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

COMPRESSED AIR BEST PRACTICES

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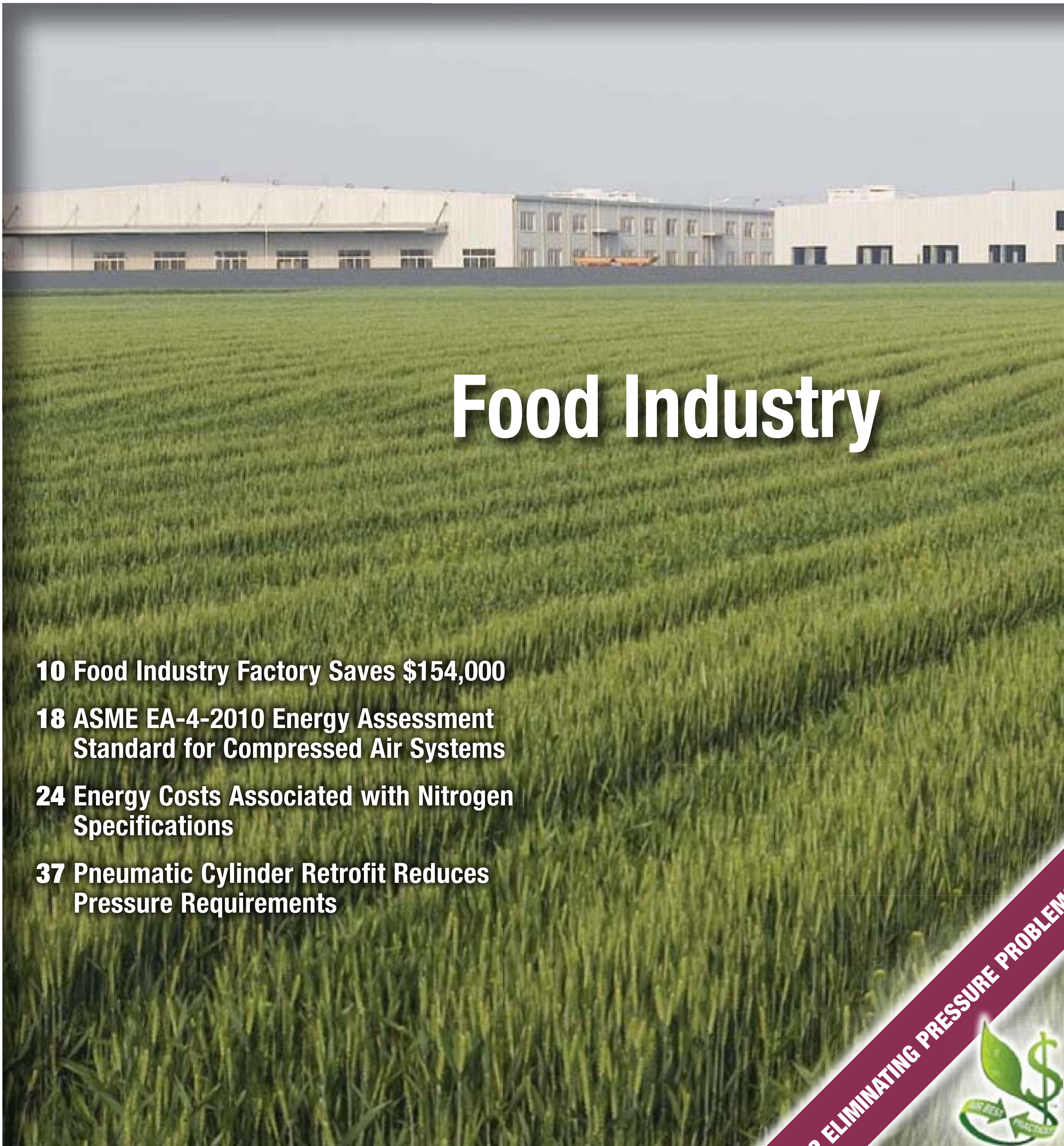
April 2012



Food Industry

Clear the way for quality air

Hi, I'm Michelle and I have been working with our customers across the United States for the last 10 years. Products that optimize quality in your air supply are not just accessories we offer; they are a way of life for us at Atlas Copco. That's why we produce such a wide variety of dryers, aftercoolers, filters and oil-mist eliminators just to name a few.

We all perform best when working within our optimum environment, right? And, manufacturing environments are no different. Moisture in your air supply is something that should be avoided at all costs. Water is a by-product of compressing air. But there are ways to ensure this moisture doesn't get downstream and cause equipment malfunction. And more importantly, moisture can lead to contamination of your end products, leading to costly product failures and potentially harming your hard-earned reputation.

Our mission is to continue to bring sustainable productivity through safer, cleaner, more energy-efficient, and cost-effective compressed air technology. Simply log onto **www.atlascopco.us/michelleusa** or call **866-688-9611** to learn more about us, our products, and how we have earned and will continue to earn our reputation.

Sustainable Productivity

Atlas Copco

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Ultimate Air Quality
ISO 8573-1:2001 Class 0

Class Zero

Approaching 100 years of compressed air experience, Hitachi has been and continues to be the technology leader via continuous innovation of air compression oriented towards Customer Value. With growing concerns for the environment we live in, along with the products we consume, not only Oil Free, but Contaminant Free air is quite important.

The foundation of Hitachi Innovation is derived from more than 50 years of Oil Free Compressor technology, with the world introduction of Hitachi Oil Free Reciprocating compressors in 1954.

Continuing our pioneering spirit with societal responsibility, Hitachi embarked upon a certification of ISO 8573-1:2001 Class 0 for the Hitachi DSP Series Oil Free Rotary Screw Compressor (15-240kW). To validate our findings for consumer knowledge, third party laboratory testing was contracted with a positive result to standards, which enables Hitachi to provide a variety of Innovative, Technologically Superior, and Value Oriented Product for our Customers.

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SUSTAINABLE MANUFACTURING FEATURES


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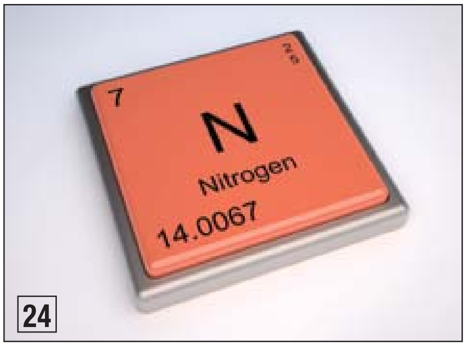

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FROM THE EDITOR | Food Industry Energy Savings

Compressed air systems offer many opportunities to save energy. Veteran system assessment expert, Hank van Ormer, provides us with a case study on how his firm helped a food industry factory significantly reduce compressed air demand. Just as important, this "April System Assessment" of the month points out that without installing a variable speed drive air compressor and a compressor automation system, that the energy savings would not have been realized — even with reduced compressed air demand.

Joe Ghislain, from the Ford Motor Company and on behalf of the Compressed Air Challenge®, provides us with a valuable review of the ASME EA-4-2010 Energy Assessment Standard for Compressed Air Systems. In addition, veteran compressed air system auditor, Dean Smith, also provides a good "fundamentals" article called, "Eliminating Pressure Problems in Compressed Air Systems."

Nitrogen plays an important role in many food industries. Mike Flowe, a veteran nitrogen system application engineer, writes about "The Energy Costs Associated with Nitrogen Specifications." The article provides good insights into understanding why your factory has certain nitrogen purity specifications, technologies and what the energy cost ramifications are.

Pneumatics continue to be, in my humble opinion, the next frontier of compressed air system assessments — focusing on OEM production equipment. Gary Wamsely provides an excellent example of how one manufacturing facility, with 50 molding machines, was able to reduce system pressure (and energy costs) by retrofitting pneumatic air cylinders and using amplifiers.

Our mission is to distribute educational and motivational content on the **positive work** being done every day by people, like you, who get their hands dirty and get the job done with profitable energy efficiency projects. We thank the authors above for sharing their knowledge and thank you for your support and for investing in *Compressed Air Best Practices®*. BP

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COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

SMC Recognized in the Media

After being recognized as the 49th most innovative company in the world by Forbes Magazine in late 2011, SMC and the leadership given by Director of Operations, Kelley Stacy, continues to gain attention in 2012.

In the Winter 2012 edition of Metro North Business, Ms. Stacy was listed on the "Top Ten Business Leaders You Need to Know" cover story. Citing the philosophy of Chairman Yoshiyuki Takada as the foundation of SMC's continued success, she states, "As Mr. Takada does, I truly believe in working to produce the highest quality product possible. He insists that a strong percentage is invested each year into engineering so that we can continue to lead the market with new and innovative products." With the leadership of Ms. Stacy and COO, Yoshiki Takada, the company aspires to reach $1 billion in annual sales and double the company's market share in the coming years. The North American headquarters in Indiana, already with its own 100-acre complex and 1-million square foot production facility is due to expand within the next 2 years. www.smcusa.com

SMC®

Pneu-Logic Appoints Former Top PepsiCo Executive to Board Position

Pneu-Logic Corporation, a leading supplier of compressed air monitoring and control

systems that help factories save energy, announced the appointment of Scott Gillesby to the company's Board of Directors. Gillesby recently retired after more than 30 years with PepsiCo in various capacities, most recently as Senior Vice President & General Manager, where he generated over $2B of revenue annually, and increased corporate leading margins and operating profit performance while motivating and developing 5,000 employees.

"Scott brings a unique blend of executive and technical skills to Pneu-Logic," said J. Ned Dempsey, Pneu-Logic Chairman. "He has experience with manufacturing and supply chain operations and launching successful products from the perspective of a leading player in the food processing industry, one of our target markets." www.pneulogic.com

PNEU LOGIC

Pneumatech Promotes Joe Fresch to Vice President

Pneumatech President Ellen Steck today announced the promotion of Joseph A. Fresch to Vice President, Pneumatech North America. Fresch, who joined Pneumatech in 1991, is responsible for sales, technical service and customer service for the company, an established and innovative manufacturer in the compressed air system engineering market with unparalleled custom-design capabilities. Fresch has previously served in a variety of roles at Pneumatech, including regional sales manager and most recently as national sales manager.

"Joe brings a tremendous wealth of product knowledge and leadership experience to his new position, as well as his already-strong working relationships with Pneumatech customers and distributors," Steck said. "Of course, Pneumatech's legacy runs deep in his family, and Joe is eager to continue growing Pneumatech and provide world-class technical and customer service to our customers in North America."

The Pneumatech name has a rich history in Fresch's family. His father, Vince Fresch, and uncle Ray Rossi purchased the company, based in Kenosha, Wis., in 1980. Pneumatech expanded several product lines and extended its presence across North America and into international markets such as China before Atlas Copco acquired the company in October 2005.

"I'm honored to be able to build upon Pneumatech's tradition," Fresch said. "We will continue to provide our customers with high-quality, custom-designed compressed air systems that boost productivity while conserving energy and production costs, backed by our commitment to outstanding customer service." www.pneumatech.com.

Cameron Fourth Quarter Earnings Released

Cameron reported net income of $99.9 million, or $0.40 per diluted share, for the quarter ended December 31, 2011, compared with net income in the prior year's fourth quarter of $164.6 million, or $0.66 per diluted share. The fourth quarter 2011 results include after-tax charges of $90.5 million, or $0.37 per share, primarily related to the Deepwater Horizon matter. The fourth quarter 2010 results included after-tax charges of $6.2 million, or $0.03 per share, primarily related to costs associated with Deepwater Horizon and the continued integration of the NATCO Group Inc. Excluding the above items, the Company's earnings per diluted share were $0.77 for the fourth quarter of 2011, compared with $0.69 for the fourth quarter of 2010.

Revenues for the fourth quarter of 2011 were a record $2.03 billion, up more than 12% from the prior year, and revenues for the year were $6.96 billion, up more than 13% from 2010's $6.13 billion, also a new record. Excluding charges, earnings per diluted share for 2011 were $2.67, compared to $2.42 for 2010. Including charges, earnings per diluted share were $2.09 for 2011 and $2.27 for 2010. Cameron Chairman, President and Chief Executive Officer Jack B. Moore commented that each segment saw record revenues in 2011 reflecting the investments Cameron has made in each of its businesses over the last three years. www.c-a-m.com

COMPRESSED AIR, PNEUMATICS, VACUUM & BLOWER INDUSTRY NEWS

Parker Acquires Railroad Filtration Business

Parker Hannifin Corporation announced that it has acquired the railroad filtration business of the Camfil Farr Group. The railroad filtration business of the Camfil Farr Group is a leading manufacturer of air and liquid filtration products used in rail and transit, mining and marine engine applications. Terms of the transaction were not disclosed.

Headquartered in Laval, Canada, the railroad filtration business of the Camfil Farr Group had sales of approximately $22 million in 2011. With approximately 90 employees and operations and sales in Canada, Mexico and India and a sales presence in the United States and Australia, approximately 75% of the ongoing revenues of the business will be reported in Parker's Industrial North America reporting segment with the remaining 25% reported in the Industrial International segment. The acquired business will become a part of Parker's Filtration Group.

"Parker sees significant opportunities to broaden our large engine and air filtration product lines and leverage products in other large combustion engine applications," said Peter Popoff, President — Filtration Group. "The railroad business of Camfil Farr brings expertise and services that allow Parker's Filtration Group to build a worldwide presence in specialized rail, marine and mining markets, while adding clean air technologies to strengthen our filtration solutions capabilities. Additionally, this transaction will give Parker Filtration manufacturing capacity in Canada and Mexico to better service customers in those markets." www.parker.com

Sullair Corporation

Sullair Corporation launched its fully redesigned and comprehensive Web site at www.sullair.com. The new Web site distinguishes Sullair as the complete compressed air provider, representing a broad range of reliable, energy efficient products. It also illustrates Sullair's commitment to superior customer service through its employees and an extensive worldwide network of distribution partners. Sullair's new Web site focuses on compressed air solutions with Stationary Air Power products and services targeting manufacturing industries and Portable Air Power products and services targeting mining, infrastructure and energy markets. In addition, Sullair serves various OEM markets. Also featured on the new site is information on the company's full line of air treatment products, vacuum systems, and other related products. www.sullair.com

Bosch Plans to Acquire SPX Service Solutions

The Bosch Automotive Aftermarket division plans to acquire the Service Solutions business of SPX Corporation, headquartered in Charlotte, NC (NYSE, SPW). An agreement to this effect was signed in New York City on January 23, 2012. SPX Service Solutions develops, manufactures and sells diagnostic and service tools, workshop equipment, and software for the global automotive aftermarket. For 2011, the business, which is based in Warren, MI (USA), is expected to generate sales of approximately 920 million dollars (660 million euros). It employs some 2,700 associates in 17 countries, primarily in the U.S., Germany, France, and China. This makes the planned acquisition the largest in the history of the Automotive Aftermarket division. The transaction is subject to normal closing conditions and regulatory approvals, and is expected to close during the first half of 2012. The purchase price amounts to 1.15 billion dollars (roughly 883 million euros). www.bosch.us

EnergAir Opens U.S. Sales Office

EnergAir, a world leader in supplying and implementing System Master Controls for compressed air networks, has recently opened their U.S. subsidiary in Van Nuys, California. EnergAir currently has successful operations in the UK, Belgium, France, Germany & China and has developed an extensive worldwide sales network of distributors.

"EnergAir Solutions Inc. has been established to better serve our existing customers and expand our distributor sales network in the United States" said Nicolas De Deken, EnergAir's Chief Operating Officer. "To better serve U.S. customers we've invested heavily in the development of Master Control interconnects with U.S. compressor variants such as the SullAir Spiral Valve, Quincy Power$ync, Gardner Denver Turn Valve, etc., making EnergAir one of the only suppliers of System Master Controls that can truly say they effectively and efficiently network all types and brands of positive displacement compressors." www.energair.com and www.metacentre.eu

EnergAir

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

THE SYSTEM ASSESSMENT

Food Industry Factory Saves $154,000 in Annual Energy Costs

By Hank van Ormer, Air Power USA

April 2012 System Assessment of the Month

Where: North America
Industry: Food Industry
Audit Type: Supply and Demand Side

System Assessment Win/Win Results*

Energy Savings per year:	$154,372
Project Investment:	$289,540
Utility Incentive:	$159,778
Net Project Cost:	$129,762
Simple ROI with Incentive:	10 months
Reduction in Energy Use:	1,929,697 kWh
Equivalent CO_2 Emissions:	1,386 metric tons*
Equivalent CO_2 for homes:	180 homes
Equivalent CO_2 for vehicles:	265 vehicles

*Source: CO_2 Calculator on www.airbestpractices.com

The Facility

This food industry factory, located in California, was spending $386,533 annually on energy to operate their compressed air system. This system assessment detailed eleven (11) project areas where yearly energy savings totaling $154,372 could be found with a investment of $289,540. A local utility energy incentive, paying 9 cents/kWh, provided the factory with an incentive award of $159,778. This reduced the investment to $129,762 and provided a simple ROI of ten months on the project.

This project represents a true "supply and demand-side assessment". The demand-side work identified significant opportunities to reduce compressed air consumption in blow-off air applications and in leaks. Due to article length space constraints, this article will detail how the factory reduced compressed air consumption by over 841 cfm.

It is important to note, that the supply-side, of the compressed air system, had to be modified in order to turn the reduced compressed air consumption into energy savings. A new variable speed drive air compressor and a compressor control automation system was required to turn the reduced compressed air demand into energy savings.

Supply-Side System Overview

The "specific power" rating of the current system was 5.27 cfm/kW. This energy efficiency metric means that for every one kW consumed, the air compressors generate 5.27 cfm (cubic feet per minute) of compressed air flow.

The air system operates 8,760 hours per year. The load profile or air demand of this system varies during the day based on production cycles (not shifts) — 55% of the time two

compressors meet the demand while 45% of the time three compressors meet the expanded demand. Overall system flow ranges from an average of 2,591 acfm during two-compressor periods to 3,258 during three-compressor periods. The system pressure runs from 103 to 104 psig in the headers during production.

The #1 and #2 300 horsepower air compressors run as primary lead air compressors and the #3 air compressor runs as the trim (lag) unit. All the existing air compressors are sequence controlled and are rotated in sequence on a scheduled interval.

When doing system assessments, the energy savings estimates depend, in part, on the air compressor capacity control system effectively translating lower air use into reduced electric cost. The currently installed air compressors have this type of unloading controls-but they are oversized. It was necessary to install a smaller (150 hp) variable speed drive air compressor to improve the specific power of the system to 5.68 cfm/kW. Additionally, the existing piping system will allow the controls to accomplish their goals.

The focus of this article is to detail the projects realized to reduce the consumption of compressed air.

Project #1: Leak Identification and Repair

A partial survey of compressed air leaks was conducted at the plant and 43 leaks were identified, quantified, and logged. Potential savings totaled 245 cfm for the 43 leaks that were identified. We recommend an ultrasonic leak locator be used to identify and quantify the compressed air leaks in an ongoing manner. The plant already has such a leak detector in house. Some of the areas surveyed in the leak study included a great deal of high

THE SYSTEM ASSESSMENT

Food Industry Factory Saves $154,000 in Annual Energy Costs

TABLE 1: COMPRESSOR USE PROFILE — CURRENT SYSTEM							
UNIT #	ROTARY SCREW AIR COMPRESSOR (HORSEPOWER)	FULL LOAD		ACTUAL ELEC DEMAND		ACTUAL AIR FLOW	
		DEMAND (KW)	AIR FLOW (ACFM)	% OF FULL KW	ACTUAL KW	% OF FULL FLOW	ACTUAL ACFM
Clean-up and Sanitation Period: Operating at 108 psig discharge pressure for 4,818 hours							
1	300 hp	266.2	1,515	88%	235.1	84%	1,273
2	300 hp	266.2	1,515	90%	240.5	87%	1,318
3	300 hp	266.2	1,515	OFF			
4	300 hp	266.2	1,515	OFF			
			TOTAL (Actual):		**475.6 kW**		**2,591 acfm**
Primary Production Period: Operating at 108 psig discharge pressure for 3,942 hours							
1	300 hp	266.2	1,515	88%	235.1	84%	1,273
2	300 hp	266.2	1,515	90%	240.5	87%	1,318
3	300 hp	266.2	1,515	63%	168.8	44%	667
4	300 hp	266.2	1,515	OFF			
			TOTAL (Actual):		**644.4 kW**		**3,258 acfm**

TABLE 2: COMPRESSOR USE PROFILE — PROPOSED 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
Clean-up and Sanitation Period: Operating at 104 psig discharge pressure for 4,818 hours							
1	300 hp	260.9	1,515	100%	260.9	100%	1,515
2	300 hp	260.9	1,515	OFF			
3	300 hp	260.9	1,515	OFF			
4	300 hp	260.9	1,515	OFF			
5	150 hp VSD	106.7	717	40%	42.7	38%	275
			TOTAL (Actual):		**303.6 kW**		**1,790 acfm**
Primary Production Period: Operating at 104 psig discharge pressure for 3,942 hours							
1	300 hp	260.9	1,515	100%	260.9	100%	1,515
2	300 hp	260.9	1,515	74%	193.1	62%	942
3	300 hp	260.9	1,515	OFF			
4	300 hp	260.9	1,515	OFF			
5	150 hp VSD	106.7	717	OFF			
			TOTAL (Actual):		**454.0 kW**		**2,457 acfm**

*Full load kW demand has been reduced by 2% from 266.2 kW to 260.9 kW reflecting the 4 psig drop in pressure resulting from projects realized.

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.

Estimated reduction of air flow by fixing 43 leaks	245 cfm
Recoverable savings from air flow reduction	$110.70/ cfm/yr
Annual electric cost savings with proposed project	$27,120/ year
Unit cost of leak repairs ($25 materials per leak and $75 labor per leak)	$100
Total project cost (materials and installation) (43 x $100 each)	$4,300

Project #2: Thermoelectric Refrigeration

An older technology now emerging into the commercial industrial cabinet cooling market is "Thermoelectric Refrigeration". It was originally developed and applied to internal cooling of computers and other electronic components. The thermoelectric plates utilize an efficient Pelletier cooling design. As current is supplied to the plate, it cools the surface. As current to the plate is reduced, the cooling effect is reduced. The control system modulates the amount of current to maintain the target temperature.

The energy cost to operate a thermoelectric refrigeration cabinet cooler is from 50% to 80% less than Freon refrigeration units. This technology does not always have the capability to develop the higher temperature differential of some others, particularly vortex tube cooling. In some higher ambient areas (such as furnaces, etc.) with poorly insulated cabinets they may not be usable. We have applied thermoelectric cooling very successfully in manufacturing plants all over the continental United States.

Thermoelectric Coolers Summary

- No refrigerated type cooler has lower electrical energy cost than the thermoelectric air conditioner. Today its practical limit is 1500 Btu/hr cooling in a single unit (or multiples of 1500 Btu/hr). This will handle many of today's cabinet cooling jobs in the industrial environment. It will cool below ambient or the surrounding air temperature. It does have limited cooling temperature differential (10–30 ˚F) from ambient

- Thermoelectric can cool in a sealed cabinet and does not have to exchange cool air for hot air!

We saw 53 refrigerated cabinet coolers in the plant. All of these 1,500–4,000 Btu/hr-rated coolers can be replaced with similar rated thermoelectric refrigeration with automatic temperature control units

System Before Assessment		System After Assessment	
Energy Costs per year:	$386,533	**Energy Costs per year:**	$260,193
Operating hours:	8760 hours	**Operating hours:**	8760 hours
Power Cost kW/h:	$0.08	**Power Cost kW/h:**	$0.08
Avg. System Flow:		**Avg. System Flow:**	
Sanitation Period:	2,591 acfm	Sanitation Period:	1,790 acfm
Production Period:	3,258 acfm	Production Period:	2,457 acfm
Annual kWh:	4,831,666 kWh	**Annual kWh:**	3,252,413 kWh
Specific Power:	5.27 cfm/kW	**Specific Power:**	5.68 cfm/kW
Compressor Discharge: Pressure	108 psig	**Compressor Discharge: Pressure**	104 psig
Avg. System Pressure:	104 psig	**Avg. System Pressure:**	103 psig

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Food Industry Factory Saves $154,000 in Annual Energy Costs

TABLE 3: PLANT LEAK LIST

NO	LOCATION	DESCRIPTION	EST CFM
1	COP Tank #1	Fittings	2
2	COP Tank #2	Fitting	2
3	COP Tank #2	Two lower fittings	4
4	COP Tank #3	Fittings	2
5	Whey area CP-CRR8	Filter fitting	1
6	Whey area S8-EVR5-PERM A	Filter fitting right side	2
7	Vat room	Bottom tap near hose reel	2
8	Crystal 6-10 Lower Solenoid Box	Fitting	5
9	Five TriClover valves in Whey area	Whey gets into packing and damages seals	15
10	SB-EVR7-PERM A	Filter fitting	2
11	Header behind 19C1 West fitting	Near valve	5
12	Yamamoto filler room line #1	Filter under conveyor	5
13	CO_2 Injection room middle Triangle machine	Fitting on right side of roll	3
14	CO_2 Injection room East Triangle machine	Inside machine	6
15	East AMF machine	Under unit	2
16	East AMF machine	Fitting on north side	3
17	West AMF machine area	Split nylon tube	20
18	Upstairs NW corner Nucon	Fitting on left side	1
19	Upstairs freezer deck line 1	2 leaks on stuck solenoid	20
20	Hallway between freezers	Filter fitting	6
21	Line #1 portable chemical Trote pump	Fitting on right	3
22	Prime B Packaging area	Leftmost filter drain	10
23	Rapid Pak machine	Inside middle panel of machine	5
24	Rapid Pak	Filter under machine	5
25	Wall south of Rapid Pak	Fitting below filter	11
26	Kaufman block palletizer shrink wrapper	Fitting	5
27	A780 block palletizer	East end filter	1
28	Cheese making Line #2 Vat #20	Filter drain	5
29	Cheese making Line #2 Vat #1	Valve to right of filter	3
30	Cheese making Line #2 Vat #6	Filter bowl	1
31	Cheese making Line #2 Vat #4	Fitting on left of filter	3
32	Cheese making Line #2 Vat #2	Filter bowl	6
33	Cheese making Line #1 Vat #1	Filter drain	7
34	Cheese making Line #1 Vat #5	Filter drain	8
35	Cheese making Line #2 Vat #7	Filter drain	8
36	Cheese making Line #2 Vat #9	Filter drain	2
37	CIP room NW corner	Fitting	10
38	HTST room upstairs	Filter fitting	5
39	HTST room stairway	Filter drain	1
40	NE corner of HTST room	Fitting	6
41	HTST Silo 31	Filter drain	20
42	Milk receiving area Silo #4	Valve left of stairs	4
43	Milk receiving area Silo #2	Valve right of stairs	3
		TOTAL	**245 cfm**

with a savings of 3 to 6 kW each. They will also provide much longer life than the normal 1–3 year life of refrigeration units.

The five 4,000 btu/hr rooftop units might be replaced with two 1,500 btu/hr thermoelectric units each because the existing ones are likely oversized. Proving that the proposed solution works is one reason why we suggest experimenting to find the most economical approach instead of just replacing all 53 cabinet coolers today. It may be that a single 1,500 btu/hr unit will work if insulation is added to the sides, bottom and door of the cabinet.

We proposed the plant only replace 10 of the 53 refrigerated cabinet coolers initially. Replace the other 43 refrigerated cabinet coolers as they fail during subsequent months and years.

Current energy use of the ten refrigerated cabinet coolers is at least (5 on roof, plus 5 inside)	45 kW
Energy use of each 1,500 btu/hr thermoelectric cooler	280 watts
Number of thermoelectric coolers needed to replace the ten refrigerated units	16
New energy use with thermoelectric units (0.28 kW x 16)	4.5 kW
Electric cost savings with proposed project	40 kW
Annual electric cost savings with proposed project (40 kW x 8,760 hours x $0.08/kWh)	$28,032/ year
Project cost (material and installation)	$30,000

Project #3: Use Venturi Air Nozzles for Blow-off Air

This food industry plant can save substantial energy by installing venturi nozzles in four open blow areas. The following open blow projects are based on using stainless steel nozzles rather than the usual nylon composite nozzles. In total, these four open blow projects can save an average 440 cfm over all shifts at a cost of $6,000.

1. Whey area, northeast corner, tube blowing out 25 cfm — use 9 cfm amplifier nozzle and automatic solenoid shut off valve for half the time. Savings are 19 cfm all the time. Cost is $800

TABLE 4: TYPICAL PERFORMANCE OF THERMOELECTRIC CABINET COOLERS

CLASS	MAX POWER	APPROX NORMAL RUNNING POWER	CABINET APPROXIMATE COST
400 Btu/hr Rating	100 Watts	70 Watts	$1,000–$1,200
800 Btu/hr Rating	200 Watts	150 Watts	$1,700–$1,800
1,500 Btu/hr Rating	400 Watts	280 Watts	$2,300–$2,400

TABLE 5: CABINET COOLERS AT THE FOOD PACKAGING PLANT

LOCATION	TYPE	QUANTITY	CURRENT UTILIZATION %	COOLER BTU/HR RATING	ACTION OR RECOMMENDED COOLER	SAVINGS (NET AVG KW)
Kooltronic KNA4C4-32R	Ref	48 on roof	100%	4,000	Change to TE	10 cabinet coolers to be initially replaced
Ice Qube Inc. IQ1800VS	Ref	3 in CO_2 Injection Room	100%	1,500	Change to TE	
Industrial Cooling Equipment NR0151264KBXK	Ref	1	100%	1,500	Change to TE	
Packaging Area CR43-0826-03BH	Ref	1	100%	3,500	Change to TE	

THE SYSTEM ASSESSMENT

Food Industry Factory Saves $154,000 in Annual Energy Costs

2. Yamamoto filler room, line #1 there are 4 open blows of 25 cfm each all the time — add regulator ($200) and amplifier nozzles ($200) at 12 cfm each and automatic solenoid shut off valve ($750) for half the time. Savings are 76 cfm all shifts. Cost is $1,200

3. Yamamoto filler room, line #2 four directional wedge nozzles at 32 cfm each used to fold plastic bag flaps could be replaced with amplifying wedge nozzles and regulated air to 80 psig and then use only 16 cfm each. Operate 20 hours a day. Savings are (32-16) times 4 nozzles at 20/24 hours = 52 cfm all shifts. Cost is $1,000

4. Block cheese room uses 4x4 wedge nozzles at 32 cfm each used to blow water off the cheese (512 cfm). Operate 80% of time. Replace with 4x1 air knives each using 36 cfm, or 144 total cfm. Savings are [(512-144) x 80%] = 294 cfm all shifts. Installed cost is $3,000

Current average air flow to nozzles currently in use	642 cfm
Proposed average air flow to amplifying nozzles and air knives	202 cfm
Total air flow saved	440 cfm
Recoverable savings from air flow reduction	$110.70/ cfm yr
Annual electric cost savings from flow reduction	$48,707/ year
Total estimated cost of project (all materials and installation)	$6,000

Project #4: Use Venturi Nozzle Blow Guns

Additional savings can be created by replacing the blow guns with venturi nozzle blow guns. The system assessment recommends replacing 12 existing blow guns with OSHA-approved venturi amplifier blow guns.

Current average air flow with existing blow guns 60 cfm each (5/16" at 100 psig) x 12 guns x 2 hours/ 24 hours	60 cfm
Proposed average air flow with venturi blow guns 7 cfm each x 12 guns x 2 hours/24 hours	7 cfm
Total air flow saved	53 cfm
Recoverable savings from air flow reduction	$110.70/ cfm yr
Annual electric cost savings from flow reduction	$5,867/ year
Total estimated cost of project ($45 each times 12 blow guns)	$540

Project #5: Tank Agitation

This food industry factory has nine (eventually twelve) cleaning tanks which need agitation for maximum cleaning to occur. Cleaning takes place at night with each wash tank being agitated for about 2 hours.

The plant has built air lines with about forty-one 1/8" holes drilled every couple of inches for blowing compressed air into the water. Generally these lines are submerged only 24" and therefore have about 1 psig of water pressure on them. Thus low pressure air will work just as effectively to agitate the water, instead of using regulated but still much higher pressure compressed air.

We suggest the plant use these same lines in the same wash tanks, but beta test use of a

TABLE 6: SYSTEM ASSESSMENT PROJECT SUMMARY

	CURRENT SYSTEM		PROPOSED SYSTEM	
SYSTEM COMPARISON	CLEAN-UP AND SANITATION PERIOD	PRIMARY PRODUCTION PERIOD	CLEAN-UP AND SANITATION PERIOD	PRIMARY PRODUCTION PERIOD
Average Flow (cfm)	2,591 acfm	3,258 acfm	1,790 acfm	2,457 acfm
Compressor Discharge Pressure (psig)	108 psig	108 psig	104 psig	104 psig
Average System Pressure (psig)	104 psig	104 psig	103 psig	103 psig
Electric Cost per cfm	$70.75 /acfm/yr	$62.38 /acfm/yr	$65.37 /acfm/yr	$58.27 /acfm/yr
Electric Cost per psig	$916.58 /psig/yr	$1,016.09 /psig/yr	$585.10 /psig/yr	$715.86 /psig/yr

PROJECTED ENERGY COST SAVINGS FOR PROPOSED SYSTEM

AIR SYSTEM COMPONENT	ANNUAL ELECTRIC COST OF CURRENT SYSTEM	ANNUAL ELECTRIC COST PROPOSED SYSTEM	ANTICIPATED ANNUAL SAVINGS	ESTIMATED PROJECT COST	NET PROJECT COST AFTER REBATES
Total Compressed Air System	$386,533	$260,193	$126,340 plus $28,032 cabinet coolers = $154,372	$289,540	$129,762

small 7 psig blower to feed the system instead of hooking up to the compressed air system. This blower will require an electric hookup, but it appears service is available nearby each wash tank. The blower probably can fit under each tank so that it is out of the way.

Current air flow with compressed air 13 cfm per hole (1/8" regulated to 60 psig) x 41 holes x 2 hours/24 hours	45 cfm
Compressed air flow with blower air	0 cfm
Total air flow saved	45 cfm
Recoverable savings from air flow reduction	$110.70/cfm yr
Annual electric cost savings from flow reduction	$4,981/year
Total estimated cost of project (blower and installation)	$5,000

To be fair in the analysis, the blower will consume electricity. This will depend on the blower, but it will be in the range of 1 kW. This will cost 1 kW x 2 hours/day x 365 days/year x $0.08/kWh = $58 annually to operate. In other words, the blower solution is about 85 times more energy efficient than using compressed air. If this project is completed the utility company rebate will be calculated on the net energy savings ($4,981 less $58). Once this beta approach proves successful, modify all 9 (or 12 once line #3 comes online) wash tanks. The energy savings and the utility rebate will scale up arithmetically.

Conclusion

This project is a good example of the opportunities that exist in a modern factory to significantly reduce compressed air consumption. It is also a good example of the fact that simply reducing compressed air demand doesn't guarantee energy savings. In fact, it is usually the case that the supply-side system (the air compressors) must be reconfigured to deliver the energy savings. BP

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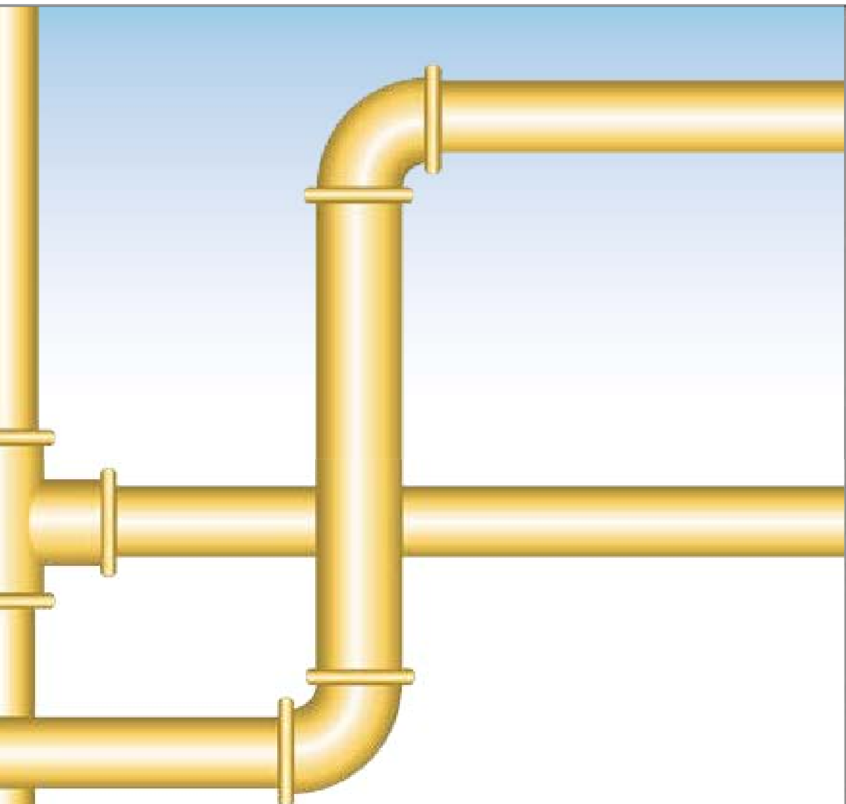
ASME EA-4-2010 — ENERGY ASSESSMENT FOR COMPRESSED AIR SYSTEMS

By Joe Ghislain for the Compressed Air Challenge®

Over the years, analyzing compressed air system operation and efficiency has gone under various names and taken many different shapes and forms. You may know these as; Assessments, Audits, Studies, and Surveys, but in all cases the compressed systems are analyzed using techniques, such as metering and measuring, to assess the system's performance and identify opportunities for improvement. The problem is that the results of these activities have varied widely; leaving the end-user to try and determine what is usable, credible and implementable. This has led to a lot of "no actions", resulting in assessments, audits, studies, and surveys being put on the shelf to collect dust. This issue is not unique to compressed air systems and applies to many other industrial systems as well. To try and alleviate this, a decision was made through work on the Superior Energy Performance program (www.superiorenergyperformance.net), which is an initiative guided by the U.S. Council for Energy Efficient Manufacturing, and supported by the Department of Energy, to develop system assessment standards. Applying these standards will assist plant personnel in identifying energy reduction opportunities through system improvements using a consistent and standard method.

In 2008, the American Society of Mechanical Engineers (ASME) Project Teams started work on the initial four system assessment standards, which cover Process Heating Systems, Pumping Systems, Steam Systems, and Compressed Air Systems. The standards were developed by cross functional teams of experts, and their work was overseen and approved by an ASME Standards Committee. For example, the compressed air project team included both members and instructors of the Compressed Air Challenge® (CAC), additional compressed air experts and knowledgeable industrial end-users. ASME issued drafts of the four new standards on August 19, 2008 for trial use to test and validate the standards. During the trial period, which ran through the end of 2009, the standards were field tested by consultants, utilities and industrial facilities. The standards were then revised, released for public comment, approved and issued as an approved ASME standard. On April 23, 2010, ASME EA-4-2010 — *Energy Assessment for Compressed Air Systems* was released as a standardized framework for conducting compressed system energy assessments.



The ASME EA-4 standard takes the same system approach that is taught in the Compressed Air Challenge® Fundamentals and Advanced Compressed Air System Management courses and provides a prescriptive but scalable process that can be tailored to each facility. Along with system definition, it sets requirements for organizing and conducting the assessment, analyzing the data, and reporting and documenting of the findings. Included in the standard are eight sections:

- Scope and Introduction
- Definitions
- References
- Organizing the Assessment
- Conducting the Assessment
- Analysis of the Data from the Assessment
- Reporting
- Documentation

The document also includes figures and appendices to further clarify the standard. The standard divides the requirements into Mandatory and Non-mandatory for further flexibility and shades the Non-mandatory items for quick reference. This standard along with its companion document ASME EA-4G-2010, *Guidance for ASME EA-4, Energy Assessment for Compressed Air Systems* provides a long need comprehensive framework for compressed air system assessment.

The standard starts with the Compressed Air System Hierarchy definition shown in Fig. 1 from the ASME EA-4-2010 standard.

The system is divided into three subsystems: Supply, Transmission and Demand. The Supply subsystem covers the conversion of primary energy to compressed air and includes the air compressors, air

ASME EA-4-2010 — ENERGY ASSESSMENT FOR COMPRESSED AIR SYSTEMS

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Joe Ghislain is currently Manager, Lean Supplier Optimization — Powertrain and a 6-Sigma Black Belt in Ford Motor Company's Lean Supplier Optimization Group. He has had over 25 years in the Automotive Industry and over 30 years' experience with Energy, Powerhouse Operations, Compressed Air Systems, and Operational/Manufacturing Efficiency Improvements. Some of the positions he has held include: Licensed Stationary Engineer, Power House Chief Engineer, Corporate Energy Engineer, Manufacturing Planning Manager, & Manager of Energy Efficiency Programs where he was responsible for developing and implementing energy management programs to reduce energy cost and usage through increased operational efficiency and improved energy practices.(including compressed air system improvements) within all of Ford's plants and divisions globally.

Joe has been part of the Compressed Air Challenge since its inceptions, serving on the Project Development Committee, Technical Advisory Committee, and as the End User Representative on Board of Directors. He is an instructor for both CAC Fundamentals and Advanced Compressed Air System Training and contributed to the development of both courses, as well as the Improving Compressed Air System Performance: A Sourcebook for Industry a CAC/ DOE Publication. Joe is CAC's designated ASME Standards Committee Member.

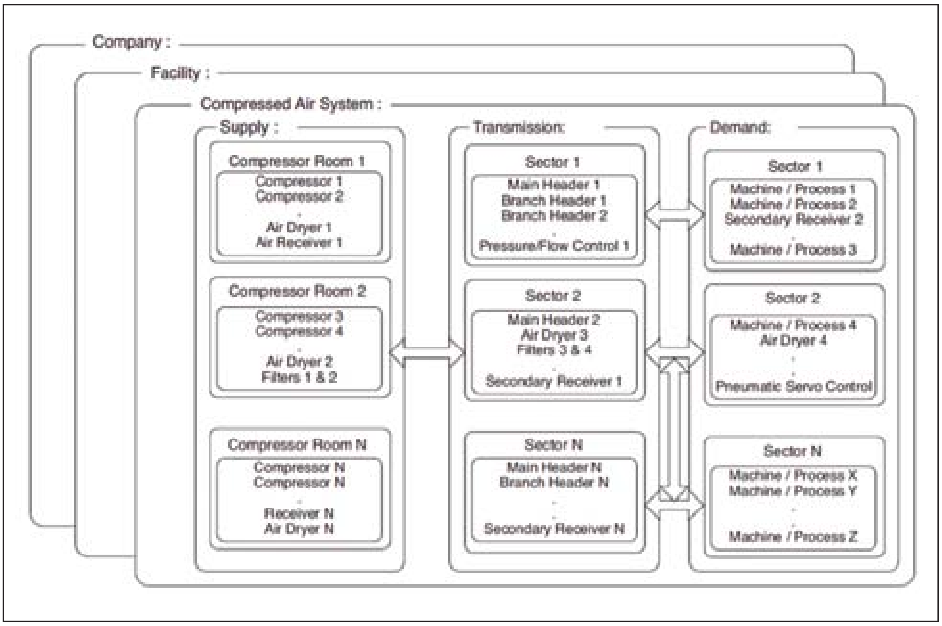

Fig. 1: Compressed Air System Hierarchy

treatment equipment and all piping and ancillary equipment up to and including the primary receiver. The Transmission subsystems covers the movement of the compressed air and includes the main header distribution piping, branch header and drops, secondary storage, treatment and controls associated with this subsystem. The Demand subsystem includes the total of all compressed air consumers including both productive end uses applications and sources of compressed air waste. This subsystem includes all end uses, point of use piping, secondary storage, treatment and controls associated with the end uses. When performing an assessment to this standard, all areas of the system are reviewed, not every application has to be addressed equally, but the study has to be comprehensive enough to be able to identify major energy efficiency opportunities for system improvement.

As with all energy systems the demand drives the supply. Taking a systems approach helps address overall system efficiency and puts the focus on total system performance rather than only concentrating on individual components, which may lead to sub-optimization of the system. A comprehensive systems approach requires understanding compressed air points of use, identifying and correcting poor performing applications, eliminating wasteful practices (including leaks, inappropriate uses, and artificial demand), creating and maintaining a balance between supply and demand, and optimizing compressed air storage and compressor controls. To accomplish this, the standard utilizes a Systems Engineering Approach, shown in ASME EA-4 Fig. 3. This 10 step methodical process covers all aspects of the planning and execution of an assessment, including defining the roles and responsibility of the assessment team.

The first step in the process is Organizing the Assessment. This is the initial pre-work required to make sure that the goals, objectives and deliverables are understood and that the onsite work is a quality event. There are nine subsections in Organizing the Assessment:

- Identification of the Assessment Team Members
- Facility Management Support
- Communications
- Access to Equipment, Resources and Information
- Assessment Goals and Scope
- Initial Data Collection and Evaluation
- Site-Specific Assessment Goals
- Assessment Plan of Action
- Goal Check

The first step starts with the Identification of the Assessment Team Members. The right people with the right skills, knowledge and authority are critical to not only to a successful assessment but more importantly to the implementations of the actions identified. The next four steps outline the guidelines and the requirements from the facility personnel and an agreement by the team on the roles and responsibilities, scope and goals. This buy-in and understanding from the facility/site personnel is essential for the success of the assessment. Gathering and analyzing the right initial data gives important insight into the facility and operations, which can save valuable time on site. The standard provides a mandatory appendix in the Preliminary Data Collection Matrix. This insures that if the standard is followed the proper data will be reviewed. The Site-Specific Assessment Goals are used to complete the Statement of Work. The Plan of Action is assessed using the Mandatory Appendix II, Plan of Action Matrix. The final step before conducting the assessment is verifying that the assessment plan will meet the stated goals.

Conducting the Assessment is the action phase that implements the plan in accordance with assessment plan and statement of work. There are nine subsections in the standard that cover this phase:

- Measurement Plan
- Site Access Procedures
- Assessment Kick-Off Meeting
- Deploy Data Collection Equipment
- Coordinate Data From Permanently Installed Data System
- Validate Data
- Plant Functional Baseline
- Functional Investigation
- Progress and Wrap-up Meeting

Establishing a baseline and understanding the system operation is critical, to creating an accurate baseline, so the measurement plan is important. In the Measurement Plan section, the standard covers measurement instruments, techniques, baseline periods, types of measurements, test points and parameters, which encompasses all of the best practices for baselining. The next two bullet points, the logistics and the kick-off meeting, are both important items in setting the stage for a successful assessment. The next four sections cover the implementation and validation of the measurement plan. The Functional Investigation is the heart of the assessment. This establishes the development and implementation of the detailed plan to perform the necessary measurements and observations of the compressed air system/

ASME EA-4-2010 — ENERGY ASSESSMENT FOR COMPRESSED AIR SYSTEMS

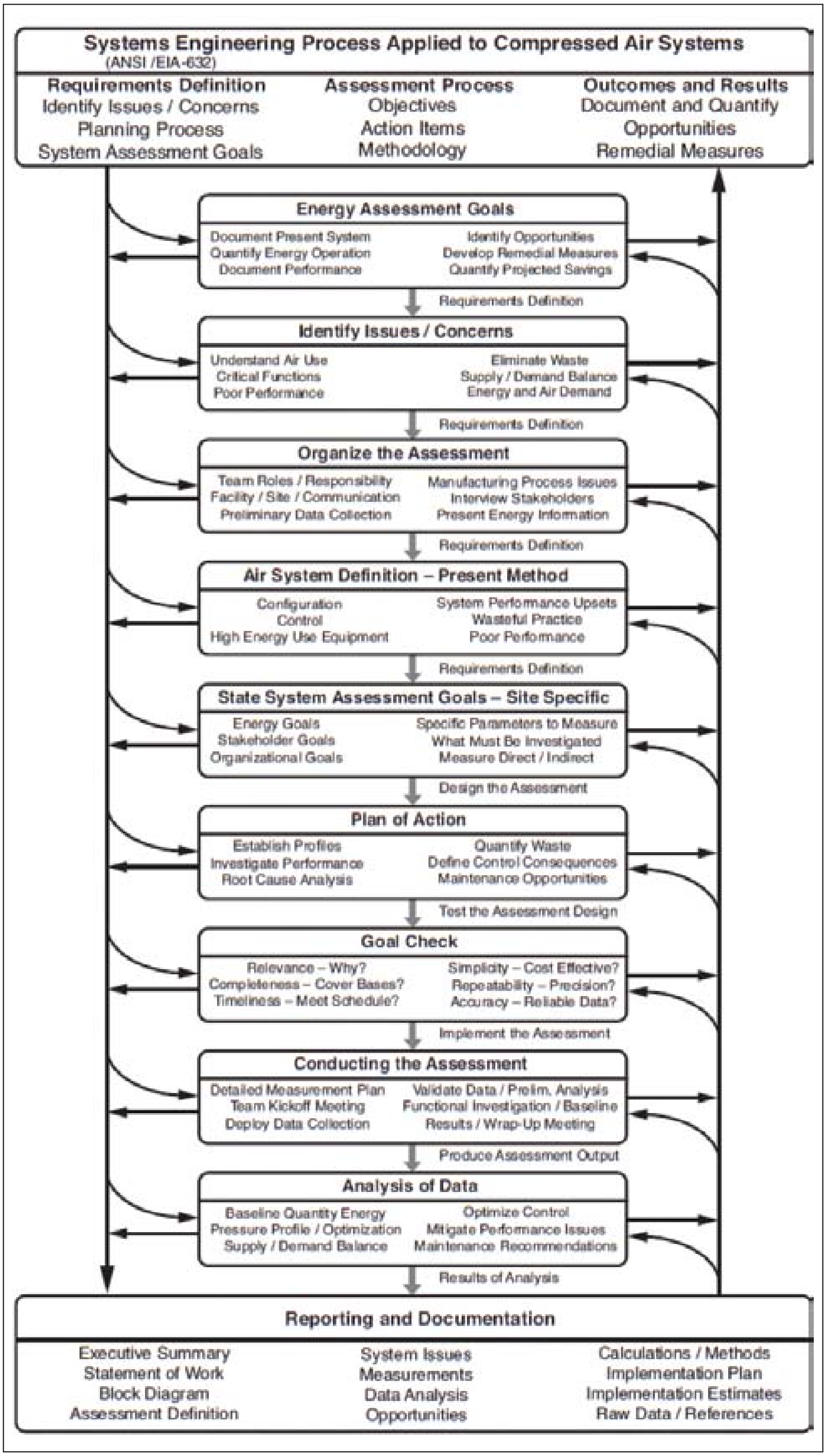

Fig. 3: Systems Engineering Process Overview

plant operations, and covers the supply, transmission and demand. The Mandatory Appendix II has extensive coverage of the elements and parameters required for proper system evaluation. The final step of the onsite process is the progress and wrap-up meetings. The progress meetings give a snapshot of where the team is in the process and identifies any additional assistance that the team may need to complete the tasks. The wrap-up meeting reviews the preliminary findings and establishes the "next steps" for the team.

Once the assessment is complete then the data analysis phase begins. Analysis of Data from the Assessment has twelve subsections that guide this process:

- Baseline Profiles
- System Volume
- Pressure Profile
- Perceived High Pressure Demand
- Demand Profile
- Critical Air Demands
- Compressed Air Waste
- Optimize Air Treatment
- Reduce System Operating Pressure
- Balance Supply and Demand
- Assessment Maintenance Opportunities
- Evaluate Heat Recovery Opportunities

For anyone that has taken the Compressed Air Challenge Fundamentals and Advanced training, this list will look very familiar as it is not only a big part of the training and CAC action plans, but the key to optimizing compressed air systems and identifying energy savings opportunities. Analysis of the Baseline Profiles gives an understanding of the system operation and establishes a baseline to compare and quantify the savings and effectiveness of future actions. These profiles can also be used to identify demand events that are adversely affecting the compressed air system including high volume intermittent uses. The remaining bullet points deal with the identification of system efficiency and operational improvements that could lead to energy usage and cost reductions.

The final section in the standard is Reporting and Documentation. The four subsections cover:

- Final Assessment Report
- Final Assessment Report Contents
- Data for Third Party Review
- Review of Final Report by Assessment Team Members

The heart of this section is in the Final Assessment Report Contents; the other three sections contain short guideline descriptions. The assessment report includes the following:

- Executive Summary
- Facility Information
- Assessment Goals and Scope
- Descriptions of System(s) Studied in Assessment and Significant System Issues
- Assessment of Data Collection and Measurement
- Data Analysis
- Annual Energy Use Baseline
- Performance Improvement Opportunities and Prioritization
- Recommendation for Implementation Activities
- Appendices

The final report outlined in the Standard is very detailed and comprehensive. The two sections, Performance Improvement Opportunities and Prioritization, and Recommendations for Implementation Activities, are the key and critical sections for system optimization and energy efficiency improvements. They have to provide the necessary detail for the recommendations to be acted upon and bought into by the plant personnel. The EA-4 standard provides a standardized framework for conducting an energy assessment for compressed air systems. The use of this standard will provide clearer, more consistent, relevant, and repeatable results from these studies. This will lead to more frequent implementation of recommended improvements and result in less studies lingering on the shelf gathering dust.

For more information, the complete standard and guidance document are available from the American Society of Mechanical Engineers at www.asme.org. Information about training in Compressed Air System Management and the comprehensive manual, Best Practices for Compressed Air Systems are available through the Compressed Air Challenge at www.compressedairchallenge.org. BP

Reference: American Society of Mechanical Engineers, ASME EA-4-2010 - Energy Assessment for Compressed Air Systems

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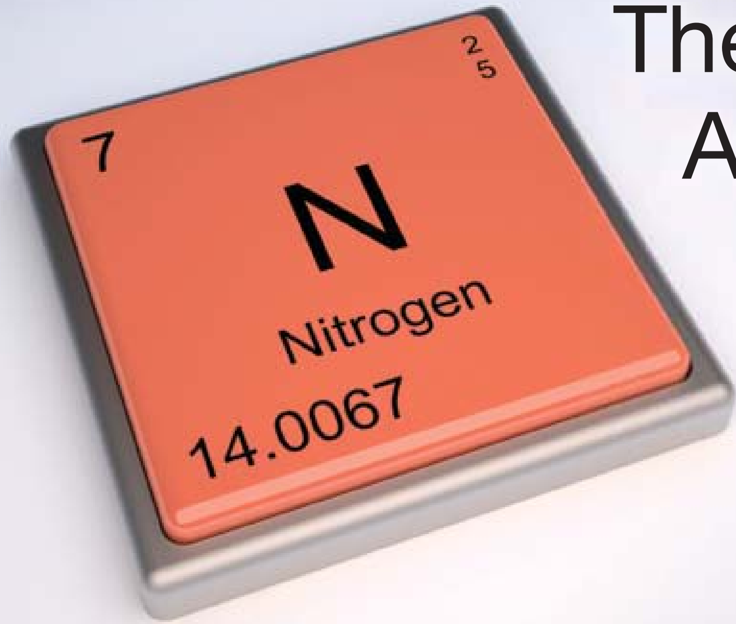

The Energy Costs Associated with Nitrogen Specifications

By Mike Flowe, Flowe Nitrogen Systems

So you need nitrogen in your plant! In a high percentage of cases, generating your own nitrogen using commercially available equipment is a very cost effective alternative to purchasing liquid nitrogen or cylinder nitrogen from traditional supply sources like the industrial gas companies. In some cases, the return on investment (ROI) ranges from six months to 2 years, but ROI can range, depending on several factors, to several years while still being a good investment. With rising fuel and energy costs, the cost of liquid nitrogen is going up and is making it much easier to justify the purchase of a nitrogen generator in a wide range of purities and pressures.

If you are considering purchasing a nitrogen generator for your facility, you may be in luck. The first question to settle is what nitrogen purity you actually need for your application and facility. Nitrogen purity is generally expressed as a percent, such as 99% Nitrogen (which means 1% Oxygen with the balance nitrogen and other inert gases). In some high purity cases, it may be expressed as PPMv Oxygen remaining in the product gas. 10 PPMV is the same as 99.999% nitrogen. 10,000 PPMv equals 1% O_2. The answer to the purity question can make or break a project's budget, and have a huge impact on the amount of electricity used. There are many factors to be considered. First there are some basic dynamics common to self generated nitrogen gas that should be considered.

About the Technologies

There are actually four main processes to generate nitrogen on site; the old traditional air separation process where large volumes of compressed air are pressurized to a high pressure (several hundred psi) and quickly expanding to at or near ambient pressure, through several stages of recirculation, compression, and expansion to liquefy the various constituents of air such as nitrogen, oxygen, argon primarily. Other rare gases are also liquefied at the same time. Each of the gases liquefies at a given cryogenic temperature. These systems are usually for customers who need high purity and use greater than 20 tons of nitrogen per day and are typically leased from an industrial gas company. There are some companies around that design, build and sell turnkey on site cryogenic plants.

In some cases, using a catalyst in conjunction with lower purity nitrogen from a membrane or PSA is used to achieve extremely low oxygen levels in the nitrogen gas, called De-Oxo, but is used rarely and will have some level of hydrogen gas in the nitrogen product. It is used to keep the compressed air requirement lower than say a PSA at 99.9995%, but the system is more complicated.

For the purpose of this article, we will focus on the two non-cryogenic methods of producing nitrogen gas; Pressure Swing Adsorption (PSA) and Membrane. Both of these technologies use compressed air as a feed stock in the production of nitrogen.

Pressure Swing Adsorption (PSA) uses, in most cases, two vessels, packed with carbon molecular sieve (CMS). The CMS adsorbs Oxygen as compressed air flows upward through one of the vessels while the other vessel is depressurized and a small amount of the nitrogen output is flowing downward (counter flow) to drive off or desorbs the oxygen and moisture collected by the vessel when it was online removing oxygen from the air. The vessels alternate this adsorption and desorption process. There are several steps in the process; equalization, pressurization/depressurization, adsorption/purge, then back to equalization. This is a basic description of the process, but there are several things happening at various times throughout the time cycle which is generally a 2 minute cycle total. PSA generally takes up a little more floor space and is a little noisier than most membrane systems. It requires in most cases an air buffer tank, nitrogen buffer tank, and sometimes is sold without the air purification system that is critical to the protection of the CMS beds. PSA is generally offered for sale using a 125 psi air compressor, common to most plant air systems. PSA technology is generally used where higher purities are needed, and in many cases if the system is very large in capacity. Over the last 10–12 years, there have been many advances in the production of both membrane and pressure swing adsorption (PSA) technologies. Flow improvements in carbon molecular sieve (CMS) used in PSA equipment has shown approximately a 60% increase in flow rates and air to nitrogen ratios have come down dramatically.

Membrane systems use hollow fibers of man-made polymers, of various lengths, diameters, materials, and efficiencies to use differential pressure in a process known as selective permeation to separate the gases from the compressed air stream. Sometimes millions of these hollow fibers are packed into a vessel and are referred to as membrane bundles, or just membranes. The membranes are generally installed in parallel with each other to provide the needed capacity. The device uses the semi-permeable fibers to allow faster gases to quickly permeate the walls of the fibers and released to atmosphere. Faster gases are mainly oxygen, carbon dioxide, hydrogen, and water vapor. There are no moving parts to the separation process, which is attractive from a maintenance and simplicity standpoint. The systems require other components which do have moving parts as well as other electrical controls to make the system functional. Most industrial systems also have an air circulation heater which adds to the kW consumption of the system. The systems generally take up a small footprint and in most cases, very quiet. If they are not quiet, the wrong membrane was used or the piping and components are severely undersized to keep costs and footprint at a minimum.

There are currently only five companies manufacturing membranes and each has its own design variations. Among these variations from the manufacturers are their air-to-nitrogen ratio (ANR) sometimes expressed as the inverse of ANR called recovery (percentage of nitrogen to the total air consumed. Other differences are the fiber materials, diameters,

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"Many companies use nitrogen when they don't need to. Because nitrogen is a very dry gas, it is sometimes used in place of dry compressed air."

— Mike Flowe, Flowe Nitrogen Systems

pressure drop characteristics, degree of sensitivity to oil vapor, physical size, pressure ranges, temperature ranges, production efficiency, energy efficiency, and range of model selection, overall quality and cost. Each manufacture has is unique advantages and disadvantages when compared to each other. They are not all the same, by any means and as this article will demonstrate the selection process will make a huge impact on, not only the capital cost, but more importantly the life cycle operating cost which is primarily the electricity to run the system.

Some membranes, with the emphasis on SOME, can reach purities approaching that of a PSA, but they cannot do so economically or reliably. These membranes are put in series, two or three stages, creating a very high pressure drop across the system and are extremely inefficient and cost much more than a PSA at the higher purities. To keep capital costs competitive, membrane systems are usually quoted using a 150–200+ psi air compressor, because a membrane will produce more nitrogen flow at a given purity at higher pressures. Membrane technology is generally used when purities required are 99% or lower and some are not efficient at that purity. Other reasons for choosing a membrane generator are portability, flexibility in system design for special space considerations, and they are simpler to understand the process and maintenance is generally simpler.

Both technologies use essentially the same filtration that requires essentially the same level of maintenance. PSA units have several valves that will leak at some point over the years and require routine maintenance. These leaking valves will cause the purity to fall off abruptly, so there are some maintenance considerations not found in membrane systems. In either case, the heart of both technologies, the membrane fiber or the carbon molecular sieve (CMS) must be protected from water, particulate, oil and in almost all cases, oil vapor. Regular filter maintenance must be performed or the nitrogen purity will decline to the point where the system is not fit for its purpose, costing a large percentage of the initial cost of the nitrogen generator to bring the system back up to original specifications. The compressed air purification system should consist of tank(s), aftercooler, water separator, air dryer (selected carefully for the application), and multi-stage particulate and coalescing filters and carbon bed, all designed to meet the unique needs of the membrane brand or PSA system.

TABLE 1: EFFECTS OF PURITY SELECTION ON ENERGY REQUIRED

CONDITIONS — 77 °F & 116 PSI @ GENERATOR INLET, 125 PSI COMPRESSOR

SYSTEM TYPE	N_2 PURITY	SCFM N_2	ANR	SCFM AIR REQ'D	CCF	MIN COMP CFM	COMP HP (KW) REQ'D
Membrane - HFLP	95%	100	2.64	264	1.25	330	75 (56)
Membrane - LFHP	95%	100	1.83	183	1.25	229	60 (45)
PSA	95%	100	1.64	164	1.25	205	50 (37)
Membrane - HFLP	99.5%	100	8.05	805	1.25	1006	250 (187)
Membrane - LFHP	99.5%	100	3.38	338	1.25	423	100 (75)
PSA	99.5%	100	2.50	250	1.25	313	75 (56)
Membrane	99.99%	Not Recommended for this purity					
PSA	99.99%	100	4.50	450	1.25	563	125 (93)
Membrane	99.999%	Not Recommended for this purity					
PSA	99.999%	100	6.85	685	1.25	856	200 (149)

The Energy Cost per scfm of Your Nitrogen Specification

The higher the percent nitrogen required, the larger the system to obtain a given flow rate. More compressed air will be required and more electricity consumed. Capital cost, long term maintenance cost, and floor space will increase as well. Whereas, a 95% N_2 system will take approximately 2 scfm of compressed air for 1 scfm of nitrogen, the ratio of air to nitrogen could be as high as 12:1 at 99.999% N_2 in some older systems. Here are a few "Rule of Thumb" Nitrogen specs for some industries (For Comparison Only)

1. Blanketing to prevent hazardous conditions — Approximately 95–97% for most applications
2. Blanketing edible vegetable oils — approximately 99.9%
3. Food Packaging — approximately 99.5% for most applications
4. Printed Circuit Boards — Traditionally has been in the 99.9%+ range, but long term testing shows that this application can be done at 97% with no visible or long term effects
5. Heat treating metals — Depending on materials and process, can be 97% to as High as 99.999% (10 PPM of O_2)

The bottom line here is that most nitrogen systems are "over spec'd" because the information is sometimes hard to obtain and so to be safe, consumers will often specify a higher purity of nitrogen than they need. Sometimes this comes from an equipment manufacturer, who has not done sufficient testing at various nitrogen purities. In the earlier days of nitrogen generators, this information was difficult to come by, but over the years more and more application specific information has become available. This can sometimes be obtained through industry associations and from equipment suppliers, and industry professionals. Another valuable source is from your own employees who may have worked in a similar job in the past and can tell what purity worked at their former company.

Using Nitrogen in Place of Compressed Air — Should you or shouldn't you?

Many companies use nitrogen when they don't need to. Because nitrogen is a very dry gas, it is sometimes used in place of dry compressed air. At steady state conditions 95% N_2 is around -85 ˚F Atmospheric Dew Point (5.3 PPMv Water Vapor). 99.5% N_2 is below -105 ˚F (<1 PPMv). It is enticing for companies to use nitrogen in place of air; but at what cost?

Below are a couple of reasons consumers use nitrogen in place of clean, dry compressed air; one possibly justified, the other a very costly practice.

In one example a company has experienced problems with compressed air quality due to a variety of reasons. Usually, however, a properly applied air dryer, the correct selection of filtration combinations, choosing a dew point suitable for the application & ambient, and having properly maintained equipment will be as reliable and certainly much more cost effective than using nitrogen gas. The user will use at least 1.8 times as much air to produce the nitrogen and you have to dry and filter the air to the nitrogen generator with greater emphasis on purification design than is generally needed for the plant. It is just

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not a good idea. Use a qualified compressed air professional to solve this problem using compressed air.

There are companies using nitrogen at multiple locations throughout the plant and only a small amount of air for pneumatics. The system might be simplified having a single piping network using nitrogen. In this example, a case could be made FOR the use of nitrogen in lieu of compressed air, as long as the nitrogen purity required is fairly low; i.e. 95–97%, and usually if an extremely low dew point is required for the facility. This should be thoroughly thought out, weighing the pros and cons before using nitrogen in place of compressed air.

Energy Cost Implications Based On Varying Nitrogen Purities

Table 1 compares a high flow, low purity membrane (HFLP), a high purity lower flow membrane (HPLF) and pressure swing adsorption (PSA) type nitrogen generators. Due to the wide disparity in membrane performance among the five manufacturers, I chose a low and a high range for an overall comparison. This is not an effort to push PSA over membranes. There are many applications where membranes are a great choice. One just needs to know the limitations of each and apply the technology that best fits the application's requirements. In the tables there are some abbreviations that need to be defined here. Scfm N_2 is an arbitrary flow rate used for the basis of these examples. Scfm is nitrogen and air flow at atmospheric conditions that the nitrogen and the compressed air manufacturers use as their standards. The standards may vary a bit, one to another, but they all come back to some ambient condition, so we will not get into conversions in this article. The safety factor applied to the air required will cover these minor differences. ANR is the air-to-nitrogen ratio. This is the measure of the efficiency of the technology. Multiply this number by the N_2 scfm to get the scfm Air required. CCF is the Compressor Correction Factor. Size the compressor 1.25–1.3 times the required compressed air scfm to allow for winter/summer ambient, variations in membrane performance, flow unit conversion, as well as the compressor manufacturer's flow tolerance. Do not go below this number. Some manufacturers recommend a 1.3 CCF. Over the years, I have used the 1.25 and this number has worked well for me.

In Table 1, one can see how drastically the effects of the purity chosen for the 100 scfm nitrogen example. The compressor horsepower ranges from 50 to 250 depending on things like the technology used, the purity percentage of the nitrogen.

How Pressure Affects The Nitrogen Flow, Compressed Air and Electrical Requirements

Table 2 builds on the examples from Table 1 only changing to a higher pressure. Temperature remains at 77 °F. This will show how both membranes and PSA increase in capacity as pressure increases. So as the capacity increases, so does the air required and the horsepower. This example can also show that fewer or smaller membranes could be used to provide the 100 scfm of N_2, but keep looking at the air-to-nitrogen ratio (ANR). Another abbreviation has been introduced in Table 2, N_2 Flow PCF. This is the pressure correction factor to be multiplied by the 100

TABLE 2: EFFECTS OF PRESSURE/PURITY ON CAPACITY AND HP (KW) REQUIRED

CONDITIONS — 77 °F & 116 INCREASED TO 141 PSI @ GENERATOR INLET, 150 PSI COMPRESSOR

SYSTEM TYPE	N_2 PURITY	SCFM N_2 116 PSI	N_2 FLOW PCF	N_2 FLOW 141 PSI	ANR	SCFM AIR REQ'D	CCF	MIN COMP CFM	COMP HP (KW) REQ'D
Membrane - HFLP	95%	100	1.22	122	2.65	265	1.25	331	100 (75)
Membrane - LFHP	95%	100	1.30	130	1.83	183	1.25	229	60 (45)
PSA	95%	100	1.16	116	1.83	183	1.25	228	60 (45)
Membrane - HFLP	99.5%	100	1.21	121	8.19	819	1.25	1024	250 (187)
Membrane - LFHP	99.5%	100	1.33	133	3.22	322	1.25	403	100 (75)
PSA	99.5%	100	1.16	116	2.78	278	1.25	347	100 (75)
Membrane	99.99%	Not Recommended for this purity							
PSA	99.99%	100	1.16	116	5.00	500	1.25	625	150 (112)
Membrane	99.999%	Not Recommended for this purity							
PSA	99.999%	100	1.16	116	7.61	761	1.25	951	250 (187)

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THE ENERGY COSTS ASSOCIATED WITH NITROGEN SPECIFICATIONS

"Over the life cycle of the equipment, 90% of the life cycle costs are the energy to run the compressor."

— Mike Flowe, Flowe Nitrogen Systems

scfm nitrogen (originally at 116 psi) but now is at 141 psig at the inlet to the membranes or the PSA adsorber beds.

We have learned from Table 2, that by raising the pressure, smaller systems could be utilized to save on capital costs for the nitrogen generator, but the compressor will usually go to the next compressor HP size by going from a 125 psi to a 150 psi compressor. In general, the compressed air industry has used a "rule of thumb" of 1% kW increase for every 2 psi increase, in this case, approximately 12.5%. Over the life of the equipment, approximately 90% of its life costs will be in the energy required to run it. Capital costs, installation and maintenance costs are small compared to the power consumption. That is why it is so important to make wise decisions on your nitrogen equipment selections.

Impact on Temperature Using the Previous Examples and Its Energy Impact

Table 3 shows the performance of the same previous examples but adding heat to the compressed air to make the membranes produce more nitrogen per membrane bundle, and coupled with the higher pressure from Table 2, the membrane generator will produce more nitrogen (or require less or smaller membranes to do the job). The circulation heater required for a membrane system is typically 2.4kW per 100 scfm of compressed air in order to cover a normal range of ambient temperatures in commercially available systems. This can be quite significant on less efficient membrane systems. In the 99.5% example, 104 ˚F, 150 psi Air which would require approximately a 28 kW heater for the HFLP system. Another Abbreviation, N_2 Flow TCF is the temperature correction factor to be multiplied by the initial 100 scfm flow as well as the pressure correction factor (PCF) to get the increased N_2 flows shown in the table.

PSA, on the other hand, loses capacity as temperature rises and its air to nitrogen ratio declines slightly as well. This is a real situation that needs to be looked at in any case, especially in hotter climates and if the PSA is located outdoors. Most quotes from PSA

TABLE 3: EFFECTS OF PRESSURE/PURITY/TEMPERATURE ON CAPACITY AND HP (KW) REQUIRED

CONDITIONS - 104 ˚F & 116 INCREASED TO 141 PSI @ GENERATOR INLET, 150 PSI COMPRESSOR

SYSTEM TYPE	N_2 PURITY	SCFM N_2 116 PSI	N_2 FLOW PCF	N_2 FLOW TCF	N_2 FLOW 141 PSI & 104 ˚F	ANR	SCFM AIR REQ'D	CCF	MIN COMP CFM	COMP HP (KW) REQ'D
Membrane - HFLP	95%	100	1.22	1.1	134	2.65	356	1.25	445	125 (93)
Membrane - LFHP	95%	100	1.3	1.18	153	1.89	290	1.25	362	100 (75)
PSA	95%	100	1.16	0.9	104	1.825	191	1.25	238	60 (45)
Membrane - HFLP	99.5%	100	1.21	1.2	145	8.19	1189	1.25	1486	350 (261)
Membrane - LFHP	99.5%	100	1.33	1.14	152	3.58	545	1.25	681	150 (112)
PSA	99.5%	100	1.16	0.9	104	2.78	290	1.25	362	100 (75)
Membrane	99.99%	Not Recommended for this purity								
PSA	99.99%	100	1.16	0.9	104	5.00	500	1.25	625	150 (112)
Membrane	99.999%	Not Recommended for this purity								
PSA	99.999%	100	1.16	0.9	104	7.61	761	1.25	951	250 (187)

suppliers are at 68 ˚F, because they are more competitive at that temperature. The reality is that at real world ambient, considering the compressor's aftercooler efficiency, the type of dryer used, the compressed air temperature can easily get to the 104 ˚F used in this example or higher. If higher than 104 ˚F it is recommended to cool the air prior to entry into the adsorber beds.

With the addition of pressure and temperature, the compressor sizes go from a low of 60 hp to as high as 350 hp depending on system and purity selections.

In summary, it is my hope that this article will be most beneficial in providing a little more than a basic understanding of the application of nitrogen generation equipment. This is a very complex industry and much more to understand and talk about, but the purpose of this article was to make consumers aware of the effects of their choices in equipment, and to be able know what questions to ask when selecting the system, membrane or PSA that best meets their needs. There are many other factors other than energy that would affect these choices, but keep in mind, something that was stated earlier. Over the life cycle of the equipment, 90% of the life cycle costs are the energy to run the compressor. BP

About The Author

Mike Flowe is an industry professional with 31 years of experience in compressed air system application and design, over 20 years of application, design, engineering, consulting and specifying both low and high pressure systems. His experience with control systems, complete system P&ID design, gas booster systems, and previous manufacturing of both membrane and PSA systems, gas boosting equipment, and breathing air gives Mike a broad base of experience to assist clients all over the world with their unique needs. His company, Flowe Nitrogen Systems, is an independent consulting firm that offers a variety of services relating to the compressed air and nitrogen gas, and breathing air industries. The company is located in Orange Beach, Alabama.

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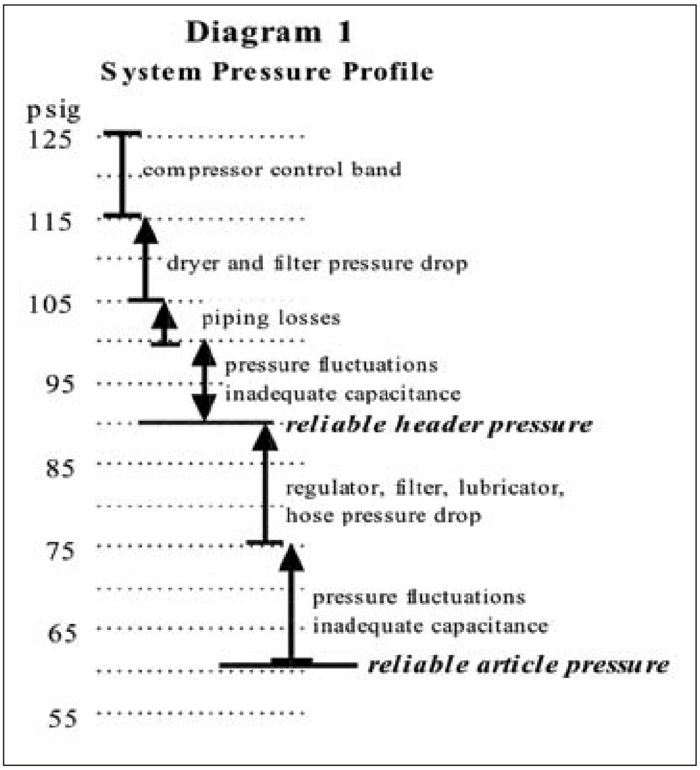
Eliminating PRESSURE Problems in Compressed Air Systems

By Dean E. Smith, iZ Systems Inc.

A couple of key principles must be considered if we want to understand and control the operating costs of your compressed air system. First, compressors pump air, they do not make pressure. The system creates the back pressure which the compressors must pump against. When the compressor delivers more air than the demand requires, the pressure rises and of course, the reverse is also true. Secondly, any component or application which forces the pressure to be higher than necessary creates wasted energy in the system. This waste is not linear to the increase in pressure but can be exponential for many reasons. However, the main contributors are artificial demand and the size of the compressors in the system.

In our experience, 25–30% of the horsepower on line in most systems is due to unnecessarily high system pressure. Therefore, if we identify and correct the applications that are driving the requirement for higher system pressure, we can turn off compressors. This is not to say that there aren't problems and opportunities in the compressor room, but the production department's requirements for pressure will normally out-weigh any available compressor control refinements. The key benefit which must be communicated to production is that the application will no longer be sensitive to system pressure. It becomes more reliable and repetitive, which increases quality and productivity.



Determine Where the Inefficiency Lies

The simplest way to determine which applications are driving the system pressure is to ask the compressor operators which applications are the most sensitive to pressure fluctuations. The compressor operators usually receive a phone call from production personnel if a compressed air application is not performing correctly. Talking to the production personnel who call identifies the application which is not performing reliably. Unfortunately, the phone call often generates an adjustment in the compressor operating arrangement or pressure until the application performs acceptably. *This is a minimum acceptable standards* approach which does not look at the process to determine what may have changed. Instead, it compensates for all problems with increased system pressure.

For example, if a filter clogs up or a leak occurs at the point of use on a critical application, higher pressure for the entire system will be required to provide the same pressure to the application. Therefore, the pressure required is determined by the cumulative delta pressures in the system added to the actual pressure required at the inlet to the device — called the *article pressure. Diagram #1* depicts an actual system pressure profile and is typical of most systems we audit. When a profile is presented in this manner it is easier to determine where the greatest pressure losses are located and how to improve the performance of an application.

Improve the Efficiency

There are two ways to increase the pressure at the article on this application. We can raise the system's pressure, or we can decrease the pressure losses between the compressors and the article pressure. Raising the system pressure is the easiest but most expensive solution in terms of operating costs. But, since most organizations do not track the cost of compressed air, the additional costs are lost in the general budget and are not associated with the decision to raise pressure. The rule of thumb is that every increase of one psi in systems pressure increases the required on line compressor horsepower by 0.5%. So, if one operates a 500 hp system and raises the header pressure by 10 psi to overcome a problem with an application, an increase of 5% or 25 hp is expected.

In an actual system, however, this is only part of the story. The increased pressure increases the demand for air by all users that are unregulated, including leaks, open blowing, and users with the regulator cranked completely open. This is called *artificial demand*.

ELIMINATING PRESSURE PROBLEMS IN COMPRESSED AIR SYSTEMS

In a system of this size in good repair, artificial demand will easily account for an additional 100 scfm of demand or another 25 hp due to the increased pressure. If this increased demand requires that an additional compressor be turned on, the increase in power will be disproportionate. If the backup compressor were 200 hp, the online horsepower would likely increase by 100 hp or more.

The alternative approach is to analyze the pressure losses and then, wherever feasible, to reduce the losses between the compressors and the article pressure of the critical application. In the system pressure profile shown in the diagram, there is more than 30 psi of pressure loss from the header pressure to the reliable article pressure. A portion of this loss is attributable to inadequate capacitance and was addressed in detail in an article published in the January 1997 issue of *AFE Facilities Engineering journal — Six Ways to Use Storage to Control Compressed Air Costs*. Here, we will examine the other obvious opportunity which is the pressure loss created by the point of use components — the filter, regulator, lubricator (FRL), and hoses.

Find the Pressure Drop

It can be very difficult to measure the pressure drop on an intermittent application with a pair of gauges. So, purchasing an accurate delta pressure measuring instrument is recommended. Observing the regulator gauge gives a general idea of the delta pressure at a particular application. The difference between the setpoint of the regulator when static and the stable pressure when the application is flowing will approximate the pressure loss. Usually, the results of the analysis are that the point of use components — the filter, regulator, lubricator, and final hoses — are the places to easily and significantly reduce the pressure losses.

ELIMINATING PRESSURE PROBLEMS IN COMPRESSED AIR SYSTEMS

In the sample profile, the pressure loss due to these components is shown as 15 psi (90 to 75 psig) but it is often as high as 25–30 psi. This is true frictional loss due to the resistance to flow and is therefore dependent upon the pressure, temperature, and rate of flow of the application. But these components are normally sized to match the connecting pipe size and are not selected based on the acceptable pressure loss. For example, at 90 psig and 40 scfm, a standard 1/2" FRL causes more than 18 psi of pressure loss. On an application that determines the operating pressure of the system, a different approach is warranted. Higher quality components are available in the same nominal size with lower designed deltas. Or, standard components can be oversized by one or two nominal sizes to achieve a similar result. (Over sizing FRL components can increase hysteresis which may lead to other problems in intermittent or critical applications, see referenced article on storage). Designing a total point of use component pressure loss of <6 psid, which allows for filter dirt loading to increase the delta to 10 psid, is recommended.

Do the Analysis

It is critical to remember that this analysis must be based on rate of flow not the average consumption. Rate of flow is the volume required in a specific period of time corrected to scfm. For instance, if a device uses four standard cubic feet in six seconds once a minute, the average consumption would be four scfm and one could improperly install 1/2" components expecting minimal pressure loss. But the rate of flow in this example, is calculated as (4 scf x 60 secs / 6 secs = 40 scfm) and will generate the >18 psi pressure loss discussed above. To obtain this rate of flow from a manufacturer of pneumatic equipment, one must ask very specific questions because they will always quote the average rate of consumption not the highest rate of flow at any specific time.

Reducing the pressure losses one identifies allows a more reasonable operating pressure, and the resultant reductions in on-line compressor horsepower may be surprising. But, because storage in a compressed air system is a function of the physical size of the receivers plus the piping and the useful pressure differential which is available, reducing the system pressure reduces the storage capability. This is a relatively straight forward problem and is discussed in the article previously referenced. Approaching poor application performance in the manner described requires some additional effort, but the good news is that these are the least expensive problems to fix in the system.

Conclusion

In most plants, a few of these point of use problems dictate the operating pressure for the entire system. Concentrating on those applications requiring higher pressures and those applications with performance problems, one quickly learns what the lowest practical header pressure should be. The improvement in the performance of the individual applications is a side benefit, but it will win the support and endorsement of production personnel. BP

Dean Smith is the General Manager of iZ Systems, a consulting firm specializing in auditing and designing compressed air systems, and was formerly the Principal of Air Management, Atlanta, GA. He is a member of the Technology Core Group which wrote the training materials for the Compressed Air Challenge of the DOE. He has performed complete system audits on over 1,000 plant compressed air systems providing recommendations that have improved quality and productivity while reducing plant operating costs. For further information, Mr. Smith can be reached at (404) 307-6836 or email at dsmith@izsystems.com.

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> **"In our experience, 25–30% of the horsepower on line in most systems is due to unnecessarily high system pressure. Therefore, if we identify and correct the applications that are driving the requirement for higher system pressure, we can turn off compressors."**
>
> **— Dean E. Smith, iZ Systems Inc.**

THE DEMAND-SIDE TECHNOLOGY PROVIDER

Pneumatic Cylinder Retrofit Reduces Pressure Requirements

By Gary Wamsely, JoGar Energy Services

A plastics molding plant had engaged us to conduct an 'on-site' Energy Assessment of their facility. The annual 'spend' for electricity, natural gas, and water was about $3.2 million for this modern 275,000 square foot, fully air-conditioned facility. During the Review, several opportunities were identified and delineated in lighting, HVAC, process ventilation, the water systems and energy supply contracts. However, the most significant savings were in their compressed air system.

The Supply Side of the Compressed Air System

Production operations (7/24/360) required two x 700 horsepower, water-cooled rotary screw air compressors. One air compressor was fully loaded and the other was a Variable Speed Drive air compressor controlling the wet receiver pressure at 120 to 125 psig.

The plant air distribution piping system was robust. The system had 8" and 6" mains, a 4" loop on each of two plant production levels and 2" size pipe drops to each of about fifty (50) large plastic molding machines. System pressure drop from compressor discharge to the mold machines was only about 4 to 6 psig.

Air pressure below 110 psig to the inlet regulator on the individual molding machines resulted in production problems. Due to an intermittent 10 psig system pressure variation (caused by manual air-hose usage), the utilities team was operating the air compressors at a 122 psig set-point. We documented air pressure to the individual molding machines between 110 and 118 psig over several days. Production was good, everyone seemed pleased.

The air compressors were relatively new. In fact the original 600 hp motors had been recently replaced with 700 hp units to assure adequate pressure. Four, originally installed 350 hp air-cooled rotary screw air compressors had been replaced due to on-going operational problems, frequent rentals needed and production quality issues. Yet, I noted that these new 3,200 scfm compressors were 115 psig nominally rated.

THE DEMAND-SIDE TECHNOLOGY PROVIDER

Pneumatic Cylinder Retrofit Reduces Pressure Requirements

> "Compressor reliability, plant-wide air leaks reduction, motor power savings and electric demand reduction were estimated to total a savings of $300,000 per year."
>
> — Gary Wamsely, JoGar Energy Services

The Demand Side of the Compressed Air System

A plant expansion was being contemplated and the engineering staff had planned to include another $350,000 compressor in the project to handle the new load. After some lengthy discussion about the compressors and energy costs, it was decided that we should conduct a more thorough analysis of the equipment and mold machines to try and identify opportunities for improvement.

The mold machines were of European design. They were robust, high-tech, compact and very productive. They operated amazingly well at high-cycle frequency rates for their eight years of age.

It was difficult for me to understand the need for 110 psig pressure to make the machines operate reliably. I had visions of a huge 'artificial demand' and long-term compressor reliability concerns. Close analysis identified the "Achilles Heal" in the demand side of the system. Actually, it identified two of them! They were located in two different types of mold machines.

Type #1 Mold Machine

One type of molding machine utilized a vertical 40 mm diameter x 16" long air cylinder that lowered and raised the heavy mold press assembly. This air cylinder was located in the center of the 20 foot square, highly automated process. Cylinder cycle time was 10 seconds. Compressed air supply, from the 2" size pipe, passed through a ½" diameter pipe to an undersized ½" Regulator/Filter/Stop Valve Station. Then, 105 psig compressed air passed on through a 6 mm inside diameter plastic hose to the solenoid station operating the cylinder.

Trials had been conducted at a lower pressure using a small surge tank. Lower supply pressure increased cycle time and reduced machine productivity. The air cylinder had difficulty lifting the heavy mold assembly back to the START position. Further discussion with the maintenance crew identified air cylinder re-builds as a regular repair issue. We also learned that a replacement air cylinder option was now being offered by the European mold machine supplier in a larger 50 mm size. Wonder why?

Our recommendation, on Mold Machine Type #1 was to install new 50 mm size cylinders and use the old 40 mm cylinder body as a surge vessel for the Solenoid valve return stroke. We also replaced the ½" air supply pipe with 1" pipe, replaced the ½" size Regulator station with ¾" size and changed out the 10 feet of 6 mm tubing to 12 mm size. The cost estimate was $3,000 per machine on each of 20 identical machines.

Type #2 Mold Machine

The second type of mold machine was totally different. It had sixteen very small 1.5" diameter x 1.0" stroke air cylinders (in a common mold body plate) fed by two 3/8" rubber air hoses. All of the cylinders actuated simultaneously. Again, the plastic air lines to the solenoid valve appeared to be undersized. Extensive trials by the maintenance team, using a one-gallon surge tank, did not permit the lowering of the plant air pressure. Lower air pressure produced defective molded parts. They had determined that 102 psig was needed to consistently assure the production of quality parts. To change the stainless mold plate body was obviously 'out of the question'.

Our recommendation, on Mold Machine Type #2, was to install an air amplifier and surge tank unit on each machine. This had the effect of raising the compressed air supply pressure from 95 psig to 115 psig for the air line that feeds from the solenoid valve to the mold body plate. The cost estimate was $4,000 per machine on each of 30 identical machines.

Summary and Comment

The changes to the two mold machines were estimated to cost $180,000. They included installing the new 50 mm size air cylinders on the twenty Type #1 Molding Machines and the air amplifier and surge tank units on the thirty Type #2 Molding Machines. These changes would allow the air compressors to be lowered from 122 psig to a 102 psig nominal control setting. Compressor reliability, plant-wide air leaks reduction, motor power savings and electric demand reduction were estimated to total a savings of $300,000 per year.

If your air compressors operate above 95–100 psig for normal industrial process systems, understand why and have a sound technical reason for that condition. Not only energy cost savings, but also long term reliability of the air compressors can significantly improve when operating at 95–100 psig versus units operating continually at 115–125 psig. Most process equipment should operate reliably with 85 psig air supply to the machine manifold (with some specific exceptions such as large air cylinders, Pulse-Jet bag houses and sandblast units). Tackle those issues locally and closely review the compressed air specifications for equipment provided by vendors of automated production systems. BP

About the Author

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SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Optimizing the Steam Signature at Craft Breweries

By Drew Fink, Miura Boilers

Craft brewers, the fastest-growing segment of the U.S. beer-making industry, are generally defined as smaller brewers using an innovative mix of traditional and new ingredients and techniques to produce no more than 6 million barrels annually.

Spoetzl Brewery is the nation's fourth largest craft brewer, and although founded 102 years ago, the Shiner TX-based company uses the latest, most efficient technologies — along with its traditional, time-tested beer production protocols — to make its range of popular Shiner beer brands. Among the advanced brewing technologies Spoetzl uses are two Miura ultra-low NOx modular on-demand steam boilers, which provide multiple advantages for the unique needs of the craft-brewing industry.

"Craft brewers are getting much more savvy about boilers," notes Jaime Jurado, Director of Brewing Operations for The Gambrinus Company Breweries, owner of Spoetzl and its sister companies BridgePort Brewery, in Portland OR, and Trumer Brauerei, in Berkeley CA. "We remember when little craft breweries were using used dairy equipment. Now there's a whole new flavor of sophistication and awareness, and it's very exciting."

Jurado explains that he and his team first became acquainted with Miura seven years ago when The Gambrinus Company Breweries needed to replace an aging fire-tube boiler at the BridgePort Brewery. "Ours is a family-owned brewing company, and the owner Carlos Alvarez is a capable engineer in his own right who always has us focused on performance and efficiency, along with concern for the environment," Jurado explains. "We took several competitive bids and discovered we preferred the features and compact size of the Miura LX-200. It was perfect for our needs. Miura also impressed us with their knowledge, and when it came time to replace the boilers at the Spoetzl Brewery we looked at Miura again along with the energy-conservation engineering professionals at EPS Corporation (Project Manager Steven James, P.E.)."

SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Optimizing the Steam Signature at Craft Breweries

Jurado and Spoetzl Brewery Master Brewer Jimmy Mauric chose a gas-fired LX-200 and a dual-fuel EX-200 to leverage the advantages in having both types of Miura boilers for Spoetzl's unique craft-brewing needs. At Gambrinus' Trumer Brauerei, meanwhile, Jurado's colleague Master Brewer Lars Larson also choose a Miura LX-200 boiler after evaluating competitive bids. "Miura works seamlessly with regional dealers who are specialists in installing boilers," Jurado explains. "They made us realize that installing a Miura LX Series boiler at our Berkeley brewery would enable us to expand while also ensuring full compliance now and in the future with California's stringent air-quality regulations and low-NOx emissions rules. Choosing Miura boilers for all our breweries also prepares us for the day when other states adopt stricter emissions standards as well."

Multiple Miura Advantages

Employing a unique "once-through" fin-tube design, Miura boilers use less fuel and produce fewer emissions than conventional boilers. Miura boilers can, on average, save as much as 20% annually on fuel costs over other boiler designs. Miura boilers output reduced levels of nitrogen oxides (NOx), a major contributor to air pollution, as well as carbon dioxide (CO_2), the most prevalent of greenhouse gases. Miura boilers accomplish this by reducing the temperature of the boiler's flame, which in turn reduces the amount of excited nitrogen atoms available to bond with oxygen to form nitrogen oxides. As a result of this, NOx emissions are reduced to around one-quarter of what traditional fire-tube boilers emit and comply with even the most stringent air-quality regulations.

Miura's exclusive technology produces BHP outputs comparable to much larger units, but with far less water consumption. In addition to reducing emissions and saving fuel and water, Miura's "once-through" fin-tube design also enables Miura boilers to go from a cold start to full steam in just five minutes (or less). This *on-demand* steam-generation capability is well-suited to modular installations in which multiple Miura boilers can be turned on or off as needed to match load fluctuations, as opposed to consuming energy while constantly idling in stand-by. On-demand steam generation is well-suited to craft breweries because their smaller size tends to vary the schedule for such essential processes as heating, pasteurization, and CIP (cleaning in place).

"We have irregular needs for hot water for cleaning our tanks and our lines," Jurado

says. "With two Miura boilers we can choose between having them both fully fired or having one of them shut off and completely cold to the touch, instead of being on all the time, like our old fire-tube boiler. That tells you right there that we're saving about half the natural gas we were using before. We can get full steam from our second Miura boiler in about five minutes, whereas with the old boiler it would take hours before it could provide steam."

A modular installation of *on-demand* Miura boilers is also better suited to deliver the increased steam capacity needed when craft brewers experience sudden growth. Plus, the smaller footprint of Miura boilers conforms to the physical space limitations typically faced by craft breweries. This smaller size can reduce new-construction costs and better utilize existing boiler-room space.

"We like the fact that Miura's design makes it easier if you want to add another boiler in the future," Jurado says. "Two Miura boilers tie into the same manifold, so it's truly modular. Their smaller physical size and reduced footprint also makes installing another Miura boiler much more feasible. The footprint of the Miura LX-200 we installed at the BridgePort Brewery enabled us to repurpose the boiler room, which had previously housed a much larger fire-tube boiler. The new Miura LX-200 that replaced it not only takes up less space, it also requires less maintenance. The brewery is now doing 50,000 barrels a year, and that new boiler will enable us to exceed that volume in the future."

Serving Craft Brewers

Given its satisfaction with its new boilers, The Gambrinus Company Breweries are moving toward standardizing on Miura to simplify operations and maintenance procedures at its three locations.

"We have the same German bottling line, filler, labeler, and crowner in every brewery," Jurado informs. "If there's an overhaul our maintenance people can get on a plane and be instantly familiar with the machinery when they arrive at our other locations. It's the same with our boilers. Our maintenance guys respect the Miuras and we now have a standardized boiler we all know. Also, what Miura provides as standard features is better than what's offered by any of its competitors. The EX-200's Miura Online Maintenance feature provides real-time reporting. You can extract that data and analyze it if you want to. If you were to call our individual brewmasters — Jimmy Mauric at Spoetzl, Jeff Edgerton at BridgePort, or Lars Larson at Trumer — they'd all tell you that maintenance is easy on Miura boilers, and if there's an issue, Miura or their authorized agents are right there at the phone or at the plant."

"Miura boilers can, on average, save as much as 20% annually on fuel costs over other boiler designs."

— Drew Fink, Miura Boilers

SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Optimizing the Steam Signature at Craft Breweries

"We're in the brewing business, not the boiler-making business, so we really appreciate Miura's support network, which extends from the company's manufacturing side to its sales, engineering, and installation side," Jurado continues. "Miura engineer Mario Endo visited the brewery, analyzed its steam-usage needs, and asked us how we see those needs growing in the future. Then he did some calculations and recommended how we could achieve additional capacity. Miura's Jason Smith recently did a technical conference in Texas for more than 100 craft brewery professionals on the subject of water and steam conservation and efficiency. It was extraordinary; he put a lot of interesting information 'on the radar screen' for us. I'm excited that Miura is 'connecting the dots' for craft breweries."

"Every brewery requires its own unique steam signature, and what Miura does with its partners is to broadcast expertise and engineering-evaluation capabilities so that the customer gains the know-how of savvy local installers supported by Miura engineers," Jurado adds. "In broad strokes, a brew house consumes half the steam in any brewery, but CIP sets, pasteurizers, hot-water sterilizing units, etc., all represent additional steam needs that have to be satisfied either continuously or intermittently. Whether the inquiring brewery is a start-up or one facing expansion planning or fuel economization, there is a Miura partner available to offer expertise and critical analysis."

In addition to its oil- and gas-fired ultra-low NOx modular *on-demand* steam boilers, Miura also offers integrated intelligent water-softener monitoring technology and the BOILERMATE chemical-treatment system. The Gambrinus Company Breweries are currently using BOILERMATE at the Trumer Brauerei.

"As far as we can determine, Miura is most energy-efficient steam provider that we can find," Jurado concludes. "Miura is cost-effective because of its comprehensive package. When you step back and say 'Which brand is the most cost-competitive? Which gives you the best performance, best reputation? Which has the greatest support network? Which gives you the most bang for the buck?' Then Miura owns that combination 100%." BP

For more information contact Drew Fink, Miura Boilers, tel: 800-666-2182, www.miuraboiler.com

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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

PTI Launches LeakMonitor®

Plastic Technologies, Inc. (PTI) is introducing an upgraded version of its LeakMonitor® device which uses an ultrasonic sensor to continuously monitor the blow molding process for air leaks from machine components and defective bottles. The new capability enables leak detection at production speeds typical for state-of-the-art blowmolding equipment.

Excessive air consumption due to leaks within blowmolding equipment is a costly ongoing concern for blowmolders, which can result in thousands of dollars in wasted compressed air and production downtime, annually.

When pressurized air passes through an orifice, it generates an ultrasonic signal which PTI's LeakMonitor® technology reduces to an electronic waveform. Deviation of the waveform from predetermined parameters can be used to identify defects in the product or in machine components.

During the normal reheat stretch blowing process, the LeakMonitor® device listens for leaky bottles, tracks them through the machine and triggers an eject mechanism when they are in the correct position. In addition, routine background noise is monitored and graphed. If the background noise reaches an unacceptable level the ultrasonic sensor can trigger an alarm.

Additional features of the upgraded LeakMonitor® device include many automated calibration features including a display of the relative severity of air leaks and where they are located on the blow wheel.

"Ultrasonics can help ensure that only high quality product leaves the plant and that costs from air leaks in molds and equipment are minimized to your company's standard of tolerance," said Donald Miller, vice president, technical services, Plastic Technologies, Inc.

The LeakMonitor® was originally developed as a diagnostic tool for production issues incurred by carbonated soft drink (CSD) bottles made from a percentage of recycled polyethylene terephthalate (rPET).

Prior to the introduction of rPET, the incidence of holes in PET CSD bottles was minimal. As the percentage of rPET increased — coupled with the push towards hyper lightweighting — the occurrence of holes increased 10 to 1000 times due to contaminants in certain resin grades.

The LeakMonitor® device is a powerful tool to help ensure that rPET usage does not result in defective bottles leaving the operation. This is accomplished by monitoring the blowing process for leaks in the base or sidewall (usually a result of contamination or high-stretch ratios), for short shots and for other sealing surface defects. Additionally, PTI's LeakMonitor® is an ideal device to identify and locate leaks from valves, faulty lines, compensation gaskets, stretch rod seals, misaligned tooling, etc.

Contact PTI
Tel: 419-725-5613
www.plastictechnologies.com

Michell Liquidew Moisture Analyzer Used with Liquid Petroleum Gas (LPG)

A major public transportation operator recently installed the Michell Instruments Liquidew I.S. Moisture Analyzer to check levels of dissolved water vapor in Liquid Petroleum Gas (LPG) fuel. The objective was to reduce the time and money spent on repairs to its fleet of buses.

LPG fuel is becoming an increasingly popular choice for public and private transportation as it has significantly lower CO_2 emissions, causes less wear on engines and also reduces engine noise. However, LPG fuel does contain high levels of water vapor which may lead to ice formation in the winter months resulting in blocked fuel lines. Another concern is that large amounts of dissolved water vapor can also damage fuel sensors. Both instances will take vehicle off the road for repairs.

To ensure optimal performance, the operator can apply a quality check to every LPG tanker

TECHNOLOGY PICKS

delivery using the Michell Liquidew I.S Moisture Analyzer which measures dew points as low as -100 °C with an accuracy of ±2 °C. This dew-point sensor will directly indicate the temperature at which dissolved water vapor in the LPG will start to form water or ice. This is ideal for companies such as bus operators as they can tell immediately from the display of the Liquidew I.S. whether to accept or reject the delivery.

Contact Michell Instruments
Tel: 978-484-0005
www.michell.com/us

PIAB Vacuum System Monitoring

Piab introduced a new three color display electronic vacuum switch for vacuum system monitoring and for saving energy.

The switch has a powerful three-color (red, orange, green) LCD display that makes it easy to read from a distance, preventing the need to be in close proximity to a moving robot or machine cell. The dual display shows both the set value and the actual value allowing for precise monitoring of the vacuum system.

Set up is a breeze with the easy control buttons as is the installation as mounting brackets are included. Seven different programmable units of vacuum are available and the switch features two selectable PNP outputs, NO or NC. A "power save" mode provides up to a 30% savings in energy. Along with an adjustable hysteresis and dual outputs, this switch a perfect tool for an electronic controlled energy-savings system for an air operated vacuum generator.

Other features include a key-lock mode to prevent unauthorized or accidental changes. An adjustable response time feature (2.5–1500 ms) makes it easier to fine-tune programming of related sequences for the robot or machine. The switch is both CE approved and RoHs compliant.

Contact PIAB
Tel: 800-321-7422
www.piab.com

Pneu-Logic Systems Meet or Exceed Proposed California Energy Commission Requirements

Pneu-Logic Corporation announced that the company's PL4000 system complies with the California Energy Commission's (CEC) proposed new rule on compressed air supply systems. The new rule, if approved, will be added to the Building Energy Efficiency Standards contained in the California Code of Regulations, Title 24, Part 6 (also known as the California Energy Code).

The proposed new rule would apply to compressed air systems of 25 horsepower or larger, with more than one compressor, that are being installed in new plants or plants having major renovations. The rule states that the systems must have a controller that is able to choose the combination of compressors based on the current air demand as measured by a sensor.

"Up to 10% of the energy used in factories in the U.S. is to power air compressors, and active control of compressed air systems can save between 15 and 30% of that energy," said Tom Orton, Pneu-Logic CEO. "CEC's proposed new rule is designed to take advantage of those savings."

"Not only does active compressor control save energy, it is a factory best practice that can improve productivity and extend the life of pneumatic systems," said Frank Moskowitz, a member of the International Standards Organization (ISO) technical committee for air compressors and compressed air systems and a consultant with 30 years experience in plant engineering.

Flagship in Pneu-Logic's product line, the Pneu-Logic PL4000 compressed air master control system utilizes custom software and systems technology to generate the most efficient operating level possible from each industrial air compressor in a factory. It works with all types of compressors, reciprocating, rotary and centrifugal, from all manufacturers.

Contact Pneu-Logic Corp.
Tel: 866-348-5669
www.pneulogic.com

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