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

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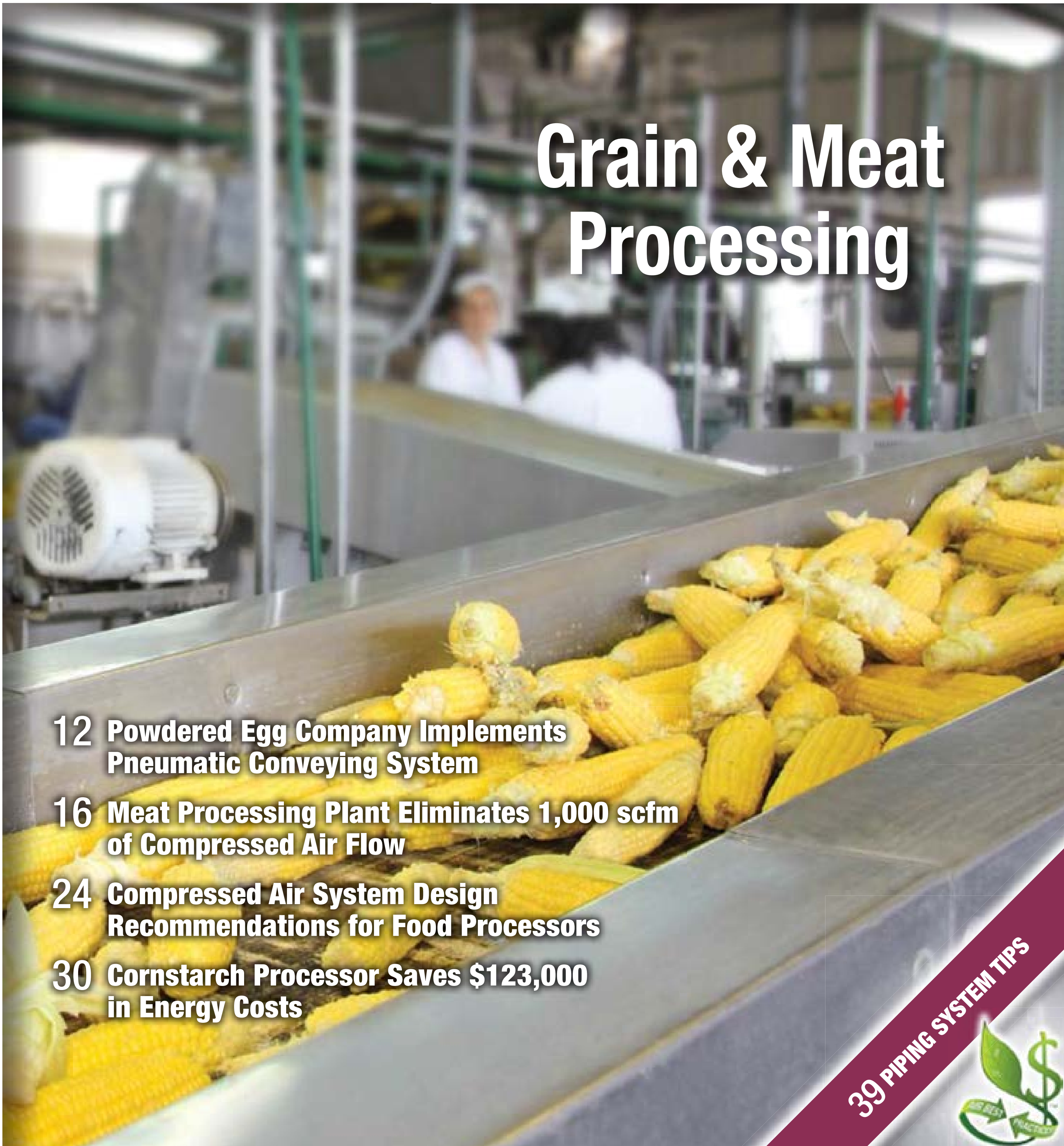

Grain & Meat Processing

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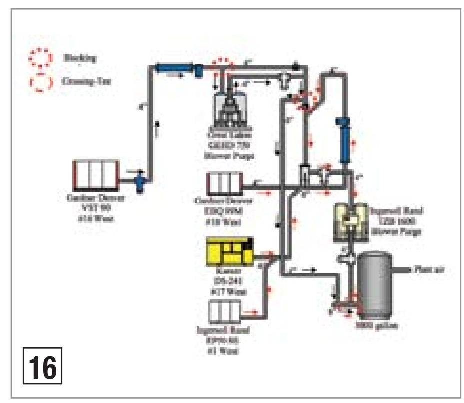

COLUMNS

FROM THE EDITOR | Grain and Meat Processing

Nutriom manufactures natural powdered egg products in a FSIS USDA facility in Lacey, Washington. The company was looking to replace their screw conveyor system with a pneumatic conveying system to improve efficiency and reduce maintenance requirements in their specialized process. Our lead article, this month, reviews the benefits of Nutriom's transition to pneumatic conveying systems driven by 60 psig compressed air supporting a vacuum venturi manifold and by another system using vacuum pumps.

In his article, "Meat Processing Plant Eliminates 1,000 scfm of Compressed Air Flow", veteran auditor Don van Ormer describes several demand-side projects. While demand-reduction opportunities were found on the compressed air dryers, leaks, and condensate drains, the main focus is on 734 scfm of wasted compressed air used at high-pressure blow-off air locations on meat packaging and conveying equipment.

Food processing plants must uphold rigorous food safety and quality standards. How should systems be designed? While there is no single answer for all plants, the compressed air industry, in both the U.K. and Germany, have issued unbiased and detailed recommendations for food plants. Review these in my article, "Compressed Air System Design Recommendations for Food Processors."

A cornstarch processor spends $553,000 per year on the electricity required to run their centrifugal and rotary screw compressors. Two separate systems delivered 60-75 psig and 80-92 psig compressed air. This required the use of all the air compressors and there were no back-up units. This system assessment story details how the plant was able to reduce demand resulting in annual energy savings of $123,000 and shut down air compressors that now serve as back-up air.

The Compressed Air Challenge®, in an article titled "Piping System Tips for Energy Efficiency," recommends that the piping differential not exceed 2% of the nominal pressure of the system. This means for a 100 psi system, a pressure differential should not exceed 2 psid from the discharge of the air compressors to the end use (not including the air dryers and filters). To achieve this, pipeline velocities not exceeding 30 fps are normally required on normal piping lengths, with lower velocities for long piping runs, and no more than 50 fps velocities for final piping drops, fittings and hoses.

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

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INDUSTRY NEWS & SUSTAINABILITY REPORTS

Chicago Pneumatic announces unique Triple Certification for Stationary Compressors

LRQA grants ISO 9001, ISO 14001:2004 and OHSAS 18001:2007 certification to Chicago Pneumatic's compressor division

Chicago Pneumatic announced triple certification to ISO 9001, ISO 14001 and OHSAS 18001 standards — three internationally recognized certification schemes — for Quality, Environmental and Occupational Health & Safety Management (OHSAS) by Lloyd's Register Quality Assurance (LRQA) effective December 2013.

This triple certification demonstrates Chicago Pneumatic's commitment to the quality of services, care for the environmental impact of its operations and the health and safety of employees, customers and the communities that CP serves.

LLOYD'S REGISTER QUALITY ASSURANCE
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OHSAS 18001

"Chicago Pneumatic focuses on product substance while emphasizing customer alignment," said Ellen Steck, President, Chicago Pneumatic. "We take a systematic approach for continuous improvement and corrective action, all while focusing on health and safety. This commitment to excellence across all aspects of our business is what made it possible to achieve the triple ISO certification, and we're proud to continue our stance on reliability, durability and customer value."

Chicago Pneumatic's ISO 9001, ISO 14001 and OHSAS 18001 certification recognizes the company's work across distinct operational pillars, and is reflective of its dedication to total quality management across the manufacturing process. Additionally, these certifications reward Chicago Pneumatic's commitment to environmental, occupational health and safety management.

"The triple certification demonstrates the commitment to our procedures, quality and innovation that has become the backbone of Chicago Pneumatic's legacy," says Steck. "We are honored to receive the triple certification, and our customers can rest assured that our almost 100-year commitment to product excellence and customer service will continue for the next 100 years and beyond."

Chicago Pneumatic is among the industry leaders in compressed air solutions, which are engineered for high-performance. As part of the global Atlas Copco Group, Chicago Pneumatic offers a full range of reciprocating and rotary screw compressors and dryers to help customers tackle everything from everyday tasks to the most complex industrial process.

For more information about Chicago Pneumatic industrial air compressors, or to find a distributor near you, please visit www.cp.com

"We take a systematic approach for continuous improvement and corrective action, all while focusing on health and safety. This commitment to excellence across all aspects of our business is what made it possible to achieve the triple ISO certification."

— Ellen Steck, President, Chicago Pneumatic

INDUSTRY NEWS & SUSTAINABILITY REPORTS

Festo Names Three New Distributors

Festo has named three new western states distributors. These include Denver-based Consolidated Parts, Inc. for Colorado product distribution, Salt Lake City-based Pro Automation, Inc. for Utah, and Custom Fluid Power, located in Nampa, Idaho, for distribution of Festo products in parts of Idaho, Oregon, and the state of Montana.

"The best distributors in automation today have advanced parts stocking and distribution systems in place as well as the engineering expertise to help customers quickly identify optimum solutions," said Bill Oliver, Head of Festo US Distribution. "These distributors invest in training their personnel and instilling a culture of service. We know that Festo products are in exemplary hands with Consolidated Parts, Pro Automation, and Custom Fluid Power."

Consolidated Products has served Colorado machinery manufacturers and automation end users with parts and engineering services for more than 65 years in such fields as packaging, robotics/palletizing, oil and gas, mining, solar, and material handling. The company also serves automation system integrators. Consolidated Products is an Automation Solutions Provider member of the Association for High Technology Distribution.

Pro Automation is a full-line stocking distributor of industrial automation components. With more than 14 years of experience in the Utah market, Pro Automation assists customers with sales and value added products and services. The company specializes in motion control and assembly solutions. Pro Automation serves such markets as material handling, automotive, printing/converting, furniture, aerospace, construction, life science, energy, recreation, transportation, and agriculture.

Consolidated Fluid Power is a full-line stocking distributor of fluid power components and accessories with more than 20 years experience. The company will distribute Festo products in Idaho, expect for the counties of Bonner and Boundary, the state of Montana, and in the Oregon counties of Baker, Grant, Harney, Malheur, Union, and Wallowa. Consolidated Fluid Power assists customers with sales, design, and value added products and services in such markets as food processing, dairy and farm equipment, packaging, semi-conductor, timber, mining, and land transportation.

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

INDUSTRY NEWS & SUSTAINABILITY REPORTS

Atlas Copco Compressors Benefit a South Wales Coal Mine

Compressors from Atlas Copco are providing an essential supply of compressed air to coal extraction operations for Unity Mine in the Neath Valley. The decision to replace the existing diesel driven compressors with Atlas Copco GA electrically-powered screw compressors has resulted in significant benefits in terms of process efficiency, energy use and reduced environmental impact. The mine, which re-opened in 2008, is now in the process of moving to full production with the capability to produce up to one million tonnes of coal per year. It is contracted to supply fuel for major industrial companies, such as the nearby coal-fired Aberthaw Power Station.

Unity Mine's Cwmgrwach operation is a drift mine, meaning that miners can walk in rather than being transported, via a vertical mine shaft winding system, as used in other deep mining sites. At the mine, the coal seams are accessed by driving sloping tunnels through the ground. It was the first to be opened in Wales since the Betws colliery in Ammanford in 1974 and is poised to take advantage of a market whereby the increasing volume of imported coal, coupled with global price increases and demand, driven mainly by booming economies such as China and India, makes formerly uneconomic domestic sites commercially viable again.

After the mine's re-opening, the company's management focus was on the reliability and efficiency of production equipment. Duncan Kilbride, Director of Projects & Procurement at Unity Mine explains: *"The initial plan of the mine's workings were based on the pillar* *and stall extraction methods that employ a continuous miner unit and secure the work with roof bolting, as opposed to arched roadways. These all require air-driven equipment fed by a reliable continuous supply of compressed air. We also operate pumps on a permanent basis to remove water."*

Air for these operations was supplied originally from a number of small, rented diesel-driven compressors but there was growing concern with their mechanical reliability and the risks of any break in the regular supply of diesel fuel. This dependency issue, coupled with increasing rental and fuel costs, made it evident that replacement with more energy and cost-efficient compressors was essential.

"We invited tenders for the system and Atlas Copco came up trumps as a one-stop shop solution for the compressors, filtration units, controller and compressor house installation. They scored as a world-leading specialist offering long term options on a range of packages best suited to our needs within the required timescale plus an ongoing support organisation", said Duncan Kilbride.

Two oil-lubricated, air-cooled, full-feature GA110 variable speed drive screw compressors were installed together with a companion fixed-speed version machine. It has been calculated that energy savings in the region of £13,000 per year are achievable, in addition to substantial savings in equipment rental costs. These Atlas Copco compressor units provide base load and back up peak 7 bar air to the drilling and roof bolting equipment, and the water pumps. Current geological estimates are that there are reserves of 90 million tons of coal that will be extracted from the Cwmgwrach mine complex over the next 25 years.

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Powdered Egg Company Implements Energy-Saving Pneumatic Conveying System

By Doan Pendleton, VAC-U-MAX

Nutriom sets the bar high when it comes to producing its premium quality natural powdered egg products Ova Easy® and Egg Crystals®, that are sold at outdoor retailers such as REI, and online merchants such as Amazon.com; so, when the screw conveyor in their FSIS USDA facility required regular unexpected attention, Leonardo Etcheto, Plant Manager at the Lacey, WA facility knew it was time to look for a better solution.

Seeking a Unique Conveying System

Nutriom developed a unique process to produce its egg products which preserves the flavor and functionality of the eggs, and needed a materials handling system that would work within that specialized process to improve efficiency without damaging the crystals.

"The screw conveyor was a difficult system to handle," says Etcheto. "There were a lot of moving parts and that meant there were more things that could go wrong. It was a difficult system to clean and to perform maintenance."

Improved efficiency and gentle transfer weren't the only provisions Etcheto required. "Our technology is very different and we're a little pickier than your average company. We needed a conveyor manufacturer that was able to modify its equipment to meet our needs," he says.

When attending a trade show for food manufacturers, Etcheto visited the booths of conveyor manufacturers. "We wanted something that would not touch the product, allow us to be full stainless steel, and one of the biggest things is we wanted to get away from having to use oil," he says.

The food-grade screw conveyor at the Lacey plant had a plastic housing outside the screw conveyor. Plastic components from equipment in the food industry hold the potential to deposit debris or shavings into product undetected, and Nutriom preferred to eliminate that potential. The screw conveyor also housed a gearbox on top of the unit that required expensive H1 lubricants that on occasion, despite regular maintenance, would leak and create a mess.

> "Our technology is very different and we're a little pickier than your average company. We needed a conveyor manufacturer that was able to modify its equipment to meet our needs."
>
> — Leonardo Etcheto, Plant Manager, Nutriom

Pneumatic Conveying Protects High Quality Products

After contacting a couple of East coast pneumatic conveyor manufacturers, Etcheto decided that one of the manufacturers could accommodate all his requirements. "We have a lot of height restrictions because our building is older and has many areas with low ceilings and VAC-U-MAX was able to come up with a system that could fit in the space that we needed to fit into."

Celebrating its 60th year designing and manufacturing innovative pneumatic conveyor systems and support equipment for the conveying, weighing, and batching of dry materials, Belleville, NJ-based VAC-U-MAX is a pioneer with many industry firsts including air-powered venturi power units, direct-loading of vacuum-tolerant process equipment, and vertical-wall Tube Hopper material receivers.

Etcheto began with one pneumatic conveying system from the company and, based on its successful performance, "we just kept adding," he says. The facility utilizes two pneumatic conveyors that connect to packaging systems, two that connect to the low temperature driers and two that connect to a mixer — one system breaks up the powder and puts it into the mixer and the other pulls it out.

"One of the reasons we use pneumatics is because we produce a very high quality, high priced product and we want to make sure that we maintain the high quality. The systems do a good job pulling the product without damaging it."

Previously, the screw conveyor would grind the egg product down as it transferred the material which made the crystals more difficult to handle. The screw conveyor also needed a fair amount of egg to be in the system for it to work properly which would sometimes bog down the process.

"The enclosed system allows for more ideal handling," says Etcheto. "It's standard GMP to make sure that nobody is handling our product, and the system easily allows us to do that. It is always traveling pneumatically through stainless lines," he says. "It is definitely cleaner than the screw conveyor we used before."

POWDERED EGG COMPANY IMPLEMENTS ENERGY-SAVING PNEUMATIC CONVEYING SYSTEM

Nutriom uses two VAC-U-MAX pneumatic conveyors with a mixer — one system breaks the powder up and puts it into the mixer and the other pulls it out of the mixer.

Experience with Food Manufacturers

VAC-U-MAX vacuum conveying systems are fully enclosed, protecting materials from air, dirt and waste. Because product does not escape from a vacuum conveying system, particulates that can endanger or jam expensive equipment are prevented from entering the environment.

Having worked with a host of major food manufacturers including General Mills, Kraft Foods, and Kellogg Company, as well as many smaller specialty food manufacturers, the conveyor manufacturer is no stranger to the strict regulations that exist in the food industry. This expertise lent itself to understanding the needs of Nutriom and the creation of a custom system that was more efficient, reduced labor, improved ergonomics, and made compliance with stringent FSIS USDA regulations simpler.

The vacuum conveying systems are complete stainless steel construction and all product contact areas are 316L with a polished surface for ease of cleaning and product flow. Nutriom utilizes two separate types of vacuum generation to accommodate its unique process. For areas with low ceiling clearance VAC-U-MAX modified its filter lids to fit the tight spaces and these units use compressed air to generate vacuum. In areas where ceiling height is not an issue, more efficient vacuum pumps are utilized.

To further accommodate Nutriom's stringent standards, the conveyor manufacturer replaced the iron rings that secured the filter with stainless steel rings. Etcheto says, "they're cleaner, fit better within our inspection system and last a lot longer."

In addition to streamlining materials transfer and enhancing sanitation practices, the system has also improved ergonomics in the plant. "One of our systems only moves the powder about 10 feet, but it moves 10 feet up. Before implementing the pneumatic conveyors, the material had to be transferred manually and now that's not an issue," says Etcheto.

In the beginning, there was a learning curve, he says. "You've got to set them up right. You can't have tight turns, you need the right amount of air flow, but once you figure them out, they really aren't that complicated."

Etcheto appreciates that the VAC-U-MAX system uses standard dairy wiring with all 30A clamps, and says that operators do most of the maintenance themselves and have no issues keeping the systems running. The systems he says are "easy to put together and take apart because they use standard parts the operators are used to, and they don't need tools."

"Over time, it's really been surprising how reliable the VAC-U-MAX systems are," says Etcheto. "With the screw conveyor we had to do something to it at least once a month. By replacing it with a pneumatic conveying system, we have saved over $150,000 annually. That is really good technology." BP

For more information contact Doan Pendleton, Vice President Sales, VAC-U-MAX.

Founded in 1954, VAC-U-MAX has been at the forefront of leading edge conveying systems and components across a wide range of industries including food, pharmaceutical, chemical and industrial markets. To learn more about how VAC-U-MAX pneumatic conveying systems can improve efficiency, ergonomics, preserve product integrity, or reduce costs, write to them at 69 William Street, Belleville, NJ 07109; call 1-800-822-8629; e-mail info@vac-u-max.com; or visit www.vac-u-max.com.

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VAC-U-MAX custom pneumatic conveying system above filling machine at Nutriom plant.

THE SYSTEM ASSESSMENT

Meat Processing Plant Eliminates 1,000 scfm of Compressed Air Flow

By Don van Ormer, Air Power USA

This food & beverage plant is a large (500,000 sq ft) meat processing plant with twenty packaging lines and nine palletizers. The compressed air system is supplied from three separate rooms with seven individual lubricant-cooled, single and two-stage rotary screw compressors. The plant has four blower purge desiccant dryers designed to deliver a -40 ˚F pressure dewpoint.

Current System Summary

Annual plant electric costs for compressed air production, as operating today, are $230,640 per year. If the electric costs of $32,640 associated with operating ancillary equipment, such as dryers are included, the total electric costs for operating the air system are $263,100 per year. These estimates are based upon a blended electric rate of $0.06 /kWh.

The air system operates 8,760 hours per year. The load profile or air demand of this system is relatively stable during all shifts. Overall system flow ranges from 2,554 acfm during production to 1,903 acfm during sanitation. The system pressure runs from 96 to 100 psig in the headers during production.

Production is 16 hours per day, 6 days a week; sanitation is 8 hours per day, 6 days a week; and non-production is on Sunday. Energy cost estimates are based upon a blended rate of $0.06 per kWh.

Primary Air Compressor Supply

Compressor Capacity Control

The two most effective ways to run air compressors are at "Full Load" and "Off."

Capacity controls are methods of restricting the output air flow delivered to the system while the unit is running. This is always a compromise and is never as efficient as full load on a specific power (cfm/hp) basis.

"Reducing average compressed air consumption was the key to improving the efficiency of this food processing plant. Spending time examining compressed air leaks and the packaging equipment allowed our team to find the major compressed air flow-reduction opportunities."

— Don van Ormer, Air Power USA

Rotary Screw Controls (Oil-free / Lubricant-cooled)

The two most common control methods used for rotary screw compressors are **modulation** and **on-line/off-line.** Modulation is relatively efficient at higher loads, but less efficient at lower loads.

On-line/off-line controls are very efficient for loads below 60% when properly applied with adequate time for blow down. There are several other control types — e.g., "variable displacement" (75% to 100% load) and "variable speed drive" (25% to 75% load) — that have very efficient turn down from when applied correctly. Two-stage, oil-free, rotary screws generally are not applied with modulation. As a result they use either two-step (full-load/no-load) or VSD capacity controls.

These controls must be installed correctly to operate efficiently. Piping and storage should be available close to the unit with no measurable pressure loss at full load to allow the signal to closely match the air requirements.

THE SYSTEM ASSESSMENT | Meat Processing Plant Eliminates 1,000 scfm of Compressed Air Flow

TABLE 1. COMPRESSOR USE PROFILE – CURRENT SYSTEM

UNIT #	COMPRESSOR: MANUFACTURER/MODEL	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (ACFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL ACFM
Production: Operating at 107 psig discharge pressure for 5,616 hours							
1	IR PE 50 SE	43	198	Off			
10	GD EBP 99 125 HP	105	630	57%	73 x .82 =60	38 x .82 =31%	195
11	IR EP 125	107	563	Off			
12	IR EP 125	107	563	100%	107	100%	563
16	GD VST55-90	114	622	93%	106	91%	566
17	Kaeser DS 241	138	724	100%	140	100%	724
21	GD EBQ	78	540	99%	77	99%	534
			TOTAL (Actual):	**490 kW**		**2,582 acfm**	
Production: Operating at 110 psig discharge pressure and 3,144 hours							
1	IR PE 50 SE	43	198	Off			
10	GD EBP 99 125 HP	105	630				
11	IR EP 125	107	563				
12	IR EP 125	107	563	100	108	100	563
16	GD VST55-90	114	622	51	58	49	305
17	Kaeser DS 241	138	724	92	127	73	528
21	GD EBQ	78	540	100	78	94	507
			TOTAL (Actual):	**371 kW**		**1,903 acfm**	

The current system has 2-step control on the Gardner Denver and Kaeser. The Ingersoll-Rand compressor units have modulation and automatic control selection, and the Gardner Denver unit (in Room #1) is a variable speed drive. All the compressors are controlled by a central CAM controller.

The current units have capacity controls capable of translating "less air used" into a comparable reduction in electric cost. These controls will work effectively with the current piping and air receiver storage situation.

There are four main dryers in the system.

Compressor Room #1

All of these units are 125 psig rated discharge design except — the Gardner Denver EBQ which is a 100 psig design.

- Gardner Denver model VST55-90, 2-stage variable speed drive, lubricated air cooled, rotary screw compressor, 125-hp class producing 622 acfm at full load
- Gardner Denver model EBQ99 single-stage lubricated rotary screw, air cooled compressor, 125-hp class producing 630 acfm at full load. Currently it is running load/no load control
- Kaeser model DS241 single-stage belt driven, 180-hp class lubricated rotary screw compressor producing 724 acfm at full load. Operating in load/no load standard control
- Ingersoll-Rand model EP50SE single-stage, air cooled, lubricated rotary screw compressor, 50-hp class producing 198 acfm

- Great Lakes model GEHD-750 external heat, blower purge dryer rated for 750 scfm. It has a 5-hp blower and a 24 kW heater. Currently, it is operating using purge air for regeneration with blower cooling. It is using 15% of its rated flow for three hours and the blower for one hour
- Ingersoll-Rand model TZB1600 external heat blower purge dryer rated for 1,600 scfm. It has a 7.5-hp blower and a 30 kW heater. Purge control is installed but it is running on timer mode. This dryer is using purge air for cooling which is 15% for one hour of cooling

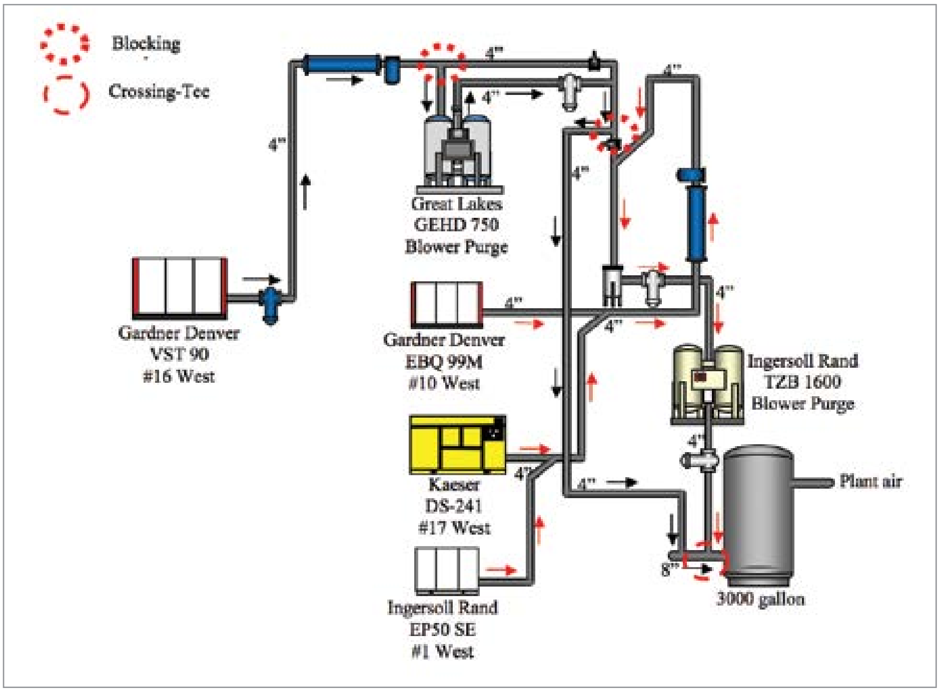

Figure 1. Current Compressed Air System — Compressor Room #1

THE SYSTEM ASSESSMENT | Meat Processing Plant Eliminates 1,000 scfm of Compressed Air Flow

TABLE 2: HIGH-PRESSURE BLOW-OFF AIR LOCATIONS

LOCATION	QTY	TYPE / SIZE	ESTIMATED CURRENT CFM USAGE	UTILIZATION %	NET AVG CFM	RECOMMEND VENTURI NOZZLE	NEW AVG NET CFM EACH	NET AVG CFM USAGE	TIMED W / PROCESS – REDUCTION PERCENTAGE	EST NET AVG CFM SAVED
Breast Pack Bag Open	2	1" Venturi	8 x 2	90	14.4	--	14.4	--	20	3
Breast Pack Cryovac 8600-4	16	Blue Lechler	16 x 16	90	230	8 – 48008	7x8=56	50	60	210
Breast Pack Video Jet	2	Blue Lechler	16 x 2	50	16	1 – 48008	1 x 7	3.5	Current	12.5
Breast Bake Cryovac 8600-7	16	¼" Tube	20 x 16 (two at a time for 2 seconds)	0.66 x .9	24	8 – 48008	1 x 7	4	Current	20
Breast Pack Approach Convey #2	2	1" Venturi	16	90	14.4	--	--	--	20	3
Bologna	1	1" Venturi	8	90	7.2	--	7.2	--	20	3
Pack Bag Open BM Convey	2	1" Venturi	8 x 2	90	14.4	--	14.4	--	20	3
Cryovac 8600-8	16	¼" Tube	20 x 16 (two at a time for 2 seconds)	0.66 x .9	24	8 – 48008	1 x 7	4	Current	20
Cryovac 8600-9	2	Blue Lechler	16 x 2	0.66 x .9	19	2 – 48008	2 x 7	8	Current	11
Cryovac 8600-9	14	¼" Tube	20 x 14 (two at a time for 2 seconds)	0.66 x .9	24	8 – 48008	1 x 7	4	Current	20
P3 Beef Raw Roto screen for Beef Pumper	3	Blue Lechler	16 x 3	90	43	3 – 48008	3 x 7 = 21	19	20	23
Cryovac 8600-6	8	Blue Lechler	16 x 8 (one at a time for 2 seconds)	0.66 x .9	9.5	8 – 48008	1 X 7	4	Current	5.5
Cryovac 8600-6	8	¼" Tube	20 x 8 (one at a time for 2 seconds)	0.66 x .9	12	Remove	--	--	--	12
P3 Sausage Caramel Blow	1	3' x 1" Pipe 20 Holes	60	90	56	Remove	--	--	--	56
P3 Sausage Caramel Blow	1	3' x 1" Pipe 20 Holes	60	90	56	4 – 48008	4 x 7	28	--	28
P3 Sausage Oven Exit	1	3' x 1" Pipe 20 Holes	60	90	56	Remove	--	--	--	56
P3 Sausage Oven Exit	1	3' x 1" Pipe 20 Holes	60	90	56	4 – 48008	4 x 7	28	--	28
Frank Plant Retail Stuffing Exit to Bulk Pkg	1	Blue Lechler	16	100	16	Remove	--	--	--	16
Frank Plant Retail Stuffing Exit to Bulk Pkg	1	1/2" Pipe 10 Holes	20	100	20	Remove	--	--	--	20
Wex Xar Case Packers 2,3,4,&5	4	¼" Blow Gun Nozzle	20 x 4	10	8	Remove	--	--	--	8
Pump & Tumble										
Injector 3	4	Blue Lechler	16 x 4	90	58	2 – 48008	2x 7	13	Current	45
Cryovac 8600-3	8	Blue Lechler	16 x 8 (one at a time for 2 seconds)	0.66 x .9	9.5	8 – 48008	1 X 7	4	Current	5.5
Cryovac 8600-3	8	3/8" Pipe with 6 – 1/8" holes	16 x 8 (one at a time for 2 seconds)	0.66 x .9	24	Remove	--	--	--	24
Pump & Tumble Injector 1	4	Blue Lechler	16 x 4	90	64	2 – 48008	2 x 7	13	--	51
Pump & Tumble Injector 1	4	Blue Lechler	16 x 4	90	64	2 – 48008	2 x 7	13	--	51
				Total Current Usage	939.4				Proposed Usage	734.5

- The pre-filters to the Ingersoll-Rand TZB dryer are an NLM1500 and a HE2100 coalescing, and the after-filter is a HE2100 particulate

Compressor Room #2

- Two Ingersoll-Rand model EP125 single-stage, air cooled, 125-hp class rotary screw compressors producing 563 acfm at full load pressure of 125 psig
- Sahara model BP1690 external heat blower purge dryer rated for 1,690 scfm. A dewpoint demand controller is installed and utilized. This dryer is also equipped with a 5-hp blower and a 30 kW heater
- The prefiltration is an Ingersoll-Rand NLM1500 and then a Hankison coalescing pre-filter model HSF3 with a Hankison particulate HSF3 after-filter

Compressor Room #3

- Gardner Denver model EBP, 100-hp class single-stage air cooled, rotary screw compressor producing 440 acfm at full load
- AirCel model AEHD500 external heat blower purge dryer rated for 500 scfm. Equipped with a dewpoint demand controller and a 9 kW heater and 7.5-hp blower
- The dryer has an Ingersoll-Rand 500 scfm rated pre-filter and is equipped with a 500-cfm rated after-filter

The Proposed Compressed Air Flow-Reduction Projects

The estimated savings potential of the projects related to operating the air compressors totals $107,522 per year. Adding in the savings potential of $12,780 from other projects related to operating the compressed air dryers provides a total savings estimate for the entire set of projects of $120,302. Together, these projects can be completed at a cost of $21,900, resulting in a simple payback of two months.

Compressed Air Flow-Reduction Projects

Utilize blower cooling on Ingersoll-Rand TZB dryer	60 acfm
Utilize blower cooling and regeneration on Great Lakes dryer	85 acfm
Replace four timer drains with level-activated type	12 acfm
Repair identified leaks, continue leak management program	150 acfm
Install thermostatic control on Vortec cooler in KLIKKLOK	28 acfm
Install venturi nozzles on identified blow-off air locations	734 acfm
Replace two air motors in Tipper Tie 1 and 2	18 acfm
Total Reduction	1,087 acfm

THE SYSTEM ASSESSMENT | Meat Processing Plant Eliminates 1,000 scfm of Compressed Air Flow

TABLE 3. SUMMARY OF KEY COMPRESSED AIR SYSTEM PARAMETERS AND PROJECTED SAVINGS

	CURRENT SYSTEM		PROPOSED SYSTEM	
SYSTEM COMPARISON	PRODUCTION	SANITATION / WEEKENDS	PRODUCTION	SANITATION / WEEKENDS
Average Flow (cfm)	2,582	1,903	1,495	816
Compressor Discharge Pressure (psig)	107	110	107	110
Average System Pressure (psig)	99	100	99	100
Electric Cost per cfm	$56.84 /cfm/yr	$44.07 /cfm/yr	$57.09 /cfm/yr	$46.27 /cfm/yr
Electric Cost per psig	$733.82 /psig/yr	$419.37 /psig/yr	$426.81 /psig/yr	$188.77 /psig/yr
Electric Demand	490 kW	371 kW	285 kW	167 kW
Annual Electric Cost	$146,765	$83,875	$85,363	$37,755
	$230,640 /yr		$123,118 /yr	

Other Projects (Total Reduction = $12,780)	
Utilize dew point demand on IR TZB dryer	$7,384 / yr
Install dew point demand on Great Lakes dryer	$2,440 / yr
Install dew point demand on AirCel dryer	$2,956 / yr

Open Blows

Due to article space limitations, we will only outline the compressed air flow-reduction project focusing on installing venturi nozzles on blow-off air locations.

With open blows, turbulent compressed air blasts straight out of the pipe or tube. It not only wastes huge amounts of compressed air, but also violates OSHA noise and dead ended pressure requirements.

Air jets and air flow-inducing nozzles used in place of open blows can reduce noise level, lower compressed air use, and most often improve blow-off operation in both productivity and quality.

Air Power USA, Inc. has developed the following data over time. It is relative to specific standard products available in the industry. A test of one nozzle may vary somewhat from another nozzle of the same manufacturer, but not significantly. Below are some important points to remember:

- In blow-off, thrust from pressure (psig), is required to loosen the objects to be removed
- Thrust dissipates very rapidly once the air has left the "blow-off" device
- In blow off, volume of total air (cfm), compressed air plus induced air, is critical to carrying the blown-off material away within the air stream

"The compressed air equipment was in good working order. The controls on the air compressors and the compressed air dryers simply needed to be used to their full potential."

— Don van Ormer, Air Power USA

- Use expensive compressed air only as a last resort; mechanical, hydraulic, etc., will always be more energy economical and often safer
- All blow-off air should be regulated to the lowest effective pressure — higher pressure means higher flow, which may not be heeded; higher pressure air costs more to produce. Blower pressure air is cheaper
- Use Venturi air amplifier nozzles whenever and wherever possible — properly selected and applied for needed thrust and volume, this will usually reduce blow-off air at least 50%, freeing up more air flow for other more valuable applications
- All blow-off air should be shut off (automatically) when not needed for production
- When blower-generated air is available or apparently economically feasible, always compare the net energy cost to alternatives
- There is substantial potential savings to install automatic compressed air shut-off at various points using blow-off air. This will shut off the compressed air whenever the line stops or the product flow is interrupted. It will automatically blow again when needed, as sensed. If the plant does not have a current PLC or electric eye system in place, we recommend choosing something similar to the Exair Model Electric Eye Controller, which is economical and simple to install

Summary

Reducing average compressed air consumption was the key to improving the efficiency of this food processing plant. Spending time examining compressed air leaks and the packaging equipment allowed our team to find the major compressed air flow-reduction opportunities. The compressed air equipment was in good working order. The controls on the air compressors and the compressed air dryers simply needed to be used to their full potential. BP

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To read more ***Food Industry System Assessment*** articles, visit www.airbestpractices.com/system-assessments

Compressed Air System Design Recommendations for Food Processors

By Roderick Smith,
Compressed Air Best Practices® Magazine

Oil in the Würstchen!

It was the Fall of 1997 in Germany. I was just another guy working in the German compressed air industry. East Germans were still being looked down on — years after unification, the Euro was launching in little over a year — forcing marketing managers like me to scramble and create unified european Euro pricing strategies, European Cohesion Funds were flowing out of Germany and into the Mediterranean (not literally), and the diminutive Mercedes "Smart Car" was the cool car for space-challenged urban dwellers. With this going on, you can imagine the surprise of the compressed air industry when compressed air was featured in "Der Spiegel", a "Newsweek-like" weekly magazine in Germany with national distribution.

"Oil in the Sausage!" hollered the article headline! It proclaimed how a consumer-packaging expert had found mineral oil in a sampling of vacuum-wrapped frankfurter würstchen packages he had tested. The resulting investigation discovered that the food packaging facility in question, did not have proper compressed air filtration systems installed. Oil vapors (hydrocarbons), present in the compressed air system, had entered the packaging machinery — which then injected them into the sausage package. The hydrocarbons condensed at a later date and were discovered by this consumer advocate product-tester.

ISO 8573-1:2001 Air Quality Classes

	SOLIDS			WATER		OIL & OIL VAPOR	
Quality Class	Max. Number of Particles per m³ 0.1 – 0.5 micron	0.5 – 1 micron	1 – 5 micron	Pressure Dewpoint °F	°C	mg/m³	Quality Class
0	As specified by the end-user or manufacturer, and more stringent than Class 1						0
1	100	1	0	-94	-70	0.01	1
2	100,000	1,000	10	-40	-40	0.1	2
3	—	10,000	500	-4	-20	1	3
4	—	—	1,000	38	3	5	4
5	—	—	20,000	44.6	7	—	5
6	—	—	—	50	10	—	6

> "A consumer-packaging expert had found mineral oil in a sampling of vacuum-wrapped frankfurter würstchen packages he had tested. The resulting investigation discovered that the food packaging facility in question, did not have proper compressed air filtration systems installed."
>
> — Roderick Smith, Compressed Air Best Practices® Magazine

Quatsch!

You can imagine how the fingers started to point. The packaging machine manufacturer said it wasn't their responsibility to provide quality compressed air-that it was the responsibility of the factory. The consumer advocate said, "Quatsch to that!" He felt that all packaging machinery manufacturers should install activated carbon filters, which remove oil vapors, on the compressed air inlet side to their machines. He found that few do. He went on to sarcastically assert that the additional $350.00 filter on the $150,000 packaging machine should be economically feasible, given the potential liabilities. All eyes turned to the compressed air industry for a recommendation.

The "Oil in the Sausage" story spurred a swift reaction from the German VDMA (German Engineering Federation), which issued the recommendation we will document in this article. The U.K. code of practice (put together by the British Compressed Air Society and the British Retail Consortium) is more recent and incorporates the latest ISO 8573.1 air quality classes. The objective of this article is to inform food industry compressed air users and specifiers, of the voluntary compressed air quality recommendations, provided by the compressed air industry in the U.K. and in Germany.

ISO 8573.1 Compressed Air Quality Classes

Before discussing the air quality recommendations, it is useful to understand ISO 8573.1 Air Quality Classes. In the early 1990's, the International Standards Organization (ISO) announced a very practical way for compressed air quality to be defined. The ISO 8573.1 Standard (updated in 2001) established "Quality Class Numbers" to be applied to different levels of contamination in compressed air systems. Moisture, solid particulates, and oil were identified as the primary contaminants in a compressed air system and "Quality Class" numbers were applied to them. Quality Class numbers eliminate potential confusion over Fahrenheit/Celsius conversions, mg/ppm conversions, and language translations (can you say dewpoint (drucklufttaupunkt) in German?) in a specifying situation.

COMPRESSED AIR SYSTEM DESIGN RECOMMENDATIONS FOR FOOD PROCESSORS

Bottling barbeque sauce at a food processing plant

An end user can simply specify ISO 8573.1 **Quality Class 1.4.1** compressed air for his facility. The first digit represents Class 1 Solid Particulate Removal. The second digit represents a Class 4 Dewpoint of 3 ˚C (38 ˚F), and the third digit represents Class 1 Total Oil Removal of 0.01 mg/m³ (0.01 ppm). The food industry compressed air standards we will review both used ISO 8573.1 as their way to specify compressed air quality.

Germany's VDMA Recommendation for the Food Industry

The VDMA (German Engineering Federation) section for the compressed air industry responded swiftly to the "Oil in the Sausage" 1997 article in Der Spiegel, with a document titled a "Recommendation for Compressed Air Quality in the Food Industry". It used ISO 8573.1 as the method to specify air quality and it recommended the required air treatment equipment to achieve the desire air quality. It is interesting to note that the recommendation, on the front page, stated "this recommendation applies to all air compressors independent of type." This is an obvious reference to oil-free vs. lubricated air compressors and suggests that air treatment requirements are the same for either compressor technology. For a copy of the recommendation visit www.vdma.org.

The VDMA recommendation was written in two sections:

1. For packaging machines where compressed air is in contact with packaging material which is directly in contact with the food or drug product

2. If the compressed air is in direct contact with the product or mixed with it

In both sections, the recommendations varied based upon the pipework. If the pipework in the facility is new or cleaned, centralized air drying and filtration systems are recommended. If the pipework is "polluted or hard-to-clean", centralized air drying is recommend while decentralized filtration is recommended. By "centralized" the VDMA means the location of the air treatment equipment can be next to the air compressors in the "compressor room". "Decentralized" means that the air treatment should be located on the factory floor directly upstream of

> "Germany's VDMA recommends centralized compressed air treatment when new/cleaned piping systems exist — and decentralized air treatment when the pipework is "polluted"."
>
> — Roderick Smith, Compressed Air Best Practices® Magazine

the machine or process where compressed air can come into contact with food. The recommendation states that new or cleaned air pipework should be made of:

1. Zinc-plated steel suitable for food
2. V2A/V4A
3. Compressed air-approved plastic
4. Aluminum

Another installation note was that no system bypasses be used.

The recommendation calls for ISO Class 4 moisture removal equal to a 38 ˚F (3 ˚C) pressure dewpoint in all situations. It does state that the refrigerated air dryers should have a dewpoint alarm built into the unit. There is also a note that for direct contact applications with extremely moisture sensitive products, then Class 4 is not sufficient and a desiccant or membrane air dryers (providing Classes 1-3) should be used.

Oil removal and particulate removal are both specified as per ISO 8573.1 Air Quality Class 1. The section on "indirect contact" suggests using a 0.01 ppm coalescer followed by an activated carbon filter. The section on "direct contact" suggests using a 1 micron filter, a 0.01 ppm coalescer, and a activated carbon tower/adsorber. Sterile filtration is also recommended in all situations where seen as appropriate.

A Voluntary U.K. Code of Practice for Food Grade Air

Such is the name of the code of practice jointly prepared, in 2006, by the British Retail Consortium and the British Compressed Air Society (BCAS). Mr. **Greg Bordiak** is the Technical Officer of the BCAS who produced the code. For more information on acquiring a copy of the code, visit www.bcas.org.uk. This voluntary code is very complete and includes compressed air system installation requirements, compressed air quality specifications for "contact" and "non-contact" applications, and verification methods.

Within the compressed air system installation requirement section, are recommendations for air compressors. The importance of the quality of intake air is emphasized to prevent the introduction of dust, hydrocarbons, and chemical vapors into the air compressor. The importance of intake filtration (with regular maintenance) is also emphasized. The code of practice also suggests that in installations with potential contamination areas with risk, known as Critical Control Points (CCP's), that food-grade lubricants be required if lubricated (oil-injected) air compressors are used.

The use of carbon steel pipe is discouraged as it can corrode in the presence of moisture in the compressed air. Other piping materials such as aluminum, copper, stainless steel, plastic, are encouraged. It is noted that with plastic pipe, considerations for temperature acceptance of the plastic pipe material should be made.

Contact is defined in the code as, "the process where compressed air is used as a part of the production and processing including packaging and transportation of safe food production." The code of practice calls for the equivalent of ISO 8573.1 Quality Class Air 2.2.1. The "2" digit calls for a -40 ˚C (-40 ˚F) pressure dewpoint. This dewpoint specification

Lubrication Standards in the U.S.

Lubrication standards cover what lubricants an air compressor may use, in a food industry application. The United States Department of Agriculture (USDA) has requirements for the use of the designated H1, H2 and H3 lubricants. NSF (National Sanitary Foundation) also has a standard (NSF 116-2000) which follows Germany's food grade lubricant standard DIN V 0010517, 2000-08. It is up to the factory to determine what lubricants are required in the factory. The guidelines provided by the USDA on lubricants are:

- H1 lubricants are food-grade lubricants used in food-processing environments where there is the possibility of incidental food contact
- H2 lubricants are nonfood-grade lubricants used on equipment and machinery where there is no possibility of contact
- H3 lubricants are food-grade lubricants, typically edible oils, used to prevent rust on hooks, trolleys and similar equipment

COMPRESSED AIR SYSTEM DESIGN RECOMMENDATIONS FOR FOOD PROCESSORS

BCAS & BRC FOOD GRADE PURITY RECOMMENDATIONS

CONTACT RECOMMENDATION	DIRT (SOLID PARTICULATE) MAX NUMBER OF PARTICLES PER M³			HUMIDITY (WATER VAPOUR)	TOTAL OIL (AEROSOL + VAPOUR)	ISO8573.1 EQUIVALENT
	0.1–0.5 MICRON	0.5–1 MICRON	1–5 MICRON			
Contact	100,000	1,000	10	-40˚C PDP	0.01 mg/m³	Class 2.2.1
Non-Contact — Low Risk	100,000	1,000	10	+3 ˚C PDP	0.01 mg/m³	Class 2.4.1
Non-Contact — High Risk	100,000	1,000	10	-40˚C PDP	0.01 mg/m³	Class 2.2.1

Reference Conditions from ISO8573.1 : Absolute atmospheric pressure 1 bar, Temperature = 20 ˚C.
Humidity is measured at air line pressure.
Chart provided courtesy of Parker domnick Hunter.

therefore recommends the installation of desiccant air dryers and membrane air dryers (for lower flow volumes).

Non-contact is defined in the code as, "the process where compressed air is exhausted into the local atmosphere of the food preparation, production, processing, packaging or storage." This application calls for the equivalent of ISO 8573.1 Quality Class Air 2.4.1. The "4" digit specifies a +3 ˚C (38 ˚F) pressure dewpoint — which signals the possible use of a refrigerated air dryer. Whether or not separate drying systems (desiccant and refrigerated) are practical will depend upon the characteristics of each installation. Some may find it more practical

to use one desiccant air dryer for the whole installation. They should, however, be aware of the energy costs involved with desiccant air dryers vs refrigerated air dryers.

Particulate and oil removal filtration are specified as ISO Classes "2" and "1" respectively, for both contact and non-contact applications. This means that one micron filtration for particulates and 0.01 mg/m³ (0.01 ppm) oil coalescers and activated carbon filters will be required. Please note that the code specifies "total oil", which therefore mandates the use of activated carbon (also known as charcoal filters) filters, which can capture oil vapors (particularly hydrocarbons).

The BCAS/BCR Code of Practice has a section dedicated to measurement and testing. This is an area of great "opportunity" in compressed air systems. This code recommends testing the installation twice per year for solid particles (dirt), humidity, total oil, and microbiological contaminants. The code suggests the appropriate ISO codes which define how to conduct the specific tests for air purity.

Conclusion

The codes and recommendations put forth by the BCAS/BRC and by the VDMA provide the compressed air user and specifier in the food industry with some VOLUNTARY guidelines to consider when designing a compressed air system. The key word here is "voluntary". These recommendations do not recommend the involvement of any inspectors or the creation of new regulations. The compressed air industry has simply shared very solid, unbiased, and practical recommendations to the food industries in their respective countries. BP

For more information contact Rod Smith at Compressed Air Best Practices Magazine, email: rod@airbestpractices.com or visit www.airbestpractices.com

To read more ***Compressed Air Standards*** articles, visit www.airbestpractices.com/standards

THE SYSTEM ASSESSMENT

Cornstarch Processor Saves $123,000 in Energy Costs

By Hank van Ormer, Air Power USA

This is a corn mill processing cornstarch, sugar, and other byproducts. Ambient air is contaminated with extremely high levels of dust due to the manufacturing processes and material handling. Average electric rates at the plant are $0.04 / kWh. The actual plant electric cost for compressed air production is $553,630 per year.

The load profile of this compressed air system is relatively stable during all shifts. The full load operating range is 355 days a year, 24 hours a day, 8520 hours a year. There are no flow meters in the system. The system pressure appears to run from 60 to 75 psig in the headers during production for general plant compressed air and at 80-92 psig in Buildings A and B.

There are a number of measures, recommended in this review, able to reduce the electric costs to operate the compressed air system. Collectively, these potential measures total $123,234 per year in annual energy savings. Due to article length limitations, we will highlight only a few of the measures.

The General Plant Compressed Air System

The general plant compressed air supply comes from two 800 horsepower Joy centrifugal compressors rated for 3800 acfm each at 100 psig full load pressure. This compressed air then goes to two (2) PE 4000 External Heat Reactivated desiccant compressed air dryers

capable of handling 4000 scfm of air at 100 ˚F, 100 psig inlet conditions and delivering a –40 ˚F pressure dew point. When the dryer, drains and traps are working correctly, the plant does not have condensate or oil carryover in the production areas — according to plant personnel.

The general plant compressed air system can run on 60 psig pressure and the compressors are run at 84-85 psig to deliver various pressures to production areas. The below pressure readings were taken with local pressure gauges.

Compressor Discharge	84 - 85 psig
After Dryer / Filters	75 - 80 psig
Grind I	65 - 70 psig
Grind II	68 - 75 psig
New Refinery	65 - 68 psig
Bldg. 128	50 - 52 psig
BCD	60 - 75 psig
Dextrin	60 - 65 psig
Tear Down	50 - 60 psig
Tear Down	65 - 70 psig
Syrup Solids	70 - 75 psig

Past records indicate both 800 horsepower compressors were often at full load (amps) particularly during the summer weather. In the past, the general plant compressed air system could run with just one 800 horsepower centrifugal compressor and with a partial load on the 500 horsepower centrifugal compressor.

MEASURE	GENERAL PLANT AIR	BUILDINGS A & B	TOTAL
Average System Flow acfm	7000 cfm	1600 cfm	
System Operation	1160.3 kW	464.2 kW	
Operating Hours	8520 hrs	8520 hrs	
Specific Power	6.033 cfm/kW	3.45 cfm/kW	
Unit Electric Cost for Air	$56.49 cfm/yr	$98.87 cfm/yr	
Total Electric Cost for Air / Year	$395,430/yr	$158,200/yr	**$553,630/yr**
Total Electric Cost psig/year	$1,977.15 psig/yr	$790.99 psig/yr	

Blended Power Rate: $0.04 kWh / Hours – 8520 per year

Buildings A & B

There are two buildings requiring higher compressed air pressure than the 60-75 psig of the general plant air system. The building A warehouse averages 85 psig pressure and the blenders in building B require a 90 psig pressure minimum.

"There are a number of measures, recommended in this review, able to reduce the electric costs to operate the compressed air system. Collectively, these potential measures total $123,234 per year in annual energy savings."

— Hank van Ormer, Air Power USA

THE SYSTEM ASSESSMENT | Cornstarch Processor Saves $123,000 in Energy Costs

TYPE	2-STAGE CENTRIFUGAL (2 UNITS)	3-STAGE CENTRIFUGAL (1 UNIT)	SINGLE STAGE ROTARY SCREW (2 UNITS)	SINGLE STAGE ROTARY SCREW (1 UNIT)	SINGLE STAGE ROTARY SCREW (1 UNIT)
Brand	Joy (Cooper)	Joy (Cooper)	Gardner Denver	LeRoi	Atlas Copco
Model	TA 28	TA 28	EAU	—	GA 809
ACFM	3800 each	2350	1250 acfm/ea.	—	475
FL Press	100 psig	100 psig	100 psig	100 psig	100 psig
kW @ 100 psig (full load)	663 kW (800 BHP)	414 kW (500 BHP)	228 kW (275 BHP)	—	84.7 kW (100 BHP)
Cfm/kW/100 psig	5.73 cfm/kW	5.67 cfm/kW	5.48 cfm/kW	—	5.60 cfm/kW
Annual Elec Cost $/cfm	$59.46 cfm/yr	$60.04 cfm/yr	$62.61 cfm/yr	—	$60.77 cfm/yr
Annual Elec Cost $/psig	$1,130 psig/yr	$705 psig/yr	$388.51 psig/yr	—	$144.33 psig/yr

Compressed air for these areas was originally supplied by one of two Gardner Denver 250 horsepower single-stage rotary screw compressors. Both units are lubricant-cooled and rated for 1250 cfm each at 100 psig. One of these units has problems with the variable displacement capacity control systems that needs to be repaired.

Today, these two units together cannot supply enough compressed air to run this area. The current system is supplied by a 500 horsepower Joy centrifugal in Building A rated for 2350 acfm and one Gardner Denver 250 horsepower rated for 1250 acfm. This compressed air also goes through a Pneumatech PE-1300 external heat desiccant dryer and the appropriate filters.

Two older units in Building A are no longer used. They are a LeRoi 100 horsepower rotary screw water-cooled unit and an Atlas Copco 100 horsepower rotary screw air-cooled unit. They are similar to the Gardner Denver unit but with different control systems. The LeRoi unit has modulation controls. The Atlas Copco unit has online / offline controls. Both could be pressed into service as smaller trim units if needed. They can be upgraded and both converted to water-cooled as required. Each of the units has a heatless type desiccant compressed air dryer applied to it with fifteen percent purge air requirements.

Observations

All of the centrifugal and rotary screw air compressors are efficient, well-applied air compressors capable of delivering the 100 psig full load pressure in a continuous manner. The units are well applied. With the exception of the one variable displacement control system, they appear to be in good operating order and well maintained.

They reflect the basic state of the art for their type of air compressor. Newer centrifugals will have some basic full load efficiency improvements (< 2% generally) and some more effective turn-down (5% better). Two-stage lubricated rotary screws will have from 7% to 10% full-load efficiency gains compared to the existing single-stage units.

All units are water-cooled. This is generally much more applicable than air-cooled in a high-dust environment like this and more so with the available supply of good cooling water. Prudent installation and reasonable maintenance should make water-cooling economical and very reliable.

If any one of the centrifugal air compressors goes down for any reason, including maintenance, the plant has no "back-up" compressed air.

A basic objective of this project is to reduce compressed air demand and then reconfigure the supply-side to optimize the efficiency, of the existing air compressors, while having back-up air compressors. The goal will be to have the general plant compressed air system run on just one 800 horsepower and one 500 horsepower centrifugal air compressor — with the other 800 horsepower centrifugal as the back-up machine. The goal for Buildings A & B is to support them with one of the Gardner Denver 250 horsepower rotary screw compressors with the second GD unit acting as back-up.

Air Compressor Controls

The two most common controls used, on centrifugal air compressors, are modulation and blow-off. Modulation is relatively efficient at very high loads, but will not work much below 80-85% load. After modulation or turn-down, the compressor then just "blows-off" and/or recirculates excess air. The basic power draw at the blow-off point then stays the same regardless of the load. There are modern electronic control systems that can be applied today that will effectively close off the inlet and will blow the unit down to idle and significantly reduce the kW draw. Inlet guide valves are available to increase the effective turn down range from 15-20% to 25-30% and increase the unloaded efficiency.

THE SYSTEM ASSESSMENT | Cornstarch Processor Saves $123,000 in Energy Costs

The current centrifugal air compressors have Joy Quad III and Quad 2000 Electronic Auto Dual Control and IGV's (Inlet Guide Vanes) on the two 800 horsepower units. The 500 horsepower unit just has straight turn-down or modulation and blow-off. The units involved have capacity controls capable of translating "less air used" into a comparable reduction in electric cost.

The two most common controls used, on rotary screw air compressors, are modulation and online/offline. Modulation is relatively efficient at very high loads — and inefficient at lower loads. Online/offline controls are very efficient for loads below 60%, when properly applied with adequate time for blow-down. There are several other control types (e.g., "rotor length adjustment" or "variable displacement" and "variable speed drive") that have very efficient turn down from 100% load to about 60% load.

The Gardner Denver rotary screw compressors, supporting Buildings A&B, use variable displacement turn valve controls. One of the units needs to have the capacity control system re-set and repaired. The unit is using 133 kW to deliver only 100 cfm of compressed air right now. This is not a difficult repair.

Reducing Compressed Air Demand

This project came up with projects reducing compressed air demand by 1,080 cfm in the general plant air system and by 480 cfm in Buildings A & B. These demand-side projects are what make it possible for the existing air compressors to be reconfigured to meet demand while now having back-up air if needed. The demand-side projects include identifying and repairing compressed air leaks, addressing inappropriate uses of compressed (like blow-off air), reducing pressure, and installing no air-loss condensate drains. Due to article length limitations, we will not provide detail on these projects in this article.

Demand-Reduction Projects	General Plant Air	Buildings A&B
Leaks	800 cfm	250 cfm
Inappropriate Use	200 cfm	150 cfm
Lowest Effect Pressure	50 cfm	50 cfm
Condensate Drains	30 cfm	30 cfm
TOTAL	**1,080**	**480 cfm**

	AIR COMPRESSOR	% OF LOAD	% OF POWER	FULL LOAD KW X % OF POWER	NET KW	CFM
1	Joy #2	90%	90%	663 x .90	596.7 kW	3600
2	Joy #3	85%	85%	663 x .85	583.6	2400
3				TOTAL AIR FLOW AVERAGE	**1,180.3 kW**	**6,000**
4	Joy #1	64%	80%	414 x .80	331.2 kW	1500
5	GD West	8%	58%	230 x .58	133 kW	100
5				TOTAL	**464.2 kW**	**1,600**

> "The two most common controls used, on rotary screw air compressors, are modulation and online/offline. Modulation is relatively efficient at very high loads — and inefficient at lower loads. Online/offline controls are very efficient for loads below 60%."
>
> — Hank van Ormer, Air Power USA

Action Plan Phase 1

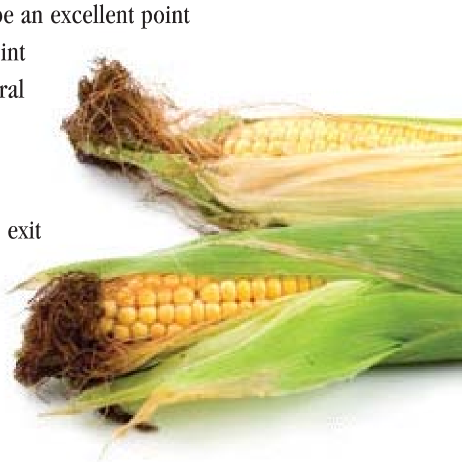
The below bullets were the actions items recommended to the client. These action items were implemented. We hope that readers of this article will get some ideas from these examples.

- Repair as necessary the controls on the GD 250 horsepower compressor to supply Buildings A & B. Reset controls to have the base-load unit stay on. The second machine to come on as needed. Idle and shut off when not needed
- Repair all leaks identified already in Buildings A & B. There were many very large leaks masking small leaks
- Go back over Buildings A & B with a leak-locating team to find the leaks passed over the first time
- Repair and continue to identify, tag, and repair leaks in all the buildings in the general plant air system
- Identify the restriction in flow to Buildings A & B
- Replace prefilters with loose-packed deep bed mist eliminator to reduce pressure drops
- Replace all timer drains and manual drains with no air-loss electric or pneumatic actuated condensate drains
- Replace, if acceptable, vortex coolers with heat tube
- Install venturi amplifiers on all open blows
- Set automatic shut-off controls on all venturi vacuum generators that run full time — or replace with central vacuum system

Piping Considerations for Phase 2

If the plant decides to build a new compressor room in the near future with the existing equipment, we have provided a suggested schematic layout drawing in our report. Some of the suggestions are detailed below.

- Install each 800 hp centrifugal with its appropriate filter (loose packed, deep bed) and dryer
- Use 10" diameter discharge pipe or larger (use long "L's" — not "T's" as you have now) and use 8" diameter discharge pipe for the 500 hp unit
- Install a high quality shut-off valve in each line and then connect to a 18" (or larger) header running the length of the compressor room (100' est). Then connect with 30° to 45° directional tie-ins. This will act as a 1300 gallon class air receiver and handle the air flow with no other pressure loss other than the filters and dryers. These can be pre-welded connections and valves for future additional compressed air flow tie-ins
- This large header will also be an excellent point to pick up a target or set-point pressure for use with a central networking capacity control system
- Slope the header toward the exit point from the room
- Install a 3500 gallon vertical (150 psig) air receiver below the header



THE SYSTEM ASSESSMENT | Cornstarch Processor Saves $123,000 in Energy Costs

RECONFIGURED SYSTEM			
MEASURE	GENERAL AIR	BUILDINGS A & B	TOTAL
Average System Flow ACFM	5920 cfm	1120 cfm	
System Power Draw - kW	1043.9 kW	219 kW	
Operation Hours	8520 hrs	8520 hrs	
Specific Power	5.67 cfm/kW	5.11 cfm/kW	
Unit Electric Cost for Air	$60.09 /cfm/yr	$66.64 /cfm/yr	
Total Electric Cost for Air	$355,761 /yr	$74,635 /yr	**$430,396 /yr**
Total Electric Cost for Air	$1,778.81 /psig/yr	$373.17 /psig/yr	

Blended Power Rate: .04 kWh / Hours 8520 /yr

- Run the main air line (12" or 14") to the bottom section of the receiver
- Run the distribution air line (s) from the upper half of the air receiver to individual areas or in header from (12" to 14") to later back up in smaller sizes for various production sectors
- Once the system is stabilized and optimized it should work very well with the existing piping

However there are some things to consider in the near future whether you relocate the general air supply or not.

- Repipe with the back up air from the Joy #1 going directly into the air receivers
- Tie the two receivers together with 8" pipe
- Leave each receiver with one line to Building A and another line to Building B
- Install one flow/pressure regulator in each line with service bypass to deliver "steady desired pressure" to each sector and eliminate system overdrive and "artificial demand"
- Measure the flow used in Buildings A & B with accurate meters appropriately timed to identify minimum flow, average flow and peak flow. With this information, establish optimum sizing for base load and trim operations. You may find there will be

> "I know of many operations running food grade lubricant today that have to change oil every 1000 hours (about every 40 + days) to avoid problems."
>
> — Hank van Ormer, Air Power USA

significant energy savings by utilizing a smaller horse power — variable speed drive trim unit — or you may not

Testing and Measurement

In order to maintain your system at peak efficiency, we recommend the plant obtain and use certain test and monitoring equipment.

- Compressed Air Leaks: The plant already owns two excellent leak locator instruments. We suggest you begin a on-going leak identification and repair program with full record keeping. This should be done 2-4 times a year in the beginning. After the first year of attention and repair this can usually be effectively reduced to 1 or 2 times a year

- Flow Measurement: Long term successful compressed air management programs usually identify the cost of compressed air and make it part of each department's overall operating cost – to do this effectively flow measurement is critical

  - It may be premature for this but we would suggest you obtain a portable flow meter able to read real time data and also log

- Pressure Measurement: Measuring pressure with the "Same Gauge" and a gauge with a high degree of repeatability is critical to compressed air distribution analysis as you saw working with us. We use a Helicoid HG2000, 0-200 psig gauge with .25 % accuracy which cost about $300. We recommend you use something similar

Lubricant Selection

The plant's air compressors are using a Food Grade lubricant which is a PAO synthetic hydrocarbon. This particular synthetic, unlike many others, does tend to "varnish" when "over run" and its ability to run long hours is very sensitive to ambient conditions and operating temperatures.

We believe, after discussion with your maintenance personnel and observing the, refilling but not changing of the oil, that you probably have "varnished compressors". This will severely shorten the life of seals, or rings, oil filters, and air oil separator and if continued to run undetected the ultimate "locking up" of the unit endangering the motor, drive coupling etc.

There are other good synthetic lubricants that are much less sensitive and should run about one year in your environment (diester synthetics, PAG's, non food grade PAO's etc.). You can only use these lubricants if you feel you can have compressed air purification systems in place through filtration and drying (consistent .05 ppm is very obtainable) equipment.

Other food products companies do both — some use food grade — some don't.

In any event, regardless of what you use you should set up a continuing oil analysis program to determine and monitor the projected oil life "without varnish" and general lubricant condition. I know of many operations running food grade lubricant today that have to change oil every 1000 hours (about every 40 + days) to avoid problems. BP

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

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

PIPING SYSTEM TIPS FOR ENERGY EFFICIENCY

By Ron Marshall for Compressed Air Challenge®

The development of extruded aluminum piping is a recent innovation in the compressed air industry. The internal bore of this piping is smooth and corrosion resistant which makes the pressure differential characteristics of a straight run of this pipe superior to that of steel pipe. Because it is much lighter than steel pipe the installation is much easier. And the manufacturers of this style of piping have come up with various twist lock connectors to make the installation even simpler.

Even though there is significantly less pressure differential across an equivalent cross section of aluminum piping compared to steel pipe, there are still some things to consider if using this pipe to gain energy savings. Due to the cost of the pipe there is a tendency for installers and designers to want to reduce the size of the pipe to save costs. But if you want more efficient operation with this new style pipe you must design the system to have less pressure differential, not the equivalent differential. For example, if good design practice previously required 2 inch steel pipe to maintain less than 30 feet per second pipeline velocities, the equivalent smaller aluminum pipe would experience much higher velocities and the same, or possibly worse, pressure differential once the piping fittings are considered. This would mean

PIPING SYSTEM TIPS FOR ENERGY EFFICIENCY

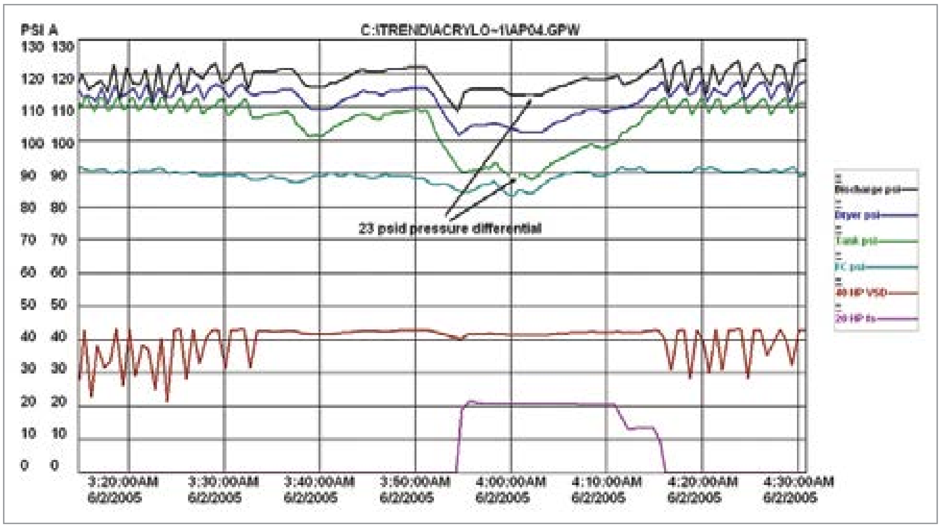


Chart 1: Data logging showed a surprising pressure differential

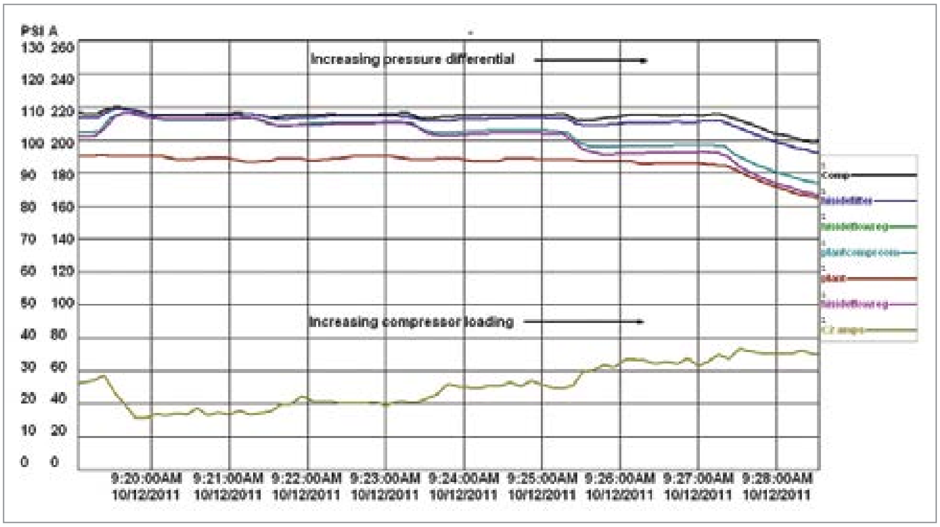


Chart 2: Special testing showed higher than desired pressure differential at full flow. Pressure differential follows an exponential curve, on the steep part of the curve very small flow change results in large pressure differential

there would be no energy savings. But if 2 inch or larger aluminum piping was used instead of 2 inch steel pipe then a savings could be achieved due to a lower pressure differential and lower required compressor discharge pressure.

The use of reduced sized piping increases the velocity of the air in the pipe and although may not be any higher pressure differential in a straight section of piping, the differential at points where the air must change direction become problematic. Compressed air has weight and compressed air in motion has momentum that must be overcome when turning 90 degrees at a connector or running up against the inside of a T connection. For this reason, at higher velocities, the aluminum connectors can have significantly higher equivalent lengths than standard steel fittings. The equivalent lengths must be totaled in the design stages of the piping layout in order to ensure that the resulting pressure differential across various lengths of straight pipe and the many 90's, T's and couplings don't exceed the intended design criteria.

The Compressed Air Challenge recommends that the piping differential not exceed 2% of the nominal pressure of the system. This means for a 100 psi system a pressure differential should not exceed 2 psid from the discharge of the air compressors to the end use (not including the air dryers and filters). To achieve this, pipeline velocities not exceeding 30 fps are normally required on normal piping lengths, with lower velocities for long piping runs, and no more than 50 fps velocities for final piping drops, fittings and hoses. The final piping must be sized for the peak flows of whatever is connected, not average flows. For more information about calculating pipeline velocities and pressure differentials refer to Compressed Air Challenge's Best Practices for Compressed Air Systems Manual which is available on the website.

The following are accounts of some issues that were experienced when applying smaller equivalent size aluminum piping to three different systems:

Rotational Molding Facility

A small rotational molding facility was growing due to increased production and needed to upgrade the compressed air system. The facility profile had a low average load but high peaks each time the large plastic parts were released from the rotational molds. A new 40 HP VSD compressor, a properly sized cycling dryer, low differential filters and a large 1,060 gallon storage receiver were installed to provide increased capacity and lower energy consumption. The large storage receiver was to provide peak flows for the rotational molder.

A table in the catalog for the aluminum piping suggested that a 1 inch aluminum pipe could supply up to 236 cfm of air in a short 65 foot section of pipe. The designer of the piping system did not account for equivalent lengths of all the many fittings that connected the various components together. Also, a design change in the location of the compressor, dryer and filter forced a longer run of pipe to be used. The piping size was not adjusted to account for these changes and as a result all the components were interconnected using one inch aluminum pipe and fittings. The resulting 26 psid pressure differential (includes the dryer and filter) is shown in Chart 1.

A post mortem of the issue showed additional problems. Due to a process change a second compressor was required to run during some peak flows causing 240 cfm of compressed air flow in the sections of the piping before the large receiver. In addition to this, much higher flows were being experienced in sections of the piping after the receiver because stored air from the tank was flowing into the rotational molder in addition to all the air the compressors were producing. Further checking into the catalog information showed the pipe size table was based on a 5% pressure differential at 116 psi (2.5 times the intended dp). In actual practice the pressure in parts of the system was falling as low as 90 psi, due to the presence of a pressure/flow control valve increasing the piping velocity. The intended design was to provide less than 2 psi pressure differential.

The system piping was upgraded to a 2 inch size reducing the pipeline velocity by 75% from a peak of around 100 fps to a new level

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>
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PIPING SYSTEM TIPS FOR ENERGY EFFICIENCY

of around 25 fps. Pressure differential fell to the design levels.

Flexible Printing Facility

A medium sized facility had just expand and needed to upgrade the compressed air system from two 25 HP fixed speed compressors to a more efficient 60 HP compressor with VSD control. A properly sized thermal mass air dryer was installed along with low differential mist eliminator filter, a 400 gallon receiver and a pressure flow control valve. Extruded aluminum piping was used, 25 mm (one inch) size was selected using a manufacturers table because the equivalent length of the planned piping layout was less than 60 feet.

Almost immediately after commissioning of the system the plant operators found that low pressure was being experienced during peak flows. The issue was so bad that the discharge pressure of the VSD compressor had to be jacked up by 25 psi to prevent low pressure from occurring.

Post mortem analysis showed the piping system configuration was less than optimum due to added unanticipated complexity of the installation. Many more fittings had to be used than expected to route the piping between various components. A pressure differential measurement was done during compressor peak flows and found 26 psi differential across the supply side piping, air dryer and filter due to this complexity. The increase in compressor discharge pressure caused the compressor to consume about 12% more power to overcome the piping differential.

This system was reconfigured using 2 inch piping with piping pressure differential dropping to less than 2 psid (not including 4 psi across dryer and filter).

Egg Processing Facility

An egg processing plant was relocated from an old facility to amalgamate two processing lines. Compressed air flow projections showed that the compressed air usage required a 60 HP compressor and refrigerated air dryer. An efficient VSD compressor was selected, with a cycling air dryer, dual parallel filters, a large storage receiver and a pressure/flow control device. Efficient aluminum piping was selected to enhance the project. At the last minute the plant management decided they would be more comfortable with a 75 HP compressor and matching air dryer. Unfortunately the piping and filters were not upsized to accommodate the new capacity.

When the power utility did verification testing (Chart 2) they found that while the air

> "The piping at the filters was reduced to match the port size of the filters to save costs. The actual compressor had higher peak output capacity than a normal 75 HP compressor (360 cfm) because it was a newer optimized version."
>
> — Ron Marshall

compressor provided very stable pressure at its discharge, the pressure at the storage receiver just before the compressed air entered the plant was experiencing significant sag. Investigation revealed higher than desired pressure differential across the air filters and compressed air piping. The piping had been selected at 40 mm (1.5 inches) using a piping manufacturer's table that equated the recommended diameter to the nominal horsepower size of the intended smaller compressor and the equivalent length of the pipe. As well, the piping at the filters was reduced to match the port size of the filters to save costs. The actual compressor had higher peak output capacity than a normal 75 HP compressor (360 cfm) because it was a newer optimized version. Pressure differential in a relatively short piping distance of less than 50 feet was 12 psid at the compressor full flow or 11%. Of this about one third of the differential was across undersized filters and one third across the piping. The remainder was air dryer differential.

The piping was upgraded to 63 mm and the filters resized. Pressure differential across the piping fell to below 2 psid at full flow.

These three experiences illustrate the misapplication of an excellent style of piping due to incorrectly downsizing, poor planning and unanticipated problems. Here are some tips to avoid issues with compressed air piping:

- Even with smooth bore piping, and this includes systems piped with stainless steel and copper, pipeline velocities should be kept to under 30 fps to minimize pressure differential where the compressed air must go around piping directional changes
- Use the same size of aluminum pipe or larger, not downsized pipe, to gain savings
- Safety margins should be left for unanticipated changes in piping layout due to facility layout changes
- Know the actual flows of the compressors being installed and ensure the design can handle without issues
- Anticipate higher than normal peak flows from storage receivers. Ensure piping capacity can handle the higher velocities that come with low pressure operating, such as after pressure/flow control valves
- Make sure that any design tables or pipe size calculators you use match with your intended design pressure differential and operating pressure BP

To read more ***Piping System Assessment*** articles, visit www.airbestpractices.com/system-assessments/piping-storage

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

New BOGE Oil-Free 45-90 kW SO Series Compressors

The water-cooled screw compressors in BOGE's new SO series use state-of-the-art technology to produce oil-free compressed air for sensitive applications. Their intelligent design and innovative cooling principle give them an edge in everyday use, providing a reliable supply of oil-free compressed air with lower energy costs, and reducing maintenance costs to a minimum.

Thanks to the absolutely oil-free compression principle, BOGE's new SO series is ideal for generating oil-free compressed air in particularly sensitive areas of production, such as the pharmaceutical, food and drink, and semiconductor industries. BOGE has now thoroughly reworked the water-cooled screw compressors in their 45 to 90 kW range. The results speak for themselves - the new screw compressors use up to eight percent less energy while still generating up to six percent more compressed air. And this is not all — compressors in the SO series are also up to three decibels quieter in operation. BOGE has designed all compressors in this range with IE3 premium efficiency class motors, thereby saving energy right from the very first minute of operation, and ensuring long-term generation of a sustainable, cost-optimized supply of compressed air.

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All components are easily accessible and are ideally positioned in the compressor's cooling air stream. The new SO series has a small footprint, as the side doors can be removed and so only require minimal clearance at the sides. The high-grade materials used, as well as the reduced number of wear parts, cut maintenance costs to a minimum and prolong service life. A radial fan is used to vent the hood, providing a powerful intake of air that allows longer exhaust air ducts to be used, and making the compressor agreeably quiet in operation. All models are also available with an optional cowl cooler or heat recovery system

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All 45 - 90 kW rated models in the SO series are also available with frequency control to perfectly match compressed air output to the actual demand at any time. In peak load operation, or where compressed air demand fluctuates, or storage volume is limited, this has the virtue of appreciably lowering energy costs, since the amount of free air delivered by the compressor is adjusted by continuously varying the motor speed. This saves wear and tear on materials, minimizes maintenance costs and reduces reaction times in operation to a minimum.

Visit BOGE America at www.boge.com/us, tel: 770-874-1570, email: s.woodward@boge.com

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

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TECHNOLOGY PICKS

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THE MARKETPLACE

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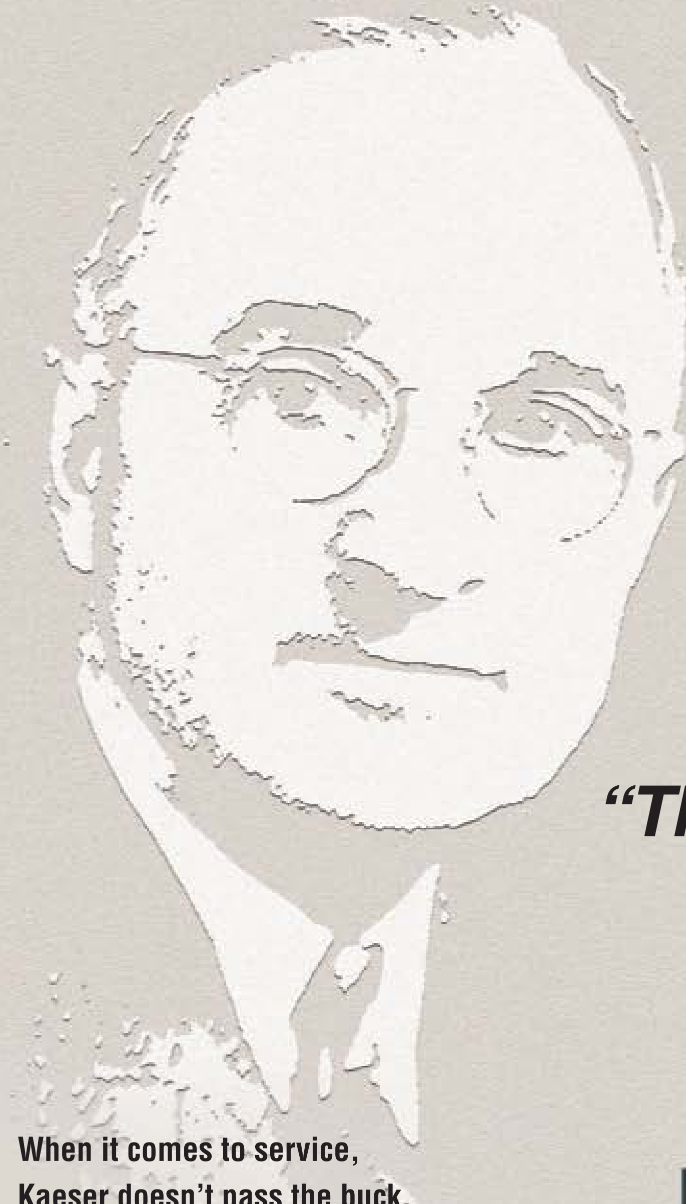

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