The Magazine for ENERGY EFFICIENCY in Compressed Air Systems

# COMPRESSED AIR BEST PRACTICES

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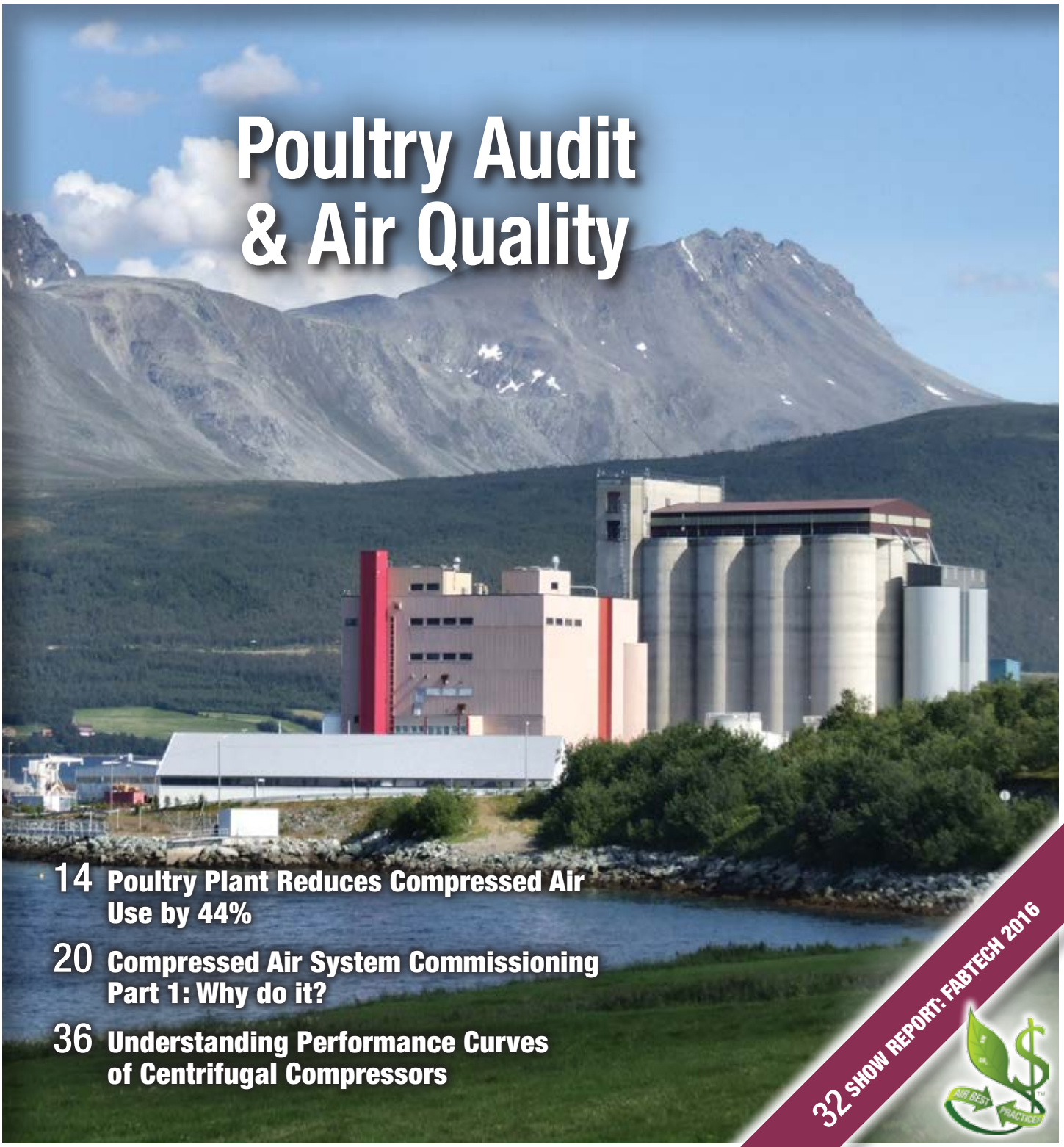
January/February 2017



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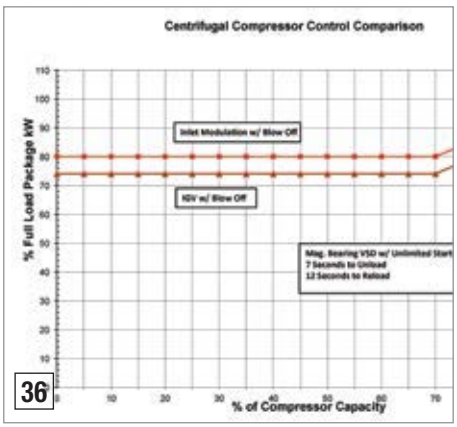

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# FROM THE EDITOR | Poultry Audit & Air Quality

We kick-off 2017 with a system assessment article of a major poultry processor operating two separate compressed air systems in their plant; one for main plant operations and the other for WPL (Weigh, Price and Label). The plant is running a mix of fixed speed and variable displacement rotary screw air compressors from Quincy, Gardner Denver and Ingersoll Rand. Don van Ormer writes about how the projects deployed to reduce compressed air consumption by 44 percent – a reduction of 252 cfm.

Tim Dugan kicks off a series of articles on compressed air system commissioning. This first one examines the utility-led emergence of Retro-Commissioning (ReCX) of compressed air systems and then proposes a definition of commissioning. The article then examines the root causes of why it's rare to see compressed air system designs keep-up (retro- and incomplete commissioning) with the changing dynamics of the system requirements.

It's always good to go back to the basics. Compressed air quality is critical to the food industry. How fresh in your mind is the importance of the heat of adsorption in regenerative desiccant compressed air dryers? It's actually very important and will determine a dryers' ability to ensure a pressure dew point! Aircel Chief Engineer Don White provides us a very solid technical process review of the many types of regenerative desiccant dryer technologies.

TRUMPF is a leading global manufacturer (no relation to the new President) of machine tools and at the FABTECH show displayed their TruFlow $CO_2$ lasers for metal welding and cutting. In order to operate properly, their lasers rely upon high-quality and reliable compressed air, nitrogen and chilled water – our favorite topics! I hope you enjoy our Show Report covering compressed air and onsite nitrogen generation technologies on display.

Centrifugal air compressors are not as well understood as rotary screws. Hank van Ormer provides us with Part 2 of his Series on Centrifugal Air Compressor Basics with this article titled, "Understanding the Basic Performance Curve."

Thank you for investing your time and efforts into ***Compressed Air Best Practices®.***

**ROD SMITH,** *Editor*
*tel: 412-980-9901, rod@airbestpractices.com*

## 2017 Expert Webinar Series

Join Hank van Ormer and Sponsor Roger Dennison from CDI Meters, on February 9th, for a Webinar titled, "Establishing Best Practice Compressed Air Flows."

Register and view our 2017 Webinar Calendar at www.airbestpractices.com/magazine/webinars



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# INDUSTRY NEWS

## Atlas Copco Acquires Air Power of Nebraska

Atlas Copco, a leading provider of sustainable productivity solutions, has acquired Air Power of Nebraska. Based in Omaha, Neb., the company sells, installs and services compressed air products and related systems to customers in the surrounding region, including Nebraska, Iowa and South Dakota.

"We're excited for the team at Air Power of Nebraska to join our company," said John Brookshire, president of Atlas Copco Compressors. "This addition strengthens our presence and capabilities in the Midwest and brings our customers in the region closer to high-quality Atlas Copco products and services."

The acquisition adds approximately a dozen team members to the compressor technique business area. Air Power of Nebraska will continue to operate under the same name and serve manufacturing, food processing, fabrication, health care, chemical plants, ethanol plants, power plants, mechanical contractors and industrial organizations across the region.

**Atlas Copco** is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and services focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 180 countries. In 2015, Atlas Copco had revenues of BSEK 102 (BEUR 11) and more than 43 000 employees. Learn more at www.atlascopcogroup.com.

**Atlas Copco's Compressor Technique** business area provides industrial compressors, vacuum solutions, gas and process compressors and expanders, air and gas treatment equipment and air management systems. The business area has a global service network and innovates for sustainable productivity in the manufacturing, oil and gas, and process industries. Principal product development and manufacturing units are located in Belgium, the United States, China, South Korea, Germany, Italy and the United Kingdom.

## Rapid Growth is Catalyst for nano Relocation

Purification Solutions LLC, parent company of nano and CTA North America, has successfully completed the move to a new, larger facility in Charlotte, NC.

Providing compressed air and gas treatment solutions as well as air separation and process cooling systems to industry, the new building will serve to support both the nano and CTA brands. The move stems from unprecedented growth, which in turn has brought a need to accommodate a larger internal team and increased inventory levels.

"For the fifth consecutive year, nano will exceed plan which is truly incredible in this economy," said Nick Herrig, Air Distribution Business Manager. Todd Allison added "And since we'll be taking the CTA brand to market in the OEM channel, the flexibility to inventory more product and increase our already high level of customer service and technical support required the increased square footage."

*New facility located in Charlotte, NC*

Four times the size of their previous location in Huntersville, NC, the new building offers the team more office and warehouse space to provide even faster turnaround from the initial phone call to shipment of product. Nano customers should expect a quicker response and better support, both before and after the sale.

"With a growing technical and customer service team, the new location was a necessity. Our customers realize the *'Experience. Customer. Service.'* philosophy is not just a tagline for nano, in fact, we expect this level of service to continue with our expanding customer base on the CTA side of the business, as well. After all, it is the very foundation on which our Purification Solutions business has been built," added Tony Hergert, Marketing Director.

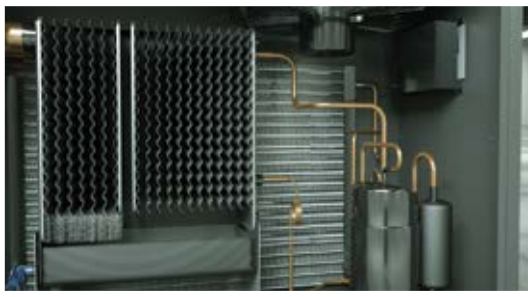
*New remittance address:*
P.O. Box 481930, Charlotte, NC 28269-9598
*New physical address:*
5509 David Cox Road, Charlotte, NC 28269

***For more information regarding Purification Solutions LLC, nano-purification solutions or CTA North America, visit www.n-psi.com or contact marketing@n-psi.com***

## FS-Elliott Announces Expanded Distribution Network

FS-Elliott Co., LLC, a leading manufacturer of oil-free, centrifugal compressors, announces new distribution agreements with Dynamic Compressor Services, CDA Systems, Power Equipment Company, and Rasmussen Air & Gas Energy.

Joining a network of over 75 distributors and representatives worldwide, Dynamic Compressor Services, CDA Systems, Power Equipment Company and Rasmussen Air & Gas Energy are staffed with factory-trained sales representatives and service technicians, providing the highest level

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The FLEX Series refrigerated air dryer is engineered to provide increased reliability and optimal dew point performance from 0 to 100% load conditions. The flexible drying solution is designed around a patented heat exchanger, utilizing Phase Change Material. With reduced capital cost, load profile flexibility, and industry-leading energy savings, the FLEX Series sets the new standard for the global dehydration market. Savings finally realized.

**To explore the FLEX Series dryer visit www.spxflow.com/flex**

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# INDUSTRY NEWS

of support to local FS-Elliott customers. Services include installation and startup assistance, maintenance training, operator training and remote or on-site technical support. Understanding the importance of reliable operation, these distributors maintain extensive inventories, providing immediate access to quality OEM parts for emergency or planned repairs.

"The caliber of distributors that we have added this year will allow us to reinforce our commitment to delivering quality products and services to our valued customers," added Will Collett, Director of Global Industrial Sales. "Delivering this level of quality to customers is something we are known for, and we are thrilled to bring our newest distributors on board to continue that strong reputation together."

### About FS-Elliott Co., LLC

FS-Elliott Co., LLC, is a leading manufacturer of oil-free, centrifugal compressors with sales, service, and manufacturing locations around the world. First introduced to the market over 50 years ago their energy-efficient machines incorporate the latest aerodynamic and control system technologies to ensure optimum performance with the lowest cost of ownership.

***For more information, visit www.fs-elliott.com.***

***To locate the nearest FS-Elliott distributor, please visit www.fs-elliott.com/locate-distributor.***

## Atlas Copco Compressors with Rick Dore at SEMA 2016

Atlas Copco Compressors attended the 2016 Specialty Equipment Market Association (SEMA) Show; the premier automotive specialty products trade show, in early November. Rick Dore, custom car builder, television personality and owner of Rick Dore Kustoms, signed autographs at the Atlas Copco Compressors booth.

Rick Dore is the co-host of the Discovery Channel reality series Rusted Development. The show, which debuted in 2014, follows Dore and co-host Chuck Palumbo, a retired WWE wrestler and mechanic, as they rescue classic cars and restore them into one-of-a-kind, drivable dream cars. The show's body

shop is powered by an Atlas Copco GA 7-37 VSD+ oil-injected, oil-cooled rotary screw compressor, an energy efficient air compressor with low noise levels and a compact footprint.

"It's incredibly efficient and quiet," Rick Dore said. "We use a lot of air and never run out. We have six guys in the shop working, using air, and never once have an issue. It also looks great."

The innovative GA 7-37 VSD+ will be on display at Atlas Copco's booth during SEMA. The compressor offers energy savings of up to 50 percent compared to load/unload compressors of the same type, and its compact footprint and low noise levels are exceptionally beneficial for customers in the automotive service and body shop industries. The potential energy savings of just one 15 horsepower GA VSD+ can save an auto body shop more than $10,000 per year.

"For the Discovery Channel studio or for the Rick Dore Kustoms shop, I couldn't find anything that was more efficient or more quiet," said Dore. "You cannot have that with any other compressor I'm aware of, period."

Dore has an Atlas Copco GX5FF oil-injected rotary screw compressor in his shop at Rick Dore Kustoms, where he and Metallica frontman James Hetfield created Black Pearl, a car with a custom-built chassis and hand-sculpted aluminum body. The Dore-Hetfield collaboration will be displayed at the Atlas Copco booth. The GX series provides high reliability with 100% continuous duty cycle and operations in ambient temperatures up to 115 degrees, and

*The Atlas Copco GAVSD+ Rotary Screw Air Compressor*

the belt-driven element and low vibration mean silent operation. Reduced energy consumption and low CO2 emissions make the GX an environmentally friendly choice.

Atlas Copco also displayed the LS and LP 5-30 horsepower cast iron piston compressors at booth No. 10121. The LS and LP are two-stage

# INDUSTRY NEWS

piston compressors designed for durability, combining high reliability and savings to provide maximum efficiency and uptime. The heavy-duty cast iron ensures lasting performance in the most demanding applications.

### About Atlas Copco Industrial Air

Industrial Air is a division within Atlas Copco's Compressor Technique business area. It develops, manufactures and markets oil-injected and oil-free air compressors, Quality Air solutions and monitoring and connectivity solutions worldwide, under several brands, for all kinds of industries. The division's focus and main drive is to further improve its customers' productivity. The divisional headquarters and main production center are located in Antwerp, Belgium.

***For more information, visit www.atlascopco.com.***

## Alliance to Save Energy Elects New Leaders to Board

The Alliance to Save Energy's Board of Directors on Wednesday elected three new members to help lead the organization's mission of achieving a more energy efficient future. The newly elected directors, who represent top business and utility entities, include:

- **Melissa E. Adams,** Chief Corporate Social Responsibility Officer, Washington Gas and WGL Holdings Inc.
- **Mark Copman,** Vice President and General Manager, Renewable Energy Division, 3M Company
- **Bruce Edelston,** Vice President, Energy Policy, Southern Company

Alliance President, Kateri Callahan, said the new board additions would continue a tradition of strong leadership at the organization across a wide variety of economic sectors. "We are thrilled to welcome these new members to the Alliance's board," she said. "With energy efficiency gaining momentum in the U.S. and globally, we are confident that adding these exceptional voices to our leadership will strengthen our efforts to advance energy efficiency and productivity in the coming years."

Adams serves as WGL's chief strategist behind the goals, policies and programs that benefit the company and the communities it serves. "I am excited to contribute to the Alliance's work and mission. As an energy company, we know that efficient energy use is essential to our mission of providing safe, reliable, sustainable and modern energy, while also promoting economic opportunity and reducing environmental impacts. That's the approach we need in our region, nationally and globally."

Copman, who oversees 3M's renewable energy division, brings to the Alliance board more than 25 years of business leadership experience, including a variety of management roles at 3M since 2003. "There are a lot of exciting things happening with energy efficiency in the manufacturing sector," he said. "Joining the Alliance board of directors presents a tremendous opportunity to develop new goals and strategies to help make it happen."

Overseeing energy policy at Southern Company, Edelston is responsible for helping the company develop and coordinate policy issues across its various operating companies and subsidiaries. He also supports state and federal policy efforts. "The policies we develop now will shape what our energy future will look like," he said. "It's an honor to join this impressive board and to be a part of the Alliance's work."

### About the Alliance to Save Energy

Founded in 1977, the Alliance to Save Energy is a nonprofit coalition of business, government, environmental and consumer leaders advocating for enhanced energy efficiency

across all sectors of the economy. Our mission is to promote energy efficiency worldwide to achieve a healthier economy, a cleaner environment and energy security.

***For more information, visit http://www.ase.org***

## Kobe Steel Provides First Screw Compressor for LNG Carrier

Kobe Steel, Ltd. announces it has received an order for two screw compressors for use with marine dual fuel engines. This is the first time screw compressors will be used to supply fuel to marine dual fuel engines.

The compressors will be installed in an LNG carrier to be owned by a 50/50 joint venture between Mitsui O.S.K. Lines Co., Ltd. (or MOL) and Itochu Corporation for Uniper Global Commodities SE, a subsidiary of Uniper SE, Europe's one of largest power and gas companies. Uniper Global Commodities will charter the new carrier for 20 years. Plans call for Kobe Steel to deliver the compressors in August 2017 to South Korea's Daewoo Shipbuilding & Marine Engineering Co., Ltd., which is constructing the vessel.

The market size of nonstandard compressors for marine dual fuel engines is estimated to total over 20 billion yen for the coming five years, according to Kobe Steel. Kobe Steel aims to gain over 50 percent of the market by 2020.

*The vessel under construction is a large LNG carrier. The vessel will have a length of 297.9 meters, a breadth of 47.9 meters and a cargo tank capacity of 180,000 cubic meters.*

## INDUSTRY NEWS

*This is the first time that screw compressors will be used to supply fuel to marine dual fuel engines.*

Nonstandard compressors for marine dual fuel engines are generally used to compress vaporized LNG, namely boil-off gas (BOG), which is then sent to the engines. To date, marine dual fuel engines have been of the middle speed, four-stroke type and driven predominantly by low gas pressure, the compressors for these engines have only been centrifugal compressors, which excel at low-pressure compression. However, in recent years due to the need to save energy in ship operation and comply with stricter environmental regulations, dual fuel, low speed, two stroke engines that offer high efficiency with a 10-percent improvement in fuel consumption have entered the market. In the future, this type of engine will become more common as its adoption is being considered for nearly all of the new vessels.

While marine dual fuel, low speed, two-stroke, engine, requires relatively high gas pressure, centrifugal compressors are less efficient. These engines need to have their fuel gas (FG) pressure controlled within the allowable level of the load percentage of the engines. Screw compressors are highly suitable for these engines as they can keep pace with load fluctuations and operate most efficiently in the medium to high-pressure range. Due to this feature, screw compressors have been adopted for use with marine dual fuel engines for the first time.

Kobe Steel has received an additional order for one reciprocating compressor for BOG reliquefaction, which will be installed in the same vessel.

Over 100 LNG carriers have been constructed from 2013 to 2015. Although the shipbuilding boom has settled slightly due to the fall in raw material prices and the downturn in the world economy, demand remains high for LNG and the market for this clean fuel is expected to grow in the future.

Kobe Steel is the only company in the world that manufactures all three main types of compressors: screw, reciprocating and centrifugal. In particular, Kobe Steel estimates that it has the world's top share of the market for screw compressors. Its extensive supply record and the outstanding performance of its compressors were factors that contributed to the order for the two screw compressors.

Under Kobe Steel's Fiscal 2016-2020 Group Medium-Term Management Plan, the company's Machinery Business has positioned nonstandard screw compressors and other products for LNG vessels as an area of focus. The Machinery Business plans to expand business and increase sales in this field.

***For more information, visit http://www.kobelco.co.jp/english/***

# Poultry Plant Reduces Compressed Air Use by 44%

By Don van Ormer, Air Power USA

A major poultry processor and packager spends an estimated $96,374 annually on energy to operate the compressed air system at its plant located in a southern U.S. state. The current average electric rate, at this plant, is 7 cents per kWh.

In this compressed air audit, a group of projects were identified that — if implemented — could reduce these energy costs by an estimated $40,667 or 44 percent of the facility's current use. These projects will also permit plant personnel to operate one air compressor to meet demand – allowing for the return of the rental compressor and saving the $3,900 per month rental charge. The estimated costs for completing the recommended projects is $48,700, representing a simple payback period of 14.3 months.

## The Current Compressed Air System

The plant's current compressed air demand is split into two separate compressed air systems, one for main plant operations, and the other for WPL (Weigh, Price and Label).

The plant air system operates 8,760 hours and the WPL system operates 6,864 hours per year. The system pressure runs from 94 to 102 psig in the headers during production.

The main plant compressed air system has two 100-hp air-cooled, single-stage, rotary screw air compressors, with a 100-hp rental for emergency backup. Both of the rotary screws are variable displacement machines

**TABLE 1. MEASURED OPERATING DATA FROM THE LUBRICANT-COOLED ROTARY SCREW AIR COMPRESSORS USING MODULATION AND TWO-STEP CONTROL**

| COMPRESSOR UNIT | QUINCY | | GARDNER DENVER | | INGERSOLL- RAND | |
|---|---|---|---|---|---|---|
| Model | QSI 500 | | EBF | | EPE50 | |
| Inlet Air Temp °F | 65 | | 65 | | 63 | |
| FL Flow (acfm) | 496 | | 440 | | 211 | |
| Capacity Control Type | Modulation | | Modulation | | ACS | |
| Discharge Pressure (PG) (psig) | 122 | | 120-124 | | 113-125 | |
| Discharge Pressure (TG) (psig) | 122 | | N/A | | N/A | |
| Set Point (FL) (psig) | 120 | | 120 | | 113 | |
| Calculated Pkg Full Load Input kW at Operating Pressure | 99.27 | | 89.98 | | 47.4 | |
| Measured Pkg Full Load Input kW | 100 | | 89.6 | | N/A | |
| Actual Average Pkg kW | 100 | | 89.6 | | 21 | |
| % Full Load Pkg kW | 100 | | 100 | | 44 | |
| Average Flow (acfm) | 496 | | 440 | | 39 | |
| Estimated Peak Flow (acfm) | 496 | | 440 | | 39 | |
| Est. Minimum Flow (acfm) | 496 | | 440 | | 0 | |
| PKG Discharge Air Temp °F | 83 | | 75 | | 55 | |
| Air End Discharge Air Temp °F | 185 | | 166 | | **130** | |
| Aftercooler | | | | | | |
| Air In °F / Air Out °F | 168 | 83 | 151 | 75 | **113** | 55 |

Note: The Ingersoll-Rand air end and aftercooler inlet temperatures are too low; this could cause internal condensation, causing liquid water to contaminate the lubricant.

using inlet valve modulation. One is a Gardner Denver EBP rated for 125 psig, producing 440 acfm and drawing approximately 90 kW at full load. The other is a Quincy QSI 500 rated for 125 psig, producing 496 acfm and drawing around 100 kW at full load. Plant personnel operate both of these air compressors during plant production. The air is dried by a Zeks 1200 HSF cycling refrigerated compressed air dryer. There is also a dedicated Ingersoll-Rand D8501N non-cycling refrigerated dryer located in the Box Room upstairs which supplies the Saddle Pack machines. The dryers are operating correctly although the Zeks unit had a high temperature warning light due to, according to plant personnel, being low on Freon. The plant had placed a large cooling fan to blow cooling air through the dryer to help the condenser perform.

The WPL, (Weight, Price and Label) has a dedicated Ingersoll-Rand EPE50, 50-hp single-stage air-cooled, lubricated rotary screw air compressor. This system is tied into the Main system but is normally valved-out. During the site visit, the inlet valve control was not working properly but plant personnel had an Ingersoll-Rand service technician dispatched for repair. The technician made some adjustments to the controller and it was working properly when he left the site. The WPL system has an Ingersoll-Rand model D3601 air-cooled, non-cycling, refrigerated dryer servicing this system. It appeared to be operating correctly during the site visit.

The water treatment plant has a Quincy 7.5 hp air-cooled, reciprocating compressor that handles the total load. At the time of the site visit it was down and the demand was being handled by the Main plant system. The plan is to repair the pump and close the tie-in valve.

**TABLE 2: KEY AIR SYSTEM CHARACTERISTICS OF THE CURRENT SYSTEM**

| MEASURE | PLANT AIR | SANITATION GARDNER DENVER | SANITATION QUINCY | WEEKENDS /HOLIDAYS | WPL |
|---|---|---|---|---|---|
| Average System Flow | 745 cfm | 246 cfm | 312 cfm | 132 cfm | 39 cfm |
| Average Compressor Discharge Pressure | 116 psig | 130 psig | 120 psig | 127 psig | 118 psig |
| Average System Pressure | 116 psig | 129 psig | 119 psig | 127 psig | 116 psig |
| Input Electric Power | 178 kW | 78 kW | 88 kW | 70 kW | 25 kW |
| Operating Hours of Air System | 4,940 hrs | 650 hrs | 650 hrs | 2,520 hrs | 6,864 hrs |
| Specific Power | 4.18 cfm/kW | 3.15 cfm/kW | 3.54 cfm/kW | 1.88 cfm/kW | 1.56 cfm/kW |
| Electric Cost for Air /Unit of Flow | $81.45 /cfm yr | $14.20 /cfm yr | $12.63 /cfm yr | $92.21 /cfm yr | $311.75 /cfm yr |
| Electric Cost for Air /Unit of Pressure | $303.37 /psig/yr | $17.49 /psig/yr | $19.73 /psig/yr | $60.86 /psig/yr | $59.20 /psig/yr |
| Annual Electric Cost for Compressed Air | $60,673/yr | $3,498/yr | $3,947/yr | $12,172/yr | $11,840/yr |
| | $92,130/year | | | | |

Based upon on a blended electric rate of $0.069 per kWh and 8,760 hours/year.

# POULTRY PLANT REDUCES COMPRESSED AIR USE BY 44%

Plant personnel run the air compressors at 120 psig discharge on both systems. The main reason for the higher pressure is to maintain 100 psig to the Saddle Pack processes. According to plant personnel these processes have trouble and shut down when pressure falls below 100 psig. The main plant has a measured 5 psig drop from the compressors to the inlet of the dryer and a 1 to 2 psig drop across the dryer.

Air Power measured a 95 to 99 psig pressure at Saddle Pack Line #7, and Line #5 was 94 to 98 psig. We also measured several other locations around the plant with similar readings.

## Comments on "Percent of Load" Gauges

The following are comments on the Quincy QSI compressor "load gauge". The "Percent of Load" gauge on these units measures the vacuum under the inlet valve. The inlet pressure (psia) falls to more vacuum as the inlet plate valve closes. As the compressor load falls below 30% to 35%, the inlet valve bypass opens and does not allow the vacuum to fall any further to avoid "rotor flutter."

Even when new and calibrated, this gauge will usually not read much below 30% load regardless of how low the flow is, unless it reaches full unload, times out, and then blows down to full idle. In practice, it will most often not read 100% load due to normal inlet filter losses, etc.

A more accurate method to accurately reflect the "Percent of Load" is to install an accurate pressure gauge (not vacuum) in the air pressure line from the control line regulator to the inlet valve actuator. At 0 psig the regulator is sending no air to the actuator, and when properly adjusted, the inlet valve is wide open (60˚ angle). As the pressure rises in the system, the regulator opens and allows air into this control line to create pressure to start closing the inlet valve. The pressure in this line will be indirectly proportional to the flow over the regulator operating band. If the full-load to no-load band is 10 psig, then each 1 psig reflects about 10% flow. If the band is 15 psig then each 1 psig is about 6.5% value. These numbers work up and down.

## Establishing the Baseline of Compressed Air Use

The following actions were taken to establish baseline measures for flow and pressure (Measurements can be seen in Table 1):

**TABLE 3. COMPRESSED AIR LEAK LIST**

| NO. | LOCATION | DESCRIPTION | EST. SIZE | SIZE OF LEAK CFM |
|---|---|---|---|---|
| 1 | Saddle Pack Line 4 | 3/8" regulator | Medium | 5.1 |
| 2 | Saddle Pack Line 3 | Threaded fitting on bottom of blow gun | Medium | 4.2 |
| 3 | Wing Line | 3/8" push lock fitting | Small | 3.1 |
| 4 | Star Flex Scale | 1/4 coupling leaking at threads | Small | 3.2 |
| 5 | Pac Mac Leg Quarter Bagger | Pressure gauge leaks | Medium | 4.0 |
| 6 | Deepak Gate Valve Cylinder | 1/4" threaded pipe leaks at threaded on bottom of cylinder | Small | 3.5 |
| 7 | WPL Pricing Display 8 | 1/4" T leaks at threads | Small | 3.9 |
| 8 | Box Shop #7 Box Former Air hose | Threaded fitting on bottom of blow gun | Small | 3.4 |
| 9 | Shipping Dock #3 Air hose | 1/2" bushing leaks at threads on elbow | Small | 3.1 |
| 10 | Shipping Dock #5 Air hose | 3/8" hose -hole in hose by crimp | Small | 3.3 |
| 11 | Shipping Dock #7 Air hose | 3/8" threaded fitting on blow gun | Medium | 4.0 |
| 12 | Shipping Dock #9 Air hose | Hose clamp | Small | 2.8 |
| 13 | Waste Water Sludge Pump | 1/4" push lock fitting | Small | 1.7 |
| 14 | Evis USDA station #2 | 1/2" filter leaks | Small | 3.7 |
| | | | **Total Est. CFM Loss** | **49.0** |

**TABLE 4. AODD PUMP CONTROL PROJECTS**

| LOCATION | SIZE | MFG. / MODEL | UTILIZATION | STROKES / MINUTE | AIR USAGE CFM | EST. CONTROLLER USAGE | CFM TOTAL SAVINGS |
|---|---|---|---|---|---|---|---|
| Kill Room - Paws | 2" | Graco | 100 | 120 | 61 | 37 | 24 |
| Kill Room - Heads | 2" | Graco | 100 | 120 | 61 | 37 | 24 |
| Gizzards - | 2" | Merzan | 100 | 60 | 26 | 16 | 10 |
| Gizzards | 2" | Merzan | 100 | 120 | 61 | 37 | 24 |
| Blood pump | 3" | Sandpiper | OFF | | | | |
| | | | | | | **Total** | **82** |

1. Temperature readings were obtained on all units using an infrared surface pyrometer. These were observed and recorded to correlate to the unit's performance, load conditions and integrity.

2. Critical pressures, including inlet and discharge, were measured with digital calibrated vacuum and pressure test gauges with an extremely high degree of repeatability.

3. Trended data was measured with plant/corporate kW meters, and trended data was sent to data loggers set for 30-second data points for two days. It was sent again at 70-second data points for two weeks.

4. Two-step controlled compressor operating performance was calculated as a percentage of full load capacity by identifying the total time at full and no load. The percentage of full load in acfm was then calculated to arrive at a very accurate average peak and minimum flow in.

5. Modulation-type controls react instantly to sensed system pressure fluctuation to match supply to demand (controls include inlet valve modulation, variable displacement, and variable speed). Average input kW was measured and trended at a measured pressure. This information was located on the DOE/CAC performance curve to give an accurate estimation of average flow.

6. The same basic measurement and logging activity was carried out for system pressure, using self-contained pressure transducers and loggers. These units are all calibrated to a single test gauge, and each is set to start logging pressure simultaneously.

## Compressed Air Flow Reduction Projects Deliver 252 cfm in Savings

A compressed air treatment project (replacing timer drains with no air-loss demand-drains) would reduce consumption by 12 cfm. Four demand-side projects were identified, during the audit, with the potential to reduce compressed air consumption by 240 cfm. Collectively, these projects have the potential to save the company $42,530 annually on electricity costs associated with the compressed air system. The cost to implement these projects was estimated at $53,700. Due to article-length constraints, we will expand a bit on two of the projects.

### 1. Repair 14 Identified Compressed Air Leaks – 49 cfm Savings

A partial survey of compressed air leaks was conducted at the plant and 14 leaks were identified, quantified, tagged, and logged. Potential savings totaled 49 cfm for the 14 leaks that were identified. An ultrasonic leak detector was used and we recommended the plant purchase one to implement their own continuous leak management program. 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. The cost to purchase an ultrasonic leak detector and repair the 14 leaks was $4,200. The annual electric cost savings, from repairing the leaks, was $7,608.

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# POULTRY PLANT REDUCES COMPRESSED AIR USE BY 44%

### 2. Install AODD Pump Controls – 82 cfm Savings

Recently, there have been two microprocessor-based AODD cycle/stroke control systems introduced, which have proven to be very effective. One requires electricity, the "MizAir", and the other is pneumatically operated, the "Air-Vantage". We found four 2" AODD pumps (two Graco units and two Merzan units) in the main plant where these controls would reduce compressed air consumption by 82 cfm. The cost to install these controls is $10,000 and the anticipated annual electricity cost savings, from reduced compressed air use, is $12,733.

The "MizAir" utilizes a special high-volume, high-speed (35 milliseconds to open / 35 milliseconds to close), air-piloted dispensing valve. This air valve is controlled by a microprocessor which analyzes the stroke frequency and throughput flow characteristics to determine the proper and lowest cycle rate to optimize the throughput. Once established, it then shuts off the air supply during the stroke and allows the product flow and pump inertia to complete the stroke without any additional air flow. It then opens the air valve again and the process is repeated. The net results are:

- At the same input air pressure the compressed air usage falls 35 to 50% (stroke and cycle rate falls)
- Product throughput per stroke increases the average product flow per SCFM increases significantly – 50 – 100%.
- The MizAir requires a separate electric power supply.

The "Air-Vantage" microprocessor control operates in a similar manner to the MizAir described earlier, but is completely pneumatically operated and requires no outside electric power supply. Power for the microprocessor comes from a small internal 12V generator. No outside power required. This factor is very convenient, offering significant installation flexibility, and most importantly, is available in a ***Class 1 / Division 1 Configuration.***

Both the MizAir and the Air-Vantage are self-adjusting to most changing conditions (such as throughput viscosity). The microprocessor calculates proper stroke control from feedback delivered by an embedded velocity sensor and restricts the air flow accordingly during a portion of each pump stroke.

The net result is about 35% to 50% reduction in air use at the same inlet pressure with no significant change in product throughput. The product is currently limited to 2" and 3" metallic pumps manufactured by Sandpiper, Versamatic, Wilden, and others.

These examples of utilizing modern microprocessors and modern fast acting control valves instead of "older spring and diaphragm" controls has significant potential positive impact to lower our industrial operating energy costs. BP

*For more information, contact Don van Ormer, Air Power USA, at don@airpowerusainc.com or visit www.airpowerusainc.com.*

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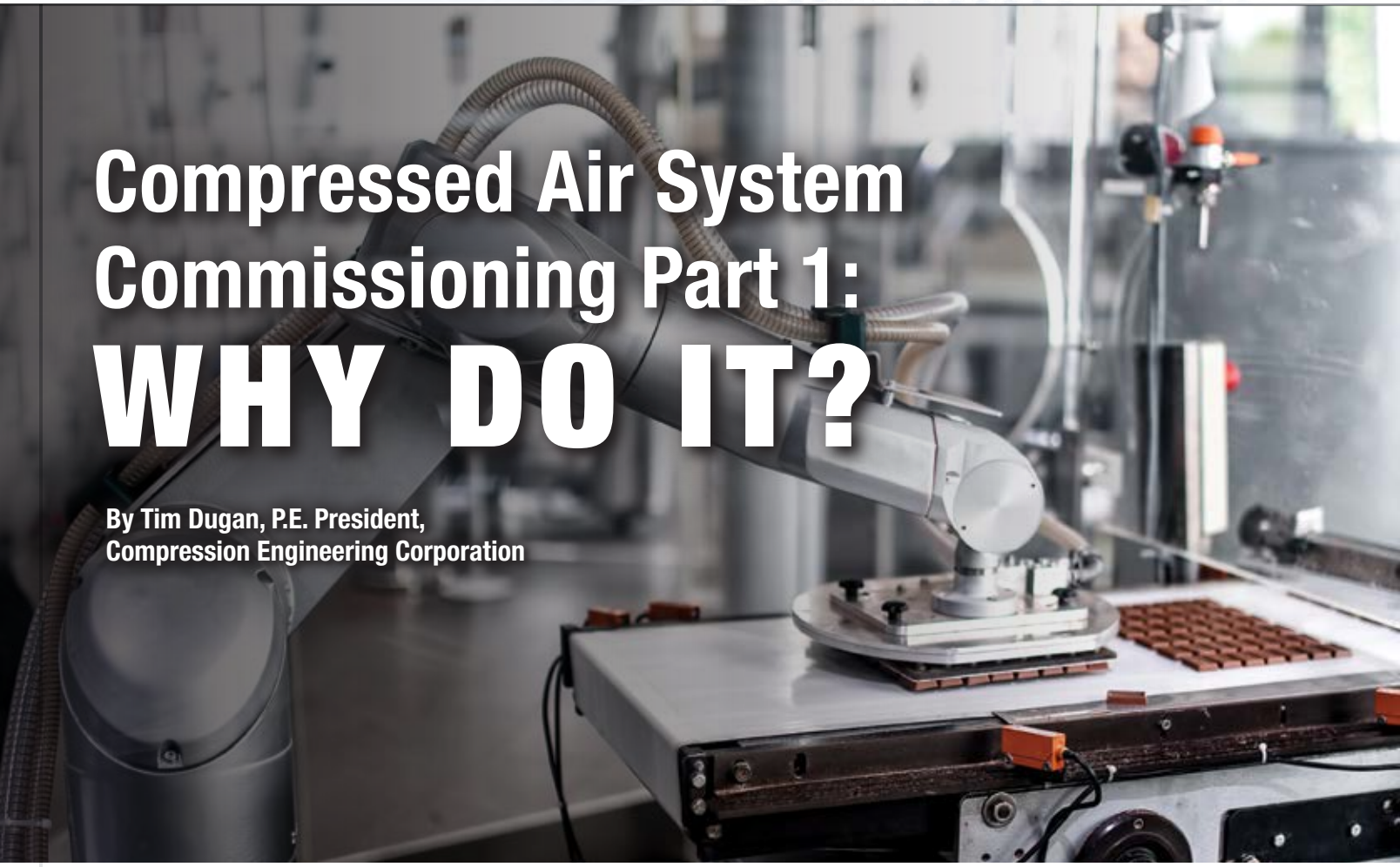

# Compressed Air System Commissioning Part 1: WHY DO IT?

By Tim Dugan, P.E. President,
Compression Engineering Corporation

## ➤ Introduction

"Retro-Commissioning" (ReCX) of compressed air systems has become a trendy activity with many utility demand-side-management programs emerging in the last 5-10 years. This is intended to be the process of "tuning up" a compressed air system, getting low cost savings from mostly adjustments and repairs. The term was borrowed from the building/HVAC industry, where it means to get a system operating as it was originally "commissioned". From ASHRAE Standard 202P,

*"The Commissioning Process is the Owner's quality-oriented process for achieving, evaluating, and documenting that the performance of buildings, systems, and assemblies meets defined objectives and criteria."*

In layman's terms, it is getting the system running per the design intent. In HVAC, when a contractor installs a new chiller and ducting, they usually also are responsible for one master control system that operates dampers, reheaters, chillers, cooling towers, etc. The system is designed by a consulting engineer, and "commissioned" as a whole.

**ReCX of many compressed air systems would not be needed if the system was actually designed and commissioned properly the first time.**

What is "commissioning" for compressed air? What if there was no real "design intent" to commission it back to? Utility DSM programs have descended on that term, and to them, it generally means post data-logging of a compressed air system that is receiving an incentive. Unfortunately, the utility-required commissioning effort is not well integrated into the owner/supplier/contractor business agreements, and is not used for actual tuning. It is merely a process to develop post-improved energy to determine the final utility incentive. Are energy-efficiency professionals missing the intent of commissioning? Shouldn't there be a more robust methodology for commissioning compressed air systems that can apply to most projects, and is integrated into the actual project?

## Proposed Definition of Compressed Air System Commissioning

I suggest the following definition:

*"Compressed air system commissioning is the process for measuring, testing, adjusting, and documenting that the performance of an entire compressed air system achieves the target system efficiencies (scfm/kW as a whole and for each piece of equipment) in all load regimes and potential failure modes."*

## Problem Definition

In reality, most compressed air system projects are not commissioned as a complete, integrated system. They are a jumble of pieces, some modifications to existing and some new, and often not well-integrated. If the projects are commissioned, usually only the part that changed is commissioned, and the full range of operating regimes is not tested. As a result, the system reliability and efficiency is fragile. For instance, the following compressed air system project types are not integrated or commissioned as a system very well:

1. Addition of one VFD compressor to a multiple-compressor system
2. Addition of a new dryer, in parallel with existing dryers
3. Addition of a new dryer, dedicated to one compressor in a multiple-compressor system
4. Addition of a sequencer
5. Addition of or adjustment of local compressor controls
6. Addition of a pressure-flow controller

See Figure 1 for a typical industrial system, with typical modification projects that get partially "commissioned", in phases.

Phase 1 is in black, originally a 300 & 200hp lubricated screw compressor system, modulation controls, and a heatless regenerative dryer. The system ran in manual control, and was stable and predictable, but inefficient.

Phase 2 is in green, about 10 years ago, the replacement of the old 200hp modulation compressor with a new load-unload compressor, storage, and sequencer. It never really got commissioned all the way.

The sequencer was provided with the new compressor, and didn't fully integrate with the old compressor. Only a start relay was added, not an unloading relay. And the pressure sensing locations for the local pneumatic controls were ahead of the dryer and filters, while the sequencer took its input from the system side. It made it through start-up, and seemed to work. But after the start-up, the new load-unload compressor started short-cycling mysteriously, and the sequencer was turned off.

Phase 3 was latest. A VFD compressor was installed, with its own dryer, and the sequencer was "connected" to the VFD compressor. Since the sequencer was not designed to work with VFD compressors, the compressor set point it local, at its own discharge, not the downstream point that the sequencer is using. The sequencer can only start and load the VFD compressor, and thinks it is a fixed-speed unit, so its algorithm is wrong. The sequencer is impossible to tune, and is turned off. The old modulation compressor and VFD compressor are run, and both dryers.

Every part of the system affects the other parts. For instance, the purging of the old heatless dryer loads up the load-unload compressor every dryer cycle (5 minutes), and then abruptly unloads it upon each brief tower switch. The dryer pressure differential varies based on compressor load, biasing the two separate control points (P1 vs. P2, or P3 vs. P2), so the system is adjusted in one operating regime that occurred when start-up and commissioning were occurring. Unfortunately, as soon as the field engineer leaves, the conditions are different, those pressure differentials are different, and the system can be out of tune and unstable.

Typically, the local utility paying an incentive requires some post-measurement for each

# COMPRESSED AIR SYSTEM COMMISSIONING PART 1: WHY DO IT?

project. Unfortunately, rarely does it include "tuning". And usually the only compressor or dryers monitored were the replaced units. Full system commissioning, in the classic sense described above, is not usually done.

Problems that can occur from the above phased, incompletely commissioned system include the following:

1. New VFD compressor runs at full speed or is off.
2. New VFD compressor controls fight system controls (manual or automatic), creating system inefficiencies and unreliability through fixed-speed compressor short-cycling.
3. New dryer is at maximum heat input even while VFD compressor is idle.
4. A high pressure drop variance occurs across the new dryer, resulting in a pressure dip after the dryer. This can cause the sequencer to start-load a compressor that shouldn't be needed. It instantly needs to unload, and the process starts again. Short-cycling occurs, creating oil-carryover, excessive motor starts and loads, and excessive pressure swing.

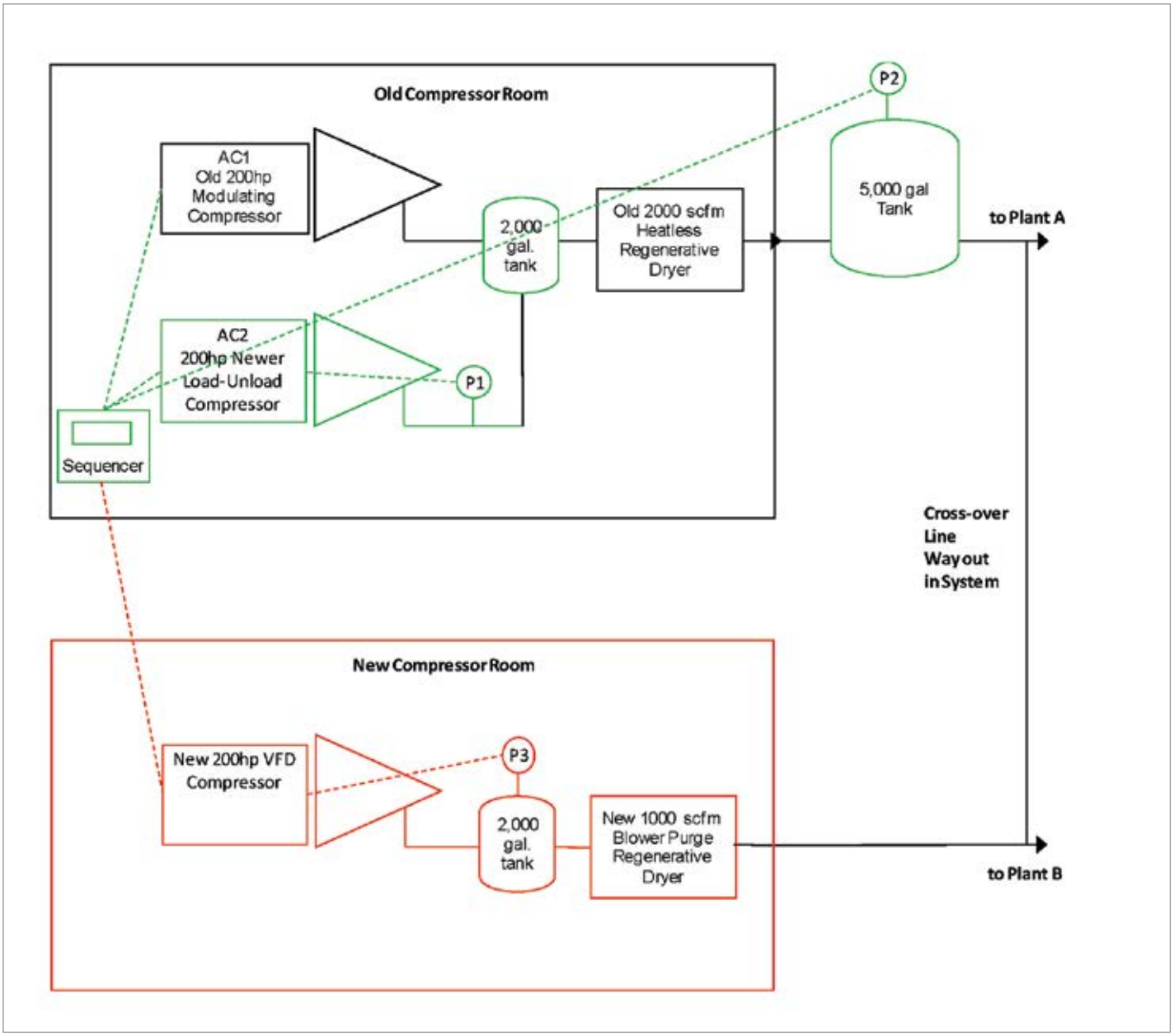


*Figure 1. Typical Compressed Air System and Typical Partial Projects*

## Root Cause 1 – Poor System Design

Part of the problem is system design and integration, which is often simple to remedy, and the other part is lack of comprehensive commissioning. Four aspects of the Figure 1 system design that make commissioning harder, and make the system less likely to operate optimally for long:

- Different pneumatic locations for pressure control. Tuning is difficult or impossible, because the pressure differentials between the points vary all the time, particularly for the VFD compressor.
- Series piping of dryers and filters. This forces the pressure differential to be the maximum on the base-load unit, and robs the operating pressure differential of load-unload compressors. The latter results in short-cycling.
- VFD (or load-unload) trim compressors are too small. They can't swing enough of a range to be able to start or stop another compressor, and compensate the difference.
- Automation needs to completely control set points, load, and start of all potentially running compressors in the system.
- Logic in sequencer is not adequate for a VFD trim compressor.

See Figure 2 for recommended improvements to the system before commissioning starts.

Three of these are not terribly expensive to do, especially at the time that the project is being implemented. The VFD size change needs to be caught early, obviously! It has the four issues corrected:

- Common pneumatic sensing location.
- Parallel piping for equalized and lower pressure drops.
- Adequately-sized VFD compressor.
- Complete automation of set points, load and start.
- Sequencer algorithm appropriate for a VFD trim compressor.

## Root Cause 2 – Incomplete Integration

I have observed a fairly new VFD compressor, supposedly "commissioned" and incentivized by the utility, running at about 50% speed. Sitting right beside it was a modulating compressor, running at about 20% capacity and requiring 75% power. The VFD could be running on its own at 70% capacity and requiring 70% power! After investigation, I determined that the utility just commissioned the VFD compressor, and never required the integration of the other compressor into the controls. Total power didn't drop at all. It went up. It used to be 70% capacity, modulated, 90% power. Now it is 130% of one compressor's power. I justified a new project to fix the old one, and the utility paid again…

# COMPRESSED AIR SYSTEM COMMISSIONING PART 1: WHY DO IT?

In that case, the system could have been "re-commissioned" so that the modulation compressor could shut off and the VFD take the demand. However, that would not meet the requirement of my definition of "system commissioning". The regime changes are not robust. In other words, when demand peaks, the modulating compressor will auto start, but will stay on. There is no reliable way to get it off and keep it off until it is needed again without proper automation that controls both compressors' set points, start and load.

I have seen other examples, including centrifugal compressor controls that only work when the load requires a constant number of compressors, in their high % capacity range. But as soon as demand creeps up to require another centrifugal compressor, which had its own dryer with high pressure drop, it starts and goes instantly into blow-off or surges. The same principles were violated.

## Root Cause 3 – Incomplete Commissioning

Let's get into the details of what many compressed air energy folks call "commissioning", and why it is incomplete. What I typically see is this:

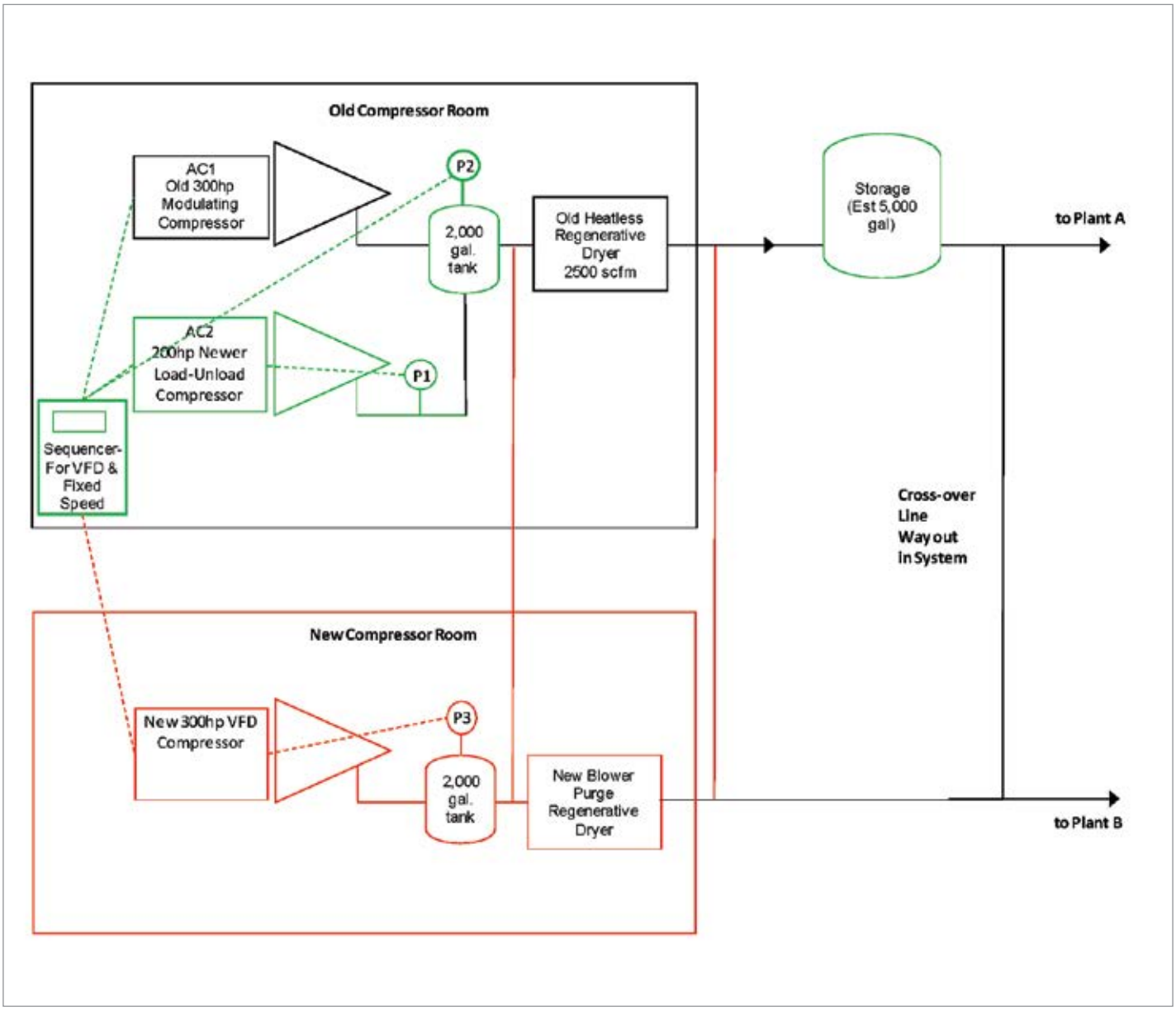


*Figure 2. Typical Compressed Air System and Well-integrated Projects*

1. Install current transducers or power transducers on the compressors that were directly affected by the project.
2. Sometimes, install a pressure transducer. Often not.
3. Data-log for a couple weeks.
4. Calculate savings based on pre-post power difference.

This is not commissioning at all. It is verification of savings, and not very good verification at that. Remember, commissioning has everything to do with validating original (or optimal) design intent. Measurement is a means to an end. And it has to be done in coordination with the design and start-up phases of the project, not a separate tag-on process when everyone is gone.

Take Phase 3 (in red) in Figure 1 for instance. Likely only the new compressor would have been "commissioned". Savings would have been calculated based on the difference between the old trim compressor operating load-unload and the new one running variable speed. That sounds clear and simple, right? Unfortunately there are too many system interactions to really tell what the savings were. Dryers could have been in different operating modes pre-post, drawing different purge loads from the trim compressors. Air flow could be drawn more from Plant A than B, making the VFD appear to be more efficient. The list goes on. So that would not have been a good verification procedure.

From a commissioning perspective, that type of post-measurement would have been worthless. The key commissioning issues in that project are:

1. Proper compressor staging, as a system. Subordinate performance indicators are low/no unloaded power on the base compressors and VFD compressor in its sweet spot speed range most of the time.
2. Dryer cycling is proportional to compressor load. For instance, testing to force the load higher and then lower on the new dryer, and comparing dryer current or power in both cases, correlated with compressor load.

## Conclusion

The next time you are asked to "re-commission" a compressed air system, use it as an opportunity to get the system design changed to the way it should have been the first time, and to get the entire system commissioned the way it should have been commissioned. It is an opportunity for a "do over". Don't just go in and tweak a few set points here and there on a screwed-up design. Your so-called savings will evaporate in a few months, and the system will be right back to where you found it, or worse. And if the utility says, "Hey that's a capital project! I brought you in here to do an O&M project!", tell them it's the right thing to do. If the customer says, "I don't have a budget for this!", sell on the reliability benefits and sustained savings. If you explain yourself well, they both will probably agree with you, and you will create a win-win. BP

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# Regenerative Desiccant COMPRESSED AIR DRYERS

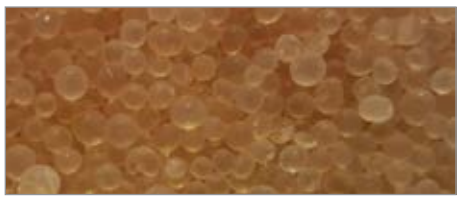
By Donald White, Chief Engineer, Aircel

Compressed air is dried to prevent condensation and corrosion which can disrupt manufacturing processes and contaminate products. Water is the primary promotor of chemical reactions and physical erosion in compressed air systems.[1] A myriad of desiccant dryer designs have been devised to provide "commercially dry" air, air having a dew point of -40°F or less, to prevent corrosion.[2] Desiccant dryers use solid adsorbents in granule form to reduce the moisture content of compressed air.

Adsorbents are miraculous microporous granules with a plethora of nanopore cavities throughout which are too small to be seen even with the aid of an optical microscope. Larger pores in the 500 to 2,000 angstrom range, macropores, provide access to the nanopores deep within the adsorbent particle. The molecular forces inside the confined spaces of the nanopores are extraordinary exhibiting unusual effects on molecules entering the cavities.[3] Natural zeolites, adsorbents formed in acidic lakes near prehistoric volcanic eruptions, may have been the birthplace of our first organic life forms. The catalytic nature of the adsorbent surfaces may have promoted chemical reactions resulting in the formation of the initial ammoniates and amino acids.[4]

Recent research at the Oak Ridge National Laboratory has revealed that the adsorption process produces a physical change-of-state. Water molecules were found to dislocate upon adsorption and the hydrogen and oxygen atoms reform in a continuous association

Activated Alumina



Silica Gel

Molecular Sieve

*Figure No. 1 Synthetic Desiccants (Photos courtesy of Porocel)*

inside the nanopores. The adsorbed state is neither gaseous, liquid, or solid, but rather a "quantum tunneling" state discovered by neutron scattering experiments.[5]

Synthetic adsorbents have been developed for industrial services to dry and purify air. These include activated alumina, silica gel, and molecular sieves. Two adsorbent filled vessels are installed in a desiccant dryer, one for drying the compressed air and one for regeneration. The vessels are switched from on-stream drying service to off-stream regeneration alternately.

The adsorption process is reversible and the adsorbed water can be desorbed by applying energy into the moisture laden desiccant. The energy source is most often an electric immersion heater, but other energy sources can be more cost effective such as high pressure steam, gas fired heater, solar heating, subterranean geothermal heating, hot air from the compressor discharge, microwave energy, or even the retention of the heat released during the adsorption process. The distinguishing feature between the various types of desiccant dryers is the method of adsorbent regeneration used to provide continuous service.

The effectiveness of the regeneration process and the dew point achieved are functions of the type of desiccant, regeneration temperature, the purge intake humidity and the operating temperature of the desiccant bed. The operating temperature augmented by the heat of adsorption is typically 25˚F higher than the compressed air inlet temperature. The regeneration air temperature is usually 400˚F or lower, sufficient to desorb moisture from the wet desiccant without degrading the adsorbent. Hydrothermal degradation affects all adsorbents. Activated alumina crystallizes over 500˚F in humid conditions becoming nonporous and inert, silica gel loses the hydroxides on its internal surfaces at 740˚F in the presence of water vapor becoming inactive, and molecular sieves recrystallize into different less adsorptive forms of zeolite above 840˚F.

| REGENERATIVE DESICCANT DRYERS | |
|---|---|
| PRESSURE-SWING DRYERS | EXTERNALLY HEATED DRYERS |
| Heatless | Heated Compressed Air Purge |
| High Pressure Heatless | Atm. Blower Wet Air Purge |
| Heat Assisted | Zero Purge Loss |
| Internally Heated | Zero Switch-Over Spike |

*Figure No. 2 Classification of Regenerative Desiccant Dryers*

Desiccant dryers are divided into two classes, pressure-swing regenerative dryers and externally heated regenerative dryers.

## Pressure-Swing Regenerative Dryers

The simplest compressed air desiccant dryer is the heatless dryer. It is composed of two or more desiccant filled vessels operating side by side, one vessel on-stream drying compressed air at line pressure and the other vessel or vessels off-stream depressurized undergoing regeneration. More than two vessels are often used in very large systems to reduce the purge consumption in the regeneration process.

Energy is released during the adsorption process as required by the Gibbs phase rule, and the temperature of the adsorbent is raised along with the temperature of the compressed air passing through the interstitial voids between the granules. The heatless dryer operates on a short NEMA cycle to retain the heat of adsorption within the desiccant bed. The short cycle, five to ten minutes, prevents the emergence of the heat front at the dryer outlet before the vessels are switched over. The heat retained within the desiccant bed during the drying phase of the process is used during the regeneration phase to desorb the moisture. The retention of the heat of adsorption is assisted by installing a dense medium with a

# REGENERATIVE DESICCANT COMPRESSED AIR DRYERS


*Figure No. 3 Heatless Compressed Air Dryer (Courtesy of Aircel LLC)*

high volumetric heat capacity at the outlet end of the desiccant bed. Clinoptilolite, a dense natural zeolite, and tabular alumina have been found to be very effective in retaining the heat within the desiccant bed[6]. Steel balls have also been applied for this function.[7]

Heatless dryers consume about 15% of the dry product air as purge when operating at 100˚F and 100 psig to regenerate the desiccant and continue the drying process. The purge consumption can be significantly reduced by the introduction of a small amount of heat directly into the purge exhaust end of the desiccant vessel. The heat assisted pressure swing dryer benefits from the elevated water vapor partial pressure in the most contaminated region of the desiccant bed. The higher partial pressure results in a reduction in the quantity of purge required to convey the desorbed moisture from the desiccant vessel. The purge consumption can be reduced to 10% or less even when operating at 100˚F and 100 psig with a low wattage heater installed near the purge exhaust end of each desiccant bed.[8]

Another method used to reduce the purge consumption is to vent the purge exhaust to vacuum. Reducing the pressure within the regenerating desiccant bed lowers the purge rate required to convey the desorbed moisture out of the vessel. Vacuum systems are costly, and this method is best considered when a vacuum utility service is available at the installation site.

## High Pressure Pressure-Swing Dryers

At elevated pressures, 500 psig and higher, the air is sufficiently dense to dissipate the heat of adsorption before the end of the drying process. No attempt is made to retain the heat in high pressure heatless dryers and they are operated on a longer cycle time, typically thirty minutes to an hour NEMA cycle time.

The required purge rate is decreased as the operating pressure is raised. High pressure heatless dryers typically operate on 5% dry purge consumption. The unheated purge air provides the energy needed to regenerate the desiccant bed and a large temperature depression results. The purge exhaust temperature may be as much as 100˚F lower than the compressed air inlet temperature.[9]


*Figure No. 4 High Pressure Pressure-Swing Dryer (Courtesy of Aircel LLC)*

## Internally Heated Regenerative Dryers

Internally heated dryers with axial heating elements inserted into the desiccant beds or band heaters clamped onto the shells of the desiccant containment vessels have been applied successfully to regenerate desiccant beds. Desiccant is a thermally refractive media, and to be effective, the heating surfaces must be close, no more than four inches apart. Even with this close spacing, the surface temperatures can reach 1000˚F during regeneration and desiccant granules in close proximity to the heating surfaces are gradually deactivated. Internally heated dryers require about 6% dry purge air to distribute the heat throughout the desiccant bed, convey the desorbed moisture out of the vessel, and to prevent water vapor condensation. Lower purge rates produce higher vapor pressures in the desiccant bed resulting in condensation on the cool vessel walls.

The dry air purge and high regeneration temperature can provide very low outlet dew points, less than -100˚F pressure dew point in some cases. The heat of adsorption is not retained and the dryer operates on a long NEMA cycle time, typically eight hours, four hours drying the compressed air and four hours regenerating at atmospheric pressure. The desiccant must be changed-out frequently because of the hydrothermal destruction of the adsorbent at elevated temperatures in moist environments.

## Externally Heated Regenerative Dryers

Externally heated regenerated desiccant dryers are built with a heater installed outside the desiccant vessel to indirectly heat the wet adsorbent. Purge air is required to convey the thermal energy between the heater and the bed of desiccant. Regeneration can be accomplished either at line pressure or at atmospheric pressure, but is most effective

at low pressure. When desorption of moisture is complete, unheated purge is required to flow through the desiccant bed to provide cooling.

The purge flow rate required to accomplish regeneration is determine by an overall heat balance:

$$Q_p = \{M_w [(c_p)_w (T_2 - T_1) + H_a] + [M_d (c_p)_d + M_v (c_p)_v](T_3 - T_1) + q_l\} / [\rho_o (c_p)_p t_h (T_3 - T_2)]$$

The purge exhaust temperature, T2, can be determined by a mass balance or approximated by the Bud Ginder chart [10]:

The thermal energy required to heat the purge to the regeneration temperature is found by a heat balance based on the purge exhaust temperature:

$$q_h = [Q_p \rho_o (c_p)_p t_h (T_3 - T_2)] + q_l$$

The amount of cooling air required to reduce the desiccant bed temperature to the adsorption bed operating temperature is approximately 1.25 pounds of air per pound of desiccant. Dry purge air is too costly to provide complete cooling, and most often the dry purge dryers are cooled to about 50%. The fraction of bed cooling provided is determined by a heat balance:

$$\text{Fraction of Bed Cooling} \approx [Q_c \times \rho_o \times t_c / (1.25 \times M_d)]$$

## Externally Heated with Dry Compressed Air

The simplest externally heated compressed air dryer is regenerated with dry air purge both during heating and bed cooling phases of the process.

The externally heated dry purge air dryers operate on a long NEMA cycle, typically eight hours. The water laden vessel is depressurized for regeneration. The required purge is dependent on the inlet flow rate, temperature and pressure. Higher temperatures and lower pressures increase the water loading on the desiccant by Dalton's law, and the purge and heat required to accomplish regeneration are increased.[10] Purge consumption is reduced approximately 25% by deenergizing the heater early when the heat content in the desiccant bed is sufficient to complete the regeneration process. Continued purge air flow will convey the heat into the unregenerated portion of the bed and the regeneration process will be completed when the cooling front

# REGENERATIVE DESICCANT COMPRESSED AIR DRYERS

| GINDER CHART | | | | | | |
|---|---|---|---|---|---|---|
| REGEN. PRESSURE [PSIG] | REGENERATION TEMPERATURE [°F] | | | | | |
| | 310°F | 350°F | 400°F | 450°F | 500°F | 600°F |
| 150 | 179 | 188 | 197 | 205 | 212 | 223 |
| 120 | 172 | 180 | 189 | 197 | 203 | 214 |
| 100 | 167 | 174 | 183 | 190 | 197 | 207 |
| 80 | 160 | 167 | 176 | 183 | 189 | 198 |
| 60 | 152 | 160 | 167 | 173 | 179 | 188 |
| 10 | 117 | 123 | 128 | 133 | 136 | 145 |
| 5 | 110 | 116 | 121 | 127 | 130 | 136 |
| 0 | 102 | 107 | 112 | 115 | 120 | 126 |

*Figure No. 5 Purge Exhaust Temperature as a Function of Regeneration Pressure and Temperature*

overtakes the heat front at the purge exhaust end of the vessel. This method results in complete thermal regeneration and total cooling of the desiccant bed.

Using dry air purge, the residual moisture in the desiccant bed is minimized and the externally heated desiccant dryers with dry purge air can achieve very low pressure dew points, often below -100°F.

The dry purge consumption can be further reduced by including an air injector with a pressure recovering venturi. The air injector operating on 7% of the dry product air can boost the pressure of ambient air to provide a combine purge air flow rate of 15%. When the desiccant bed is fully regenerated but hot, the heater is deactivated and the ambient air inlet is closed. The dry purge air continues to flow through the vessel to partially cool the desiccant bed.

Hot, wet compressed air can be used for desiccant regeneration in an externally heated dryer rather than dry process air to reduce operating costs. The air compressor discharge temperature elevated by the heat of compression to approximately 300°F can be applied directly to the moisture laden desiccant. The moist compressor discharge dew point is high, typically around 140°F, and to achieve an outlet dew point of -40°F, the air must be heated to 500°F or more. Additional valves, heat exchangers and an auxiliary immersion heater are required to attain the benefits from the heat of compression dryer. Compressed air dryers that rely on the heat of compression can be designed for split flow or full flow, and they can be designed as either two vessel systems or as rotating drum systems with partitions to separate the drying, heating, and cooling sections.


*Figure No. 6 Externally Heated Dry Purge Air Dryer (Courtesy of Aircel LLC)*

## Externally Heated Dryers with Atmospheric Blower and Wet Air Regeneration

The externally heated dryer with an atmospheric pressure blower can regenerate the desiccant bed providing -40°F dew point "commercially dry" air while operating on an eight hour NEMA cycle with a 400°F regeneration temperature. Ambient air, though moist at room temperature, is relatively dry once it has been heated to 400°F. Ambient air at 100°F saturated with water vapor when heated to 400°F has a relative humidity of 0.4% which is quite suitable for desiccant bed regeneration. An atmospheric pressure blower is installed to provide the regeneration air. An inlet damper or bypass control valve is used on the blower to maintain the required purge flow rate. The purge flow is heated in passing through the blower by the frictional heat losses and by the heat of compression. Typically these result in a temperature elevation of 20°F to 60°F. The purge air is then heated to the regeneration temperature, normally 400°F, by an immersion heater. The regeneration temperature is maintained by adjusting the blower intake control valve, decreasing the regeneration air flow rate to increase the temperature, or increasing the flow rate to lower the temperature. Once the flow

*Figure No. 7 Externally Heated Dryer with Atmospheric Blower Purge (Courtesy of Aircel LLC)*

rate is set, the control valve will require only occasional adjustment. The blower adjustment can also be accomplished with a variable frequency drive (VFD) to alter the rotational speed of the motor.

After heating the desiccant, the vessels are partially cooled either with dry purge air, 2% average of the dryer design flow rate, or with moist ambient air. When ambient air is used for cooling, the flow direction through the dryer must be reversed to keep the outlet end of the desiccant bed dry and the desiccant bed must be enlarged to account for the adsorption of atmospheric moisture entering the dryer with the cooling air.

Zero purge loss externally heat regenerated desiccant dryers use ambient air for thermal regeneration followed by closed loop bed cooling with dried ambient air. The regeneration blower is used to circulate the dry air. The flow direction is reversed for closed loop cooling to maintain dry desiccant at the outlet end of the desiccant bed, and an air cooler is installed at the blower inlet to remove the heat conveyed out of the desiccant beds. The blower intake is left open as there is no flow through the inlet line with closed loop cooling.

Closed loop cooling provides complete desiccant bed cooling and as a result the moisture spikes and temperature elevations that normally occur during the bed switch-over process are minimized. These can be eliminated altogether by installing a second regeneration air cooler at the blower discharge to remove the heat developed in the blower housing. Switch-over spikes will not occur when the bed is completely cooled to the dryer operating temperature.

Regenerative desiccant air dryers can be designed and manufactured to meet very stringent service conditions. In the process of selecting the most appropriate dryer, the design requirements must be thoroughly evaluated to insure that the product will be sufficient and dryer sizing must be confirmed by calculations to assure the adequacy of the design. BP

*By Donald White, Chief Engineer, Aircel, email: don.white@airceldryers.com, tel: 865-268-1011, www.Airceldryers.com*

To read more ***Compressed Air Dryer Technology*** articles, please visit www.airbestpractices.com/technology/air-treatment

**Notations**

$(c_{p'})_p$ = specific heat of purge air, btu/lb-°F
$(c_{p'})_d$ = specific heat of desiccant, btu/lb-°F
$(c_{p'})_v$ = specific heat of vessel, btu/lb-°F
$(c_{p'})_w$ = specific heat of water, btu/lb-°F
$H_a$ = heat of adsorption, btu/lb of water
$M_d$ = mass of desiccant, lbs per vessel
$M_v$ = mass of desiccant vessel, lbs
$M_w$ = mass of adsorbed water per drying period, lbs
$q_h$ = total heat required for regeneration, btu
$q_l$ = heat losses to atmosphere, btu
$Q_c$ = cooling air flow rate, scfm
$Q_p$ = purge heating air flow rate, scfm
$t_c$ = regeneration cooling time, minutes
$t_h$ = regeneration heating time, minutes
$T_1$ = temperature of desiccant bed initially, °F
$T_2$ = purge exhaust temperature, °F
$T_3$ = regeneration air inlet temperature, °F
$\rho_o$ = standard air density, lb/Std.cu.ft.

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# SHOW REPORT: 2016 FABTECH Nitrogen Generators & Compressed Air Technology

By Rod Smith, Compressed Air Best Practices® Magazine

*The TRUMPF Trulaser 3030 relies on Festo Compressed Air Regulation and Preparation modules.*

FABTECH 2016, North America's largest collaboration of technology, equipment and knowledge in the metal forming, fabricating, welding and finishing industries, welcomed 1,500 exhibiting companies and a total of 31,110 attendees from over 120 countries last week to the Las Vegas Convention Center.

FABTECH's expansive exhibit space spanned more than 575,000 net square feet, giving attendees ample opportunity to see manufacturing's latest innovations, interact one-on-one with key vendors and learn about new industry trends. Throughout the three-day event, attendees also had access to more than 100 education sessions and expert-led panel discussions. A variety of special programming was featured as well, including a powerful opening keynote from boxing legend and entrepreneur Sugar Ray Leonard and an appearance from cast members of the hit reality TV show "Counting Cars."

"We are so grateful to our exhibitors, attendees, special guests and the City of Las Vegas for helping make FABTECH 2016 such a resounding success," said Mark Hoper, vice president of expositions & media, FMA. "The enthusiasm and commitment displayed by everyone at the show to improve our industries were contagious. By participating in FABTECH 2016, attendees now have stronger, more diverse business networks and increased knowledge on manufacturing's top trends and best practices."

Hundreds of live product demonstrations showcasing manufacturing's most cutting-edge equipment and technologies took place daily on the exhibit floor. These demonstrations allowed FABTECH exhibitors to present their current product offerings to targeted buyers and generate quality sales leads.

"FABTECH for us is all about networking," said Angus Catterson, president, KAAST Machine Tools Inc. "Year after year, this event is a great venue to strengthen our relationships with current customers and help us meet potential new ones as well – all while promoting our new product lines and letting more people know about who we are as a company."

Compressed Air Best Practices® Magazine was pleased to be in the literature bins at FABTECH 2016!

## Compressed Air and Nitrogen Generation Technology

Kaeser Compressors had their booth full of different rotary screw air compressors. A unit popular with metal fabricators is the rugged AS Series. The AS Series features a new airend designed specifically for it along with a standard TEFC motor, magnetic Wye-Delta starter and belt drive with automatic tensioning system. The sound attenuated cabinet keeps sound levels as low as 67 dBA and has a receiver tank inside! An integrated refrigerated dryer is an option one can choose. It's a module in a separate "bolt-on" cabinet so it's not exposed to preheated air or contaminants from the compressor package. The AS Series comes with Sigma Control Basic for convenient pressure control and system monitoring. The flow range is from 64 to 143 cfm at pressures from 80 to 217 psig.

Based in Atlanta, BEKO USA has become a major supplier of desiccant air dryers. Manufactured in their Atlanta headquarters with ASME pressure vessels, their DRYPOINT® X family of desiccant dryers covers a full range of heatless and heated dryers. The family of products covers pressures from standard 100 psig plant air all the way to special high pressure applications up to 7000 psig. The flows range from small compact units to heated units handling up to 6,000 scfm. The BEKO booth personnel were talking about the DRYPOINT® XF heated desiccant dryers-particularly the XFi unit featuring "ecoIntelligence". This system takes demand-control energy savings to another level by syncing with the air compressor and using sensors (on both inlet and outlet) to drive down energy consumption while ensuring dry compressed air.


*Josh Wagner, Zach Jackson and Bruce Lidie (left to right) next to a Kaeser AS25T rotary screw air compressor.*


*Jim Tomczyk, Adrian Fernandez and Eric Johnson (left to right) presented the new BEKO Drypoint® XF hyper-intelligent heated desiccant dryer.*


*MTA USA has expanded the size of their U.S. field sales force. Pictured left to right are Enrico Callegarin, Craig Thorsen, Matt Broxterman (Blackhawk Equipment), Tim West, Howard Kielar, Angelo Mastrangelo, Dan Rogowski and John Medeiros.*

# SHOW REPORT: FABTECH 2016


*Mike Steinke and Red Lopez (left to right) next to a COAIRE 30 hp VSD rotary screw air compressor.*


*Mike Kinnucane, from Parker GSF, discussing their NITROSource nitrogen generator.*


*Emmanuel Perez, Don Joyce and Todd Alison (left to right) at the CTA Americas booth.*

COAIRE was at the show displaying their CHSA Series, direct-coupled, single-stage, lubricated rotary screw product line. There are five models ranging from 30 to 100 horsepower for a flow range of 109 to 441 cfm (at 100 psig). The sound attenuation packages are very effective, for the 30-50 horsepower models, at 63-65 dBA. This line complements their established lineup of oil-less scroll air ends and D, M, and S Series Scroll enclosure units ranging from 3 to 50 horsepower.

MTA USA was present displaying their cycling refrigerated compressed air dryers. The DEiTech series offers thermal mass performance-without the mass. This innovative system matches the performance of their long-established DE thermal mass dryers, while reducing the unit footprint and weight by as much as forty percent (40%). The patented innovation centers around an all-aluminum 3-in-1 heat exchanger design using "pulse technology" which is a suction-side refrigerant flow control system. This refrigerant control system allows the dryer to "unload" as required and to cycle on and off when demand is low.

Purification Solutions (nano) has established a joint venture with CTA SAS (from Chaponost, France) for refrigeration products. The joint venture will focus on chiller and refrigerated dryer technologies. The refrigerated dryers will be brought to the market by nano and feature an improved NXC thermal mass and a new NDX direct-expansion refrigerated dryer technologies. The CTA Americas team will focus the CTA brand on chillers for primarily OEM opportunities.

SMC USA displayed their pneumatically-driven NAMS power clamps designed to help metal fabricators. SMC's Scott Maurer explained how their pin clamp cylinders, angular style air grippers and VQC pneumatic valves all help optimize the product. SMC offers a range of point-of-use refrigerated dryers and chillers to complete a production solution for the client.

## Nitrogen Generators

The Parker GSF Division had a booth educating the metal fabricators (particularly those using lasers) about the benefits of generating nitrogen from their compressed air systems. The Parker domnick hunter line of NITROSource nitrogen gas generators benefits from over 30 years experience in the market and over 50,000 gas generators installed globally. The environmental, the cost, and the quality benefits

(over supplied gas options) are truly very important and it's good to see the market acceptance of nitrogen generators continue to grow. I have long been impressed by the application knowledge at Parker GSF. Applying the proper nitrogen purity specification (avoiding often unnecessarily high purities) is the key to maximizing the efficiency of the technology. Parker GSF helps clients test different purity levels for their applications before settling in on the specification. An excellent reference table, within an article titled "Selecting Purity Levels with Onsite Nitrogen Generators" was written by Parker GSF's David Connaughton and is available on our website at www.airbestpractices.com/industries/food.

Gas Control Systems is a Michigan-based packager of both PSA and Permea membrane nitrogen generation systems. Established in 1982, the Company also supplies a line of oxygen generators designed to meet central pipeline requirements-such as those required by their partnership with Can-Gas Systems. While visiting the booth, Bryan Cook told me they are selling into a wide range of applications including laser cutting, plastic injection molding and food packaging. It's clear to me they have extensive packaging capabilities for customized skids. BP

*For more information about FABTECH 2017, taking place in Chicago on Nov. 6-9, 2017, please visit fabtechexpo.com.*

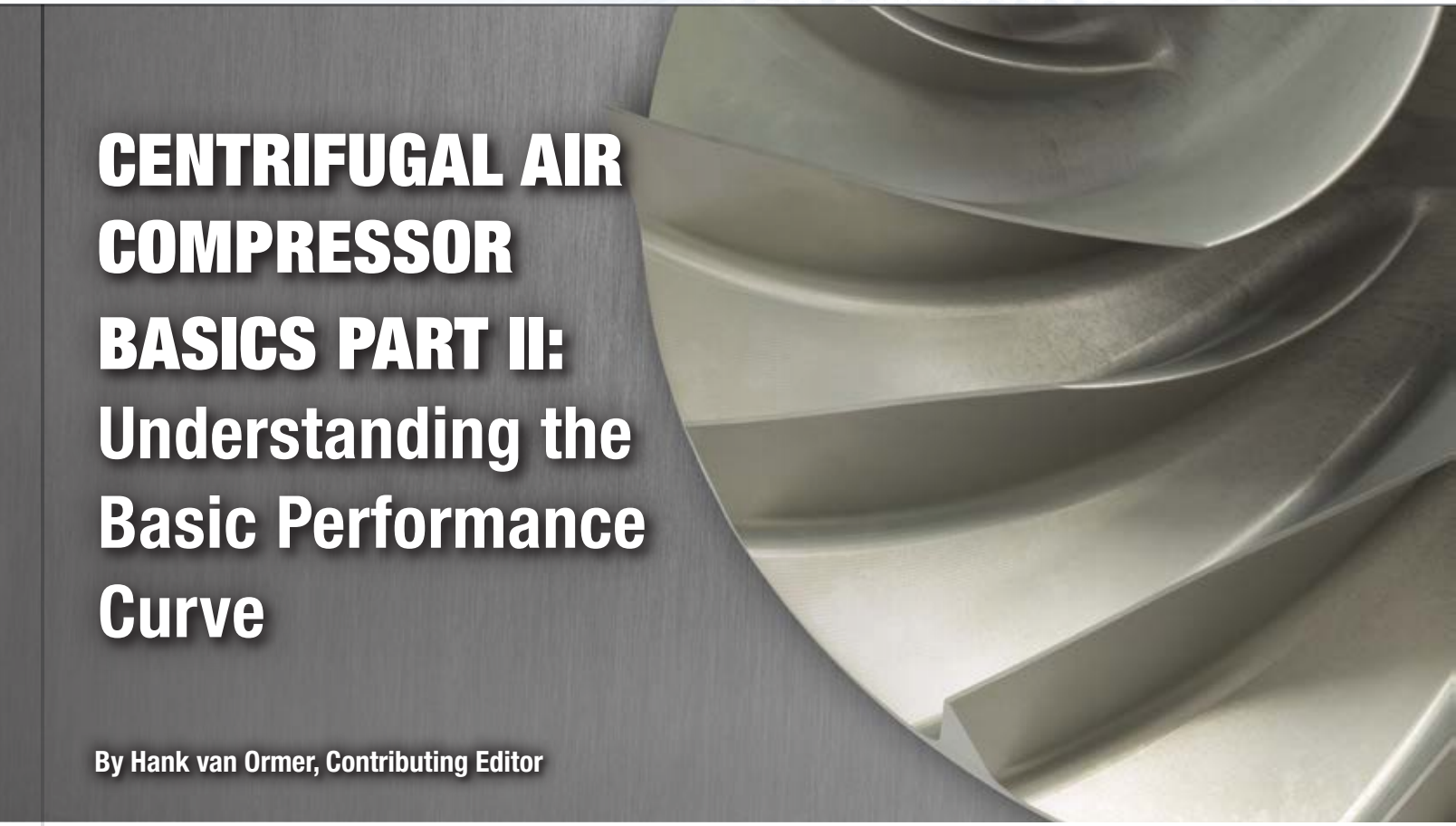
To read similar ***Metal Industry*** articles, please visit www.airbestpractices/industries/metals

*Scott Maurer in front of the NAMS Power Clamps display at the SMC booth.*

*Gas Control Systems displayed PSA and Permea Membrane nitrogen generators.*

**"FABTECH for us is all about networking, Year after year, this event is a great venue to strengthen our relationships with current customers and help us meet potential new ones as well – all while promoting our new product lines and letting more people know about who we are as a company."**

**— Angus Catterson, president, KAAST Machine Tools Inc.**



# CENTRIFUGAL AIR COMPRESSOR BASICS PART II: Understanding the Basic Performance Curve

By Hank van Ormer, Contributing Editor

**Part I explained necessary terminology to understand centrifugal operations. Part II reviews typical operating performance curves and how to interpret them.**

A centrifugal air compressor operates over a range of flows and discharge pressures. The operating performance curve is shaped by the selected individual internal components and affected by operating conditions such as inlet pressure, inlet temperature, and cooling water temperature.

The process of *dynamic compression,* as applied in a centrifugal compressor operating stage, is velocity and kinetic energy converted to pressure and temperature as the flow is restricted. Another term for this process is mass flow – the power requirement to deliver the rated cfm of flow at the rated pressure (psig) is determined by the weight of the air (some manufacturers also use the term "density").

The power requirement in this type of compression process, when the internal design parts are not considered, is basically dependent on the weight of the air going through the machine. Ignoring part loads controls anything that will increase or decrease the weight of the air going through the stages to final flow, and pressure will have a direct impact on input power.

Increasing the inlet temperature will lighten the total fixed air flow and deliver less usable air to the user (scfm) and reduce the input power requirement. Colder temperatures will produce the opposite effect.

Reducing the inlet pressure (altitude, negative compressor room pressure, dirty/poorly sized inlet filter) will lighten the compressed air flow (cfm) that travels through the stages also resulting in less usable air (scfm) at a reduce input power requirement. Higher inlet pressure will have the opposite effect.

Increasing the cooling water temperatures will again have the same "lightening" effect on the compressed air through the stages and power requirements as the previous conditions.

The actual net effect of any of these conditions is dependent on the actual performance curve and aerodynamic characteristics of the design. This is also the case of discharge pressure with a fixed wheel, or impeller/diffuser/speed, compressor stage.

Increasing the discharge pressure will normally leave the effect of raising the weight of the compressed air stream through the stages which will result in less flow of usable air (scfm) often at or near the same input power. Lowering the pressure will often allow more flow at the same or similar power input. Actual machine specific performance is covered later in this document.

## Understanding Centrifugal Manufacturer Operating Curves

Data should be equalized to:

- SCFM or $Nm^3/hr$ at full and part loads
- Input power at kW
- Pressures either in psig or bar (only using psia to convert from icfm/acfm to scfm)

Figure 2 performance curves bring up terms to address: turndown, rise to surge, and stonewall

## What are Turndown, Stonewall, and Rise to Surge?

Once an impeller is designed and a speed set, the energy that a pound of air will absorb in passing through the impeller is established.

A centrifugal compressor will deliver a pound of air with a constant expenditure of energy –

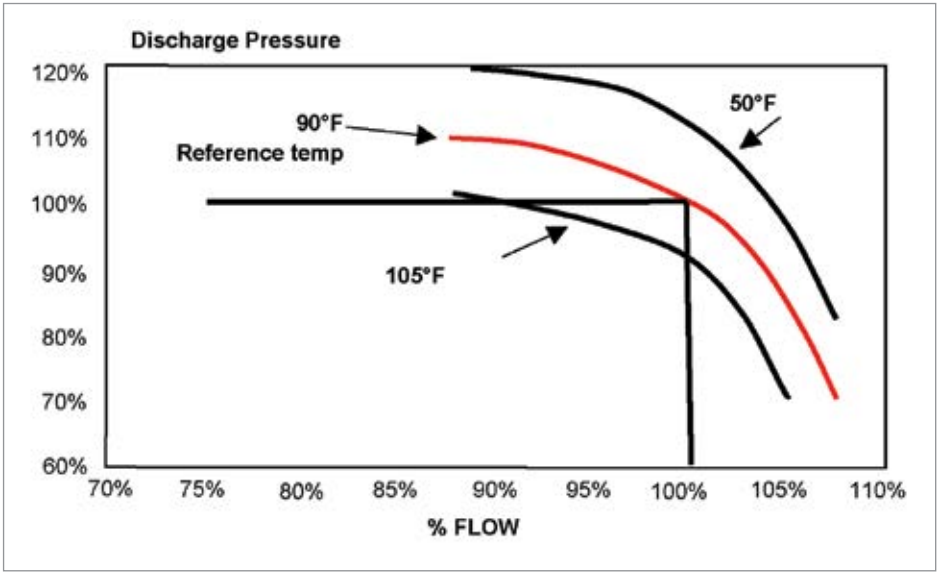



*Figure 1a. Effect of inlet air temp on discharge pressure*

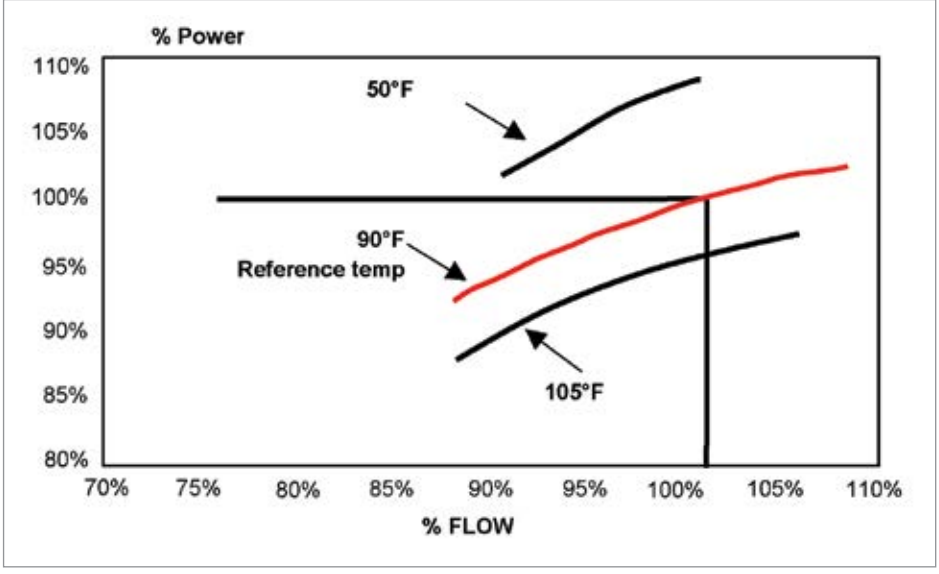



*Figure 1b. Effect of inlet air temp on power*

# CENTRIFUGAL AIR COMPRESSOR BASICS PART II

winter or summer. The actual volume of inlet air to be compressed will vary for a period of time with the inlet condition of pressure and temperature.

**Rise to Surge:** As more compressed air is produced than needed, the centrifugal compressor must unload, or deliver less air to avoid over pressure. Each centrifugal compressor has a maximum pressure it can reach for specific inlet conditions which will cause the air flow to *reverse and surge,* shutting off the compressor to avoid damage from the vibrations.

This is an oversimplification of the surge action, however, each unit has a *rise to surge* limit or maximum pressure. Turndown is the percentage below full load flow the compressor can run without experiencing surge. For example, 15% turndown means the unit can run at 85% flow or higher, as equipped without hitting surge. At greater turndown, it will be close to or at surge.

**Stonewall:** At some point, as the discharge falls and the air flow through the increases at full load, the physical limitations will not allow more air through the stages – this point is known as *stonewall.* Continued operation at or beyond this point can cause such high flow rates with greater pressure differential that the impellers will not totally fill the vane areas and a cavitation-like action will occur creating another type of surge with potentially damaging vibrations.

Figure 3 is a sample representation of a general manufacturer's performance curve and the data can be developed to a predictable and probable actual projected operating efficiency.

- 2,050 cfm at 125 psig at 430 HP (x .7457 = 321 kW)
- Turndown 1,535 cfm at 125 psig at 345 HP (x .7457 = 257 kW)

## Utilizing the Centrifugal Operating Performance Curves for System Optimization

Working with an OEM supplier and their operating performance curves effectively will help to lead to a successful application. In order for the user to provide the OEM supplier the appropriate data, the user should be familiar with the information presented to fully understand and ask for significant additional data such as:

- What are the operating characteristics of the impeller/diffuser with regard to surge point, turndown, specific power full load, etc.
- What are the set of standard impeller/diffuser for more turndown capability?

## Capacity Controls and Inlet Guide Vanes

The operating performance curves in Figure 4 show there were two different part load input kW values for the inlet butterfly valve (IBV) and

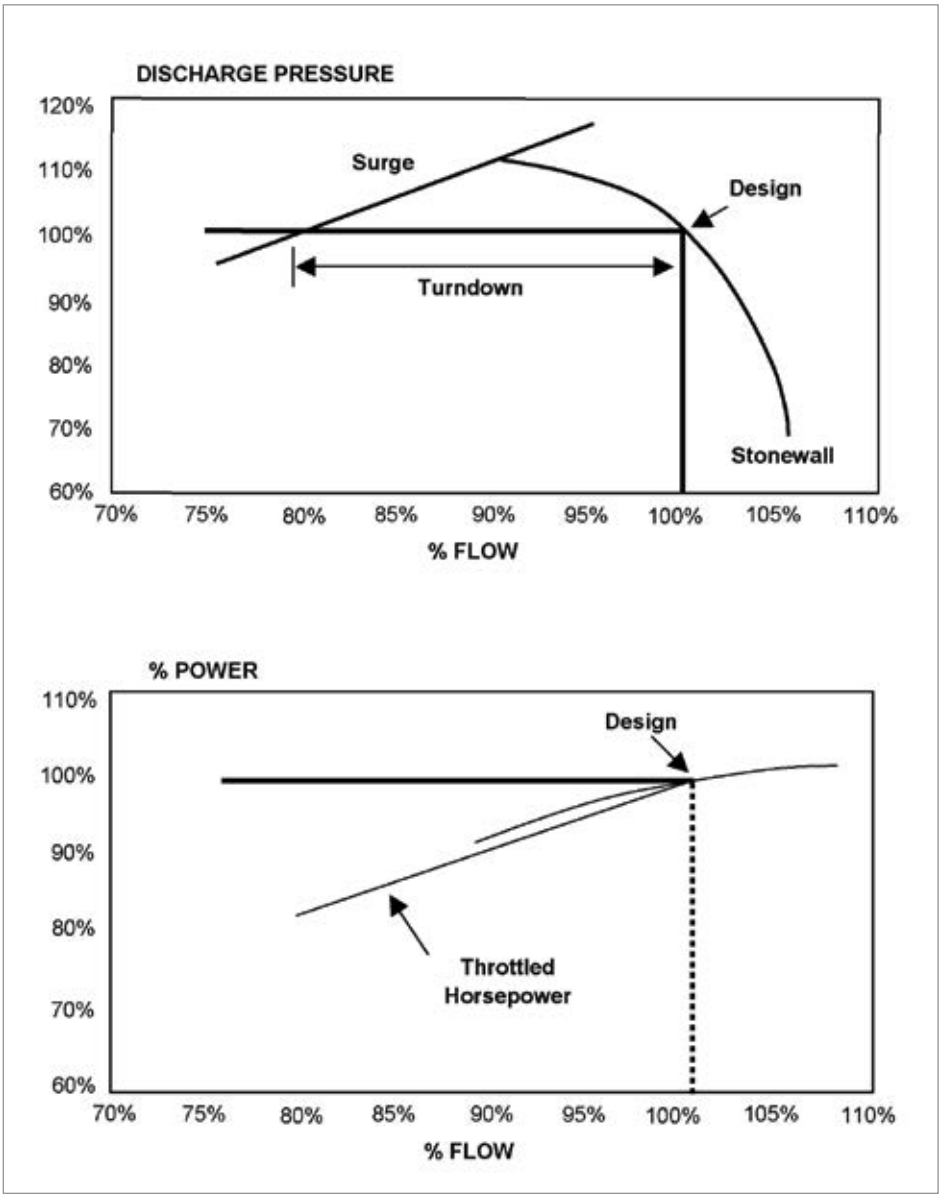



*Figure 2. Typical centrifugal performance curves*

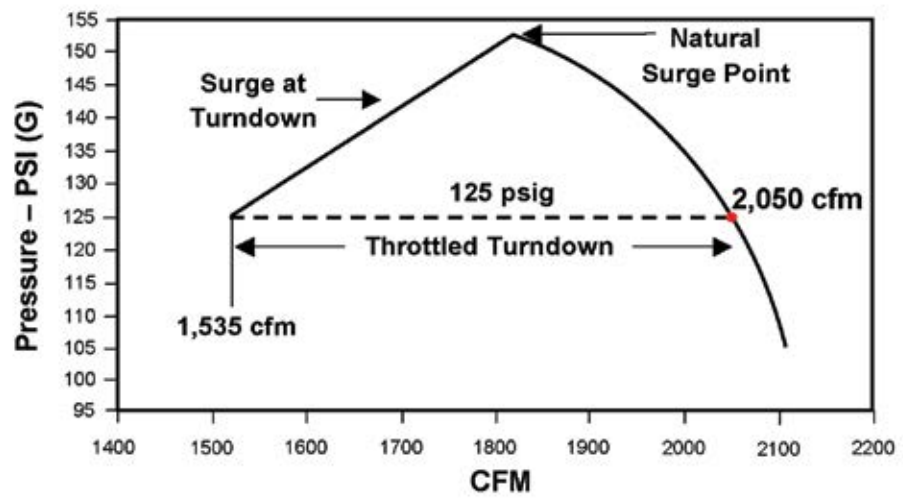
the inlet guide vane (IGV). Like all things in centrifugals, the actual data is machine specific.

## Why is All This Meaningful?

When the centrifugal compressor as designed and applied runs out of turndown, it cannot keep producing compressed air that the system cannot take so basically one of two things happen:

- A capacity control available from almost all manufacturers unloads the compressor by closing the inlet valve and opening the blow off valve, allowing the unit to go to idle at a reduced input power with no air flow.

A further refinement allows the motor to shut off; the larger the induction motor the fewer starts per hour or per day. This type of control can be very effective and is also storage dependent because the reload and or restarting of the 100 psig class unit can take up to 1 minute or more. High pressure (500 to



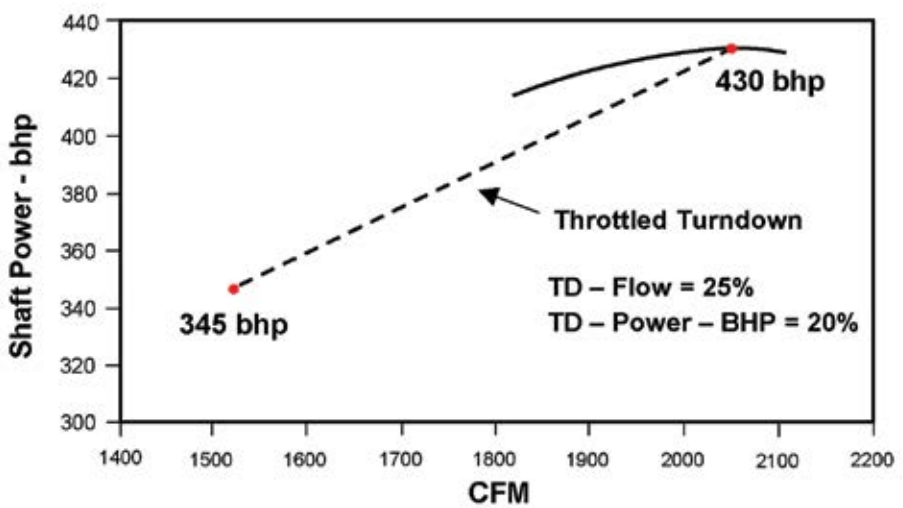




*Figure 3. Sample performance curves for full load compressor at 125 psig*

# CENTRIFUGAL AIR COMPRESSOR BASICS PART II

550 psig) units can take up to 3 more minutes to get to full load.

- The most commonly used capacity control is the blow off. When the unit reaches its full turndown (as adjusted) the blow off valve opens and blows off excess capacity to atmosphere. The input kW will no longer reduce at all regardless of whatever air demand reductions occur.

Figure 4 shows the DOE (Department of Energy) generated performance curve for the standard IBV (inlet butterfly valve) or IGV (inlet guide vane) inlet controls with a nominal 30% turndown.

The IGV's do not allow more turndown but they do allow turndown at better efficiency by reducing the turbulence losses of the air entering the impellers.

The third curve shown on Figure 4 represents a new centrifugal drive technology with magnetic bearing motors. This control is very effective VSD (variable speed drive) from 100% to 75% with the input power directly proportional. At full turndown the unit fully unloads in 7 to 12 seconds and can be loaded in 12 to 15 seconds. Effective operation requires appropriate storage.

## What About Cooling Water Discharge Pressure?

Table 1 shows a single units projected performance at 85˚F cooling water and 60˚F cooling water at different discharge pressures.

*Typical Inlet guide vanes*

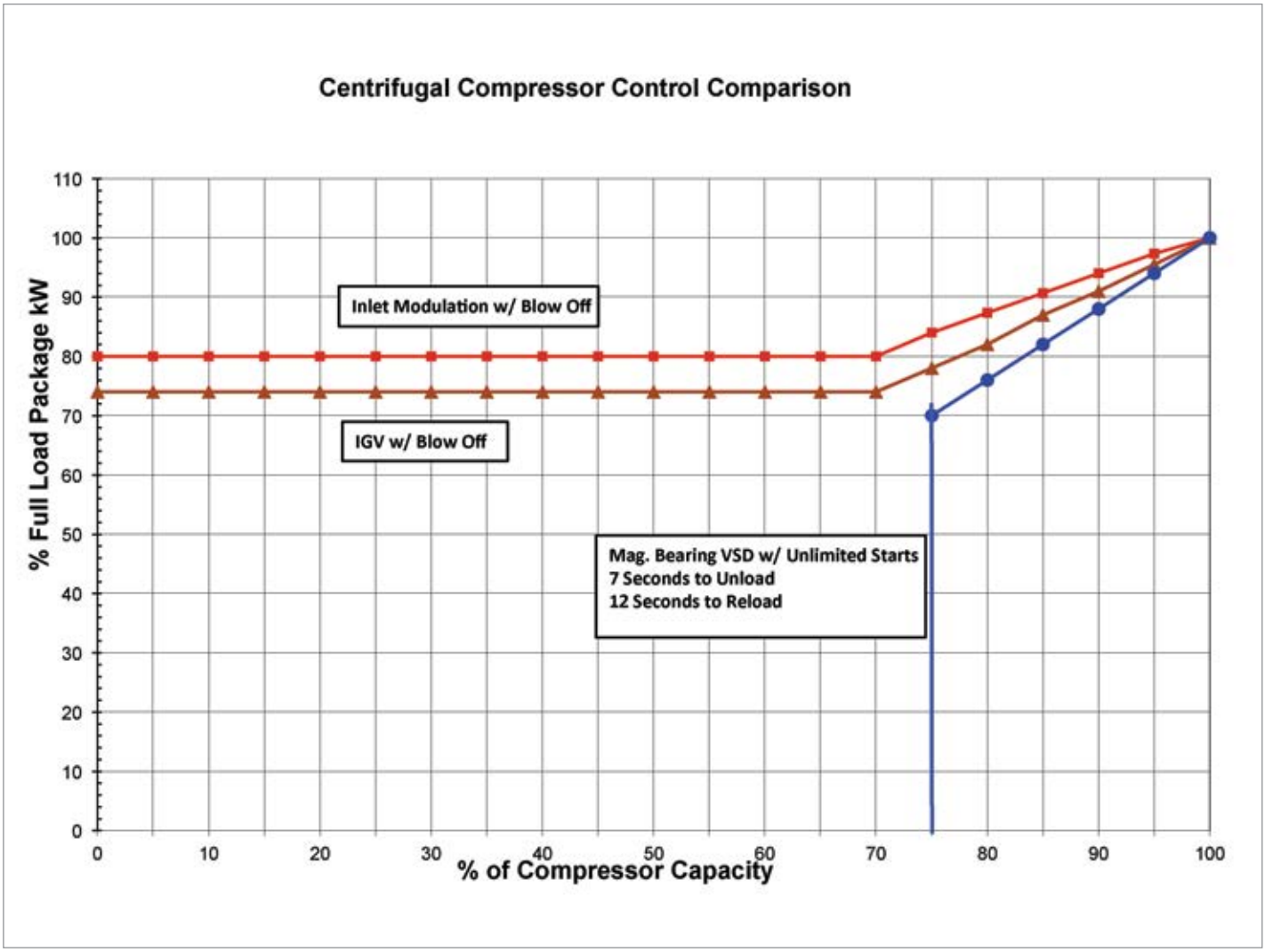



*Figure 4. Centrifugal compressor control comparison*

| TABLE 1. UNIT WITH 135 PSIG NATURAL SURGE POINT AT 85˚F COOLANT AND 60˚F COOLANT | | | | |
|---|---|---|---|---|
| STANDARD CONDITIONS | | ESTIMATED PERFORMANCE CONDITION 1 | ESTIMATED PERFORMANCE CONDITION 2 | ESTIMATED PERFORMANCE CONDITION 3 |
| **Gas** | Air | Air | Air | Air |
| **Psia Ambient** | 14.4 psia | 14.4 psia | 14.4 psia | 14.4 psia |
| **Psia Intake** | 14.1 psia | 14.1 psia | 14.1 psia | 14.1 psia |
| **Temperature In** | 95˚F | 95˚F | 95˚F | 95˚F |
| **Temperature Coolant** | 85˚F | 60˚F | 60˚F | 60˚F |
| **RH%** | 60% | 60% | 60% | 60% |
| **Psig Out** | 125 psig | 100 psig | 105 psig | 110 psig |
| **Flow** | 1,572 scfm | 1,707 scfm | 1,698 scfm | 1,689 scfm |
| **Input KW** | 262.3 KW | 263 kW | 264.1 kW | 265.4 kW |
| **Specific Power** | 5.99 scfm/kW | 6.49 scfm/kW | 6.42 scfm/kW | 6.36 scfm/kW |
| **Turndown** | 35.8% | 51.2% | 48.9% | 46.4% |

ME = nominal .95

Table 1 Notes: From 125 psig discharge pressure (85˚F cooling water) to 100 psig discharge pressure (60˚F cooling water), the flow goes from 1,572 acfm to 1,707 acfm; the shaft power goes from 334 bhp to 335 bhp (175 acfm more for 1 bhp); and turndown goes from 35.8% to 51.2%.

## Lessons Learned

This document was created to identify and explain the definitions behind centrifugal performance data and its importance. With this information, the user can work with their local OEM supplier and or technical engineering groups to select and properly apply a unit to fit the specific site conditions in an optimum manner. BP

*Hank van Ormer is the Founder of Air Power USA and a Contributing Editor for Compressed Air Best Practices® Magazine. This article was adapted from Centrifugal Training Materials provided by Air Power USA. For more information, contact Hank van Ormer at email: hankvanormer@aol.com*

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# RESOURCES FOR ENERGY ENGINEERS

## TECHNOLOGY PICKS

### Ingersoll Rand® PETStar® Reciprocating Compressors Awarded Class 0 Certification

Ingersoll Rand®, a global leader in compression technologies and services, recently earned ISO 8573-1 Class 0 certification on all of its PETStar® reciprocating compressors. This latest certification expands the collection of Ingersoll Rand Class 0 certified technologies, which already consists of air- and water-cooled, oil-free rotary screw compressors and water-cooled oil-free centrifugal compressors.

*Ingersoll Rand PETStar® 4 reciprocating air compressors provide supreme durability that reduces maintenance requirements and lowers lifecycle costs.*

For high-pressure applications such as the manufacturing of polyethylene terephthalate (PET) bottles for food and beverage, pharmaceuticals, electronics and many other critical applications, Class 0 certification eliminates the risk of air contamination that can result in damaged products and significant losses in revenue and customer trust.

"To ensure high-quality manufacturing standards, customers want the peace of mind of 100 percent oil-free air that comes with Class 0 certification," says Eric Seidel, Vice President of Product Management for compression technologies and services at Ingersoll Rand. "With this latest certification for PETStar, Ingersoll Rand now offers a full portfolio of reciprocating oil-free technology that guarantees pure air while reducing waste, inefficiencies and environmental footprint."

The PETStar Series from Ingersoll Rand was awarded ISO 8573-1 Class 0 certification after undergoing rigorous testing by TÜV Rheinland®, a global leader in independent testing and assessment services. The PETStar 4 (PS4) line from Ingersoll Rand includes nine, four-stage models that deliver between 250 kW and 525 kW of air power. The PETStar 3 (PS3) range sold in some geography, like India and Asia Pacific, were also tested and certified. Built with industrial grade components and double-acting cast iron cylinders, these compressors provide high durability. Low speeds and rugged construction gives ideal maintenance and lifecycle costs.

By generating pure air, free from additional contaminants, Ingersoll Rand oil-free compressors also minimize downtime associated with cleaning filters and other air system components. Reduced levels of contaminants also help air system components last longer and ensure higher overall product quality.

The Class 0 certification was created in 2001 in response to industry needs for oil-free air. The most stringent air quality class, Class 0 certification guarantees that a compressor discharges air free of added oil aerosols, vapors, and liquids. Ingersoll Rand has held this prestigious certification on both its oil-free centrifugal and rotary screw air compressor technologies since 2007.

#### About Ingersoll Rand

Ingersoll Rand advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands — including Club Car®, Ingersoll Rand®, Thermo King® and Trane® — work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. We are a $13 billion global business committed to a world of sustainable progress and enduring results. Ingersoll Rand products range from complete compressed air and gas systems and services, to power tools, material handling and fluid management systems. The diverse and innovative products, services and solutions enhance our customers' energy efficiency, productivity and operations.

***For more information, visit www.ingersollrand.com or www.ingersollrandproducts.com.***

***For more information about Ingersoll Rand PETStar compressors with Class 0 certifications, visit www.ingersollrandproducts.com/am-en/products/air/pet-compressed-air-solutions/pet-reciprocating***

# RESOURCES FOR ENERGY ENGINEERS

## TECHNOLOGY PICKS

### ELGi Introduces 5-15 hp Reciprocating Air Compressors

ELGi has introduced a 5-15 hp line of lubricated reciprocating air compressors for flow rates between 16-50 cfm. The 5 and 7.5 hp models are shipped with ASME coded vertical receiver tanks while the 10 and 15 hp, and duplex models are delivered with horizontal tanks and a tough, field proven pump with over 30 years of field success is utilized in the updated package design assembled in Charlotte, NC.


*The ELGi TS10-175 120H 10 hp horizontal tank model*

Designed for a maximum working pressure of 175 psig, the TS05 is rated for 16.8 cfm, the TS07 for 24.0 cfm, the TS10 for 36.1 and the TS15 for 50 cfm. ELGi reciprocating air compressors deploy a robust and completely cast-iron construction making the compressor less prone to vibration and deep fins ensuring 360 degree cooling for the cylinders. A heavy-duty industrial air filter offers clog-free filtered air while flow is not compromised. The ELGi lubricated reciprocating air compressor also has a re-forged crank shaft and connecting rod that is more rigid and designed for longer life and a double-supported industrial ball bearing to handle thrust loads and ensure longer life of the compressor. In addition, aluminum intercooler tubes and massive fan ensure superior heat dissipation for higher operating efficiency while the compressor design abides by ASME design code and OSHA Safety standards.

ELGi's reciprocating air compressors come equipped with the following standard components: ASME coded relief valves for interstage and tank pressure, all components completely pre-piped, pre-wired and operationally tested, a magnetic starter to ensures smooth start and stop of the motor, a NEMA Premium efficiency motor, ASME coded air receiver tanks and an enclosed belt guard complying to OSHA Safety standards to assure accident-free operation.

#### About ELGi

ELGi Equipments Limited is a leading air compressor manufacturer with a broad line of innovative and technologically superior compressed air systems. ELGi has earned worldwide distinction for designing sustainable solutions that help companies achieve their productivity goals and keep the cost of ownership low. ELGi offers a complete range of compressed air solutions from oil-lubricated and oil-free rotary screw compressors, oil-lubricated and oil-free reciprocating compressors and centrifugal compressors, to dryers, filters and downstream accessories. The company's portfolio of over 400 products has found wide application across industries.

***To learn more about ELGi's Reciprocating Air Compressors, visit http://www.elgi.us/lubricated-reciprocating-industrial-air-compressor/.***

### VPInstruments Introduces New Compression Fitting and Safety Cable For VPFlowScope Models

VPInstruments introduces the new compression fitting and safety cable for VPFlowScopes. The Delft based company produces flow meters that have to be inserted into pressurized systems. For this type of meters, a clearly visible safety cable is needed to keep the sensor secure, even when the compression fitting is not completely fixed. Compared to existing safety cables, safety rings and other systems, the safety cable is simple, reliable and easy to use.

Thanks to the integrated auto brake function, users can work safer and easier. Like a safety belt in a car, the proprietary auto brake automatically locks the safety cable after the user has adjusted it. It can only be adjusted intentionally, by pushing the brake release that is double secured. Compared to the old safety cable, which had to be wrapped around the pipe, the auto brake feature enhances safety and comfort.

#### About VPInstruments

VPInstruments provides real-time insight into the consumption of compressed air and technical gases. The equipment shows

# TECHNOLOGY PICKS

*For this type of meters, a clearly visible safety cable is needed to keep the sensor secure, even when the compression fitting is not completely fixed.*

where, when and how much the usage is. And that is almost always significantly more than necessary. The innovative and user-friendly meters and monitoring equipment guarantee substantial savings. The web-based software of the VPVision monitoring system is the cornerstone of any energy management system with ISO 50001 certification. Investments in products by VPInstruments very quickly pay for themselves.

***For more information, visit www.vpinstruments.com.***

## Honeywell and Sparks Dynamics Collaborate on Industrial Internet of Things (IIOT) Solutions

Honeywell and Sparks Dynamics announces they will collaborate to help industrial customers leverage the power of the Industrial Internet of Things (IIoT) and make their operations safer, more efficient and more reliable.

"A robust ecosystem is one of three key steps to an effective IIoT," said Andrew Hird, vice president and general manager of Honeywell Process Solutions' Digital Transformation business. "First, you need to have secure access to the vast amount of operational data being collected; second you need the capability to accurately and quickly analyze that data; and finally, you must have the domain knowledge to understand how to deploy information to benefit the operation. Spark Dynamic's elite domain expertise in the world of compressed air solutions makes the Honeywell-Sparks Dynamics IIoT ecosystem unique for our customers."

Honeywell's capabilities in data consolidation, cyber and software development combined with Sparks Dynamics' deep domain knowledge will allow the expansion of a robust IIoT ecosystem that will help customers solve previously unsolvable problems.

"Sparks Dynamics will work with Honeywell to provide compressed air management, systems engineering, energy analysis and assistance with analytics development," said Mac Mottley, Sparks Dynamics' chief executive officer. "An important part of this will be working with Honeywell to introduce a joint compressed air solution to the mid- to large-sized industrial plants."

Honeywell and Sparks Dynamics have a history of collaboration. Honeywell's automation and controls technologies help automate and harness data at more than 10,000 manufacturing sites around the world. Sparks Dynamics have implemented several compressed air monitoring solutions utilizing Tridium's* Niagara Framework's evolving technology from edge to cloud and JACE controllers.

Ultimately, Honeywell and its collaborators, including Sparks Dynamics, will leverage the IIoT to help customers minimize unplanned shutdowns, maximize output, minimize safety risk and optimize supply chain strategies.

With a larger, consolidated data set, manufacturers can apply higher analytics for more detailed insight, scale the data as needed to meet the varied needs of single-site or enterprise-wide operations, and leverage a wider pool of data experts for monitoring and analysis.

The goal, Hird said, is a simple-to-use infrastructure that gives customers secure methods to capture and aggregate data, so that it can be leveraged by using analytics and applying a range of domain knowledge from a vast ecosystem of equipment vendors and process licensors.

* Tridium is an independent business within Honeywell International.

### About Sparks Dynamics

Sparks Dynamics provides Industrial Internet of Things (IIoT) intelligent solutions to its manufacturing customers that enhance business profitability through smart systems that continuously monitor energy, security, and equipment status. This continuous verification allows for increased efficiencies, reliability and business continuity. Sparks' state of the art cloud based Remote Monitoring Analytics

# RESOURCES FOR ENERGY ENGINEERS

## TECHNOLOGY PICKS

System Technology for Efficiency and Reliability (ReMASTER) product provides an intelligent monitoring solution with big data analytics and specially developed artificial intelligence that keeps operating parameters remain within the performance envelope.

### About Honeywell Process Solutions

Honeywell Process Solutions is a pioneer in automation control, instrumentation and services for the oil and gas; refining; pulp and paper; industrial power generation; chemicals and petrochemicals; biofuels; life sciences; and metals, minerals and mining industries. Process Solutions is part of Honeywell's Performance Materials and Technologies strategic business group, which also includes Honeywell UOP (www.uop.com), a leading international supplier and licensor of process technology, catalysts, adsorbents, equipment, and consulting services to the petroleum refining, petrochemical, and gas processing industries.

### About Honeywell

Honeywell is a Fortune 100 diversified technology and manufacturing leader, serving customers worldwide with aerospace products and services; control technologies for buildings, homes, and industry; turbochargers; and performance materials.

***For information about Sparks Dynamics, visit www.sparksdynamics.com***

***For information about Honeywell Process Solutions, visit www.honeywellprocess.com***

***For more information about Honeywell, visit www.honeywell.com***

### Parker Unveils New Wireless Sensor Products

As the Internet of Things (IoT) leaps forward, Parker Hannifin Corporation, the global leader in motion and control technology, continues to introduce new products rooted in diagnostics and condition monitoring. Parker introduced an expanded SensoNODE™ product line at this year's Sensors Midwest conference in Rosemont, Ill.

The latest additions to the SensoNODE product line include:

- Parker's newest version of its condition monitoring software, **SCOUT Mobile 3.0,** increases readability of data and customization of alarms and dashboards. The mobile app also improves ease of exporting measurements.
- The new **Vacuum sensor** monitors expanding pressure ranges and is ideal for vacuum pump monitoring and detecting system leaks.
- The **4-20mA transmitter** turns any wired sensor into a wireless device, making it easier to monitor any asset.



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## TECHNOLOGY PICKS

- Two new **Temperature** sensors that feature foot and probe designs allow for a better accommodation of user applications.
- Parker's **ServiceJunior**™ is now wireless. The integrated digital pressure gauge, with minimum/maximum memory capability and graphic display, has a scan rate of 10ms and provides increased accuracy and frequency to diagnostics.
- The **High-Strain sensor** features Parker's durable and energy-efficient electroactive polymer (EAP) strain technology. The stretchable polymer takes accurate measurements while being strained 100% for millions of cycles.

Having a wide range of products to pick from is central to maximizing efficiency and productivity while driving uptime, says David Shannon, Parker Quick Coupling Division's business team manager.

"Connecting various motion and control systems and subsystems to each other and out to the Internet is one great way to manage the entire organization," Shannon says. "However, that can be a daunting task. Where do you start? Which standard do you follow? How do you avoid overpaying for technology that you don't need, and how do you keep it secure?"

**About Parker Hannifin:**

With annual sales of approximately $13 billion in fiscal year 2015, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of mobile, industrial and aerospace markets. The company employs approximately 55,000 people in 50 countries around the world. Parker has increased its annual dividends paid to shareholders for 59 consecutive fiscal years, among the top five longest-running dividend-increase records in the S&P 500 index. For more information, visit the company's website at www.parker.com or its investor information website at www.phstock.com.

***For more product information, please visit: www.parker.com/conditionmonitoring.***

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## Sustainable Energy Savings with Compressed Air Best Practices®

Compressed Air Best Practices® is a technical magazine dedicated to discovering **Energy Savings** in compressed air systems — estimated by the U.S. Department of Energy to represent 30% of industrial energy use. Each edition outlines **Best Practice System Assessments** for industrial compressed air users — particularly those **managing energy costs in multi-factory companies.**

*"Compressed air encompasses 20 percent, on average, of a Darigold plant's electrical energy spend."*

– Uli Schildt, Energy Engineer, Darigold Dairies
(feature article in April 2016 Issue)

*"Compressed air is our lifeline. Everything here runs on compressed air."*

– Curtis Wood, Facilities Team Supervisor, HAECO Americas
(feature article in June 2016 Issue).

"Demand Side" and "Supply Side" information on compressed air technologies and system assessments is delivered to readers to help them save energy. For this reason, we feature Best Practice articles on when/how to correctly apply **air compressor, air treatment, piping, storage, measurement and pneumatic control technology.**

**Industrial energy managers, utility incentive program managers, and technology/system assessment providers** are the three stakeholders in creating energy efficiency projects. Representatives of these readership groups guide our editorial content.

*"Compressed air optimization measures reduced consumption by 31% resulting in 3.8 million kWh and $255,000 in annual savings."*

– Abdul Mohideen, Electrical Energy Manager,
PROTON Automotive, Malaysia

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# THE MARKETPLACE

## JOBS

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Contact: Syd English – syd@marcusecompressor.com

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Aircel

### Regional Sales Manager

Aircel LLC is seeking an experienced Regional Sales Manager to manage a distribution network.

Aircel is an industry leading compressed air dryer and filtration manufacturer with over 22 years of precise engineering and reliable designs. In order to provide full support to our expanding network of distributors and customers, we are looking for Regional Sales Managers with strong backgrounds in sales, compressed air, and systems knowledge. Ideal candidates have 5 years experience in working with distribution-based industries and OEMs.

Aircel offers competitive compensation plans, health insurance, and 401K benefits with company contributions.

Please send resumes to **resumes@airceldryers.com**

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Parker

Industrial Compressed Air and Gas

### Territory Sales Manager

Parker is looking to fill sales manager positions in both the Southern California and Chicago areas.

These positions require 50 - 70% travel as well as experience in direct and/or distributor sales of capital equipment in the compressor dryer industry.

To apply, **visit www.parker.com/careers** and search on **"Industrial Compressed Air and Gas Territory Sales Manager"**.

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Contact: Janice Woodbury jwoodbury@compressorenergy.com

# THE MARKETPLACE

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A music studio equipment manufacturer had problems maintaining steady pressure with their compressed air system. Additionally, there never seemed to be enough air to meet production demand despite having both a 50 hp and a 75 hp rotary screw compressor. Month after month, energy costs soared with the compressors being the highest consumers. And during the summer months, increased condensate in the lines caused severe air quality issues.

### Solution:

An Air Demand Analysis (ADA) revealed that the 50 hp unit (with modulation control) was producing only a fraction of its total capacity yet consuming full load kW. A single 50 hp compressor with adequate storage could easily meet the plant's demand and provide significant energy and maintenance cost savings. The air quality issues were due to undersized storage and air treatment.

### Result:

The new, energy-efficient 50 hp dual control compressor provides all the air that's needed and keeps the plant pressure rock steady—with the 75 hp compressor still there for backup. The new refrigerated dryer with energy-saving controls and condensate management system have solved the air quality issues, while the 361,099 kWh reduction in annual energy consumption has this customer singing a happy tune.


| | |
|---|---|
| Specific Power of Previous System: | 59.74 kW/100 cfm |
| Specific Power of New System: | 19.05 kW/100 cfm |
| Annual Energy Costs of Previous System: | $52,981 per year |
| | |
| Annual Energy Cost Savings: | $36,110 per year |
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