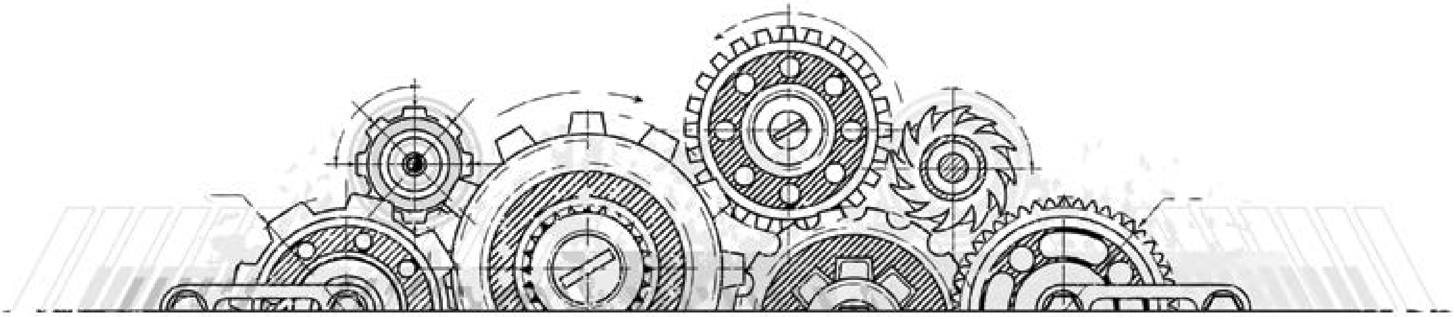
Currently, the only devices capable of sampling compressed air systems for microbes are expensive, cumbersome, require lengthy sample times and extensive training.

The Parker Balston CAMTU detection device allows food safety personnel to quickly and easily test for contamination present in compressed air supplies that come in direct contact with food product or food packaging/processing equipment. The CAMTU is portable, weighing less than one pound, and is supplied with connection tubing, shut off valve, pressure regulator, and metering orifice.

To obtain a sample, simply plug the CAMTU into the compressed air system, expose the petri dish for 20 seconds and then incubate the dish for 24 - 48 hours.

Testing is critical for understanding how to properly treat the compressed air. The CAMTU will assist with identifying Hazard Analysis and Critical Control Point (HACCP) risks. Without adequate treatment in place, an increased risk of food product contamination exists.

Contact Parker Hannifin Corporation, Filtration and Separation Division, call toll-free at 1-800-343-4048 or 978-858-0505. Visit www.parker.com/balston



TECHNOLOGY PICKS

New Kaeser Variable Speed Drive Screw Compressors Models SFC 30S & SFC 30

Kaeser Compressors, Inc. is proud to announce the new SFC 30S and SFC 30 are now available. These variable speed drive rotary screw compressors deliver the "built-for-a-lifetime" reliability, simple maintenance, and sustainable energy savings you expect from the Kaeser name.

The SFC 30S has a flow range of 37- 171 cfm at 125 psig and is available with pressures up to 190 psig. The SFC 30 has a flow range of 47 - 202 cfm at 125 psig, with pressures up to 217 psig. Both models feature the latest in Siemens drive technology.

Kaeser has improved these SFCs' specific power by up to 6% through a combination of true direct drive design, premium efficiency motors, lower internal pressure differential, and optimized airends. These VFD units are up to 25% more efficient than the competition. Additional built-in heat recovery options provide even more energy savings potential.

New features include an enhanced cooling design, eco-friendly filter element, integral moisture separator with drain, and an Electronic Thermal Management system. These variable speed drive compressors also come standard with Sigma Control 2™. This intelligent controller offers unsurpassed compressor control and monitoring with enhanced communications capabilities for seamless integration into plant control/monitoring systems. The SFC 30S and SFC 30 are also available with an integrated dryer for premium compressed air quality.

To learn more about the new SFC 30S and SFC 30, visit www.kaesernews.com/SFC30S_30 . To be connected to your local representative for additional information, please call 877-586-2691.

Atlas Copco Introduces New Heat-of-Compression Desiccant Dryers

The XD+ 550-3600, Atlas Copco Compressors' new range of heat-of-compression desiccant dryers, utilizes Zero Purge cooling in two design variants to eliminate compressed air consumption. The first variation produces a guaranteed dew point of -40°C; the second variation minimizes energy consumption and delivers dew point suppression due to extra heating elimination.

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TECHNOLOGY PICKS

Atlas Copco is an industrial group with world-leading positions in compressors, expanders and air treatment systems, construction and mining equipment, power tools and assembly systems. With innovative products and services, Atlas Copco delivers solutions for sustainable productivity. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 170 countries. In 2012, Atlas Copco had 39 800 employees and revenues of BSEK 90.5 (BEUR 10.5).

Oil-free Air is a division within Atlas Copco's Compressor Technique business area. It develops, manufactures, and markets worldwide oil-free and oil-injected air and gas compressors combined with air and gas treatment systems. The division focuses on sustainable solutions for all kind of industries where the gas quality is critical to the production processes. The divisional headquarters is located in Shanghai, China, and the production centers are in Antwerp, Belgium; Wuxi, China; Pune, India and São Paulo, Brazil.

Learn more at www.atlascopco.com

TECHNOLOGY PICKS

Spectronics Introduces New Marksman II Ultrasonic Diagnostic Tool

Spectronics Corporation has introduced the **MDE-2000NC Marksman™II,** an ultrasonic diagnostic tool that converts and amplifies inaudible ultrasonic sound into audible "natural" sound. This highly advanced tool allows the technician to "hear" even the smallest compressed air, natural gas, propane tank, vacuum, steam, and other pressurized leaks…*before* they lead to major breakdowns.

The Marksman II uses a two-tiered approach to ensure accurate diagnosis. The receiver converts inaudible ultrasonic sound into audible sound using heterodyne circuitry. Then, its unique Sound Signature Technology finetunes the audible sound into the natural sound emitted by the leak itself. A 5-LED signal intensity indicator and audible alarm pinpoint the exact source of the problem. An Internal Noise Control (INC) feature safeguards against ambient noise.

The Marksman II comes complete with an ultrasonic receiver, full-sized, heavy duty, noise-canceling headphones, a hollow air probe, a solid contact probe and an ultrasonic emitter that helps locate faulty seals, gaskets and weatherstripping in doors, windows, ductwork and other non-pressurized enclosures. All components are packed in a sturdy carrying case.

*For more information about the Spectroline® **MDE-2000NC Marksman™II,** call toll-free 1-800-274-8888. Outside the United States and Canada, call 516-333-4840. Website at www.spectroline.com*

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