The Magazine for ENERGY EFFICIENCY in Blower and Vacuum Systems

# BLOWER & VACUUM BEST PRACTICES

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July 2018

## INDUSTRIAL VACUUM & BLOWER SYSTEMS



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# INDUSTRIAL VACUUM & BLOWER SYSTEMS

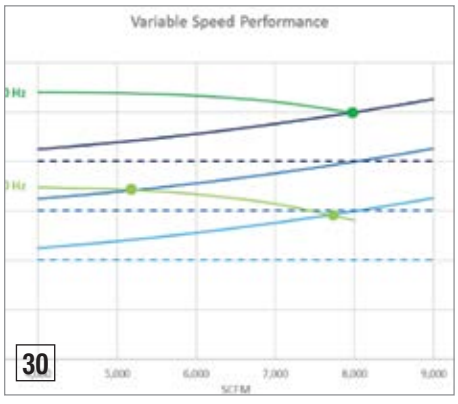



# AERATION BLOWER SYSTEMS




# COLUMNS





# FROM THE EDITOR

Industrial vacuum systems, known by some as "rough vacuum" systems, remind me of where we were 25-30 years ago with compressed air. Plants own vacuum pumps to operate equipment and are completely unaware of their energy costs. Utility incentive programs, with a few rare exceptions (one profiled this issue), do not have incentive dollars going towards these projects. Why? Projects aren't being brought to the utilities because there are very few people out there able to conduct a good industrial vacuum system audit-similar to where we were, in the 1980's, with compressed air.

A Pennsylvania-based manufacturer of tin or aluminum-based decorated packaging uses vacuum primarily for pick-and-place operations with their printing, stamping and forming machines. I'd like to commend Bud Fogleman, who works for PPL Electric Utilities' partner, CLEAResult for awarding an incentive under their Custom Program for a fully measured and verified vacuum system upgrade for this PPL client. Please take a look at how this project reduced the vacuum pressure specification from 25" Hg to 21" Hg and used a new VSD air-cooled vacuum pump to reduce kW consumption by 68% and turned OFF a water chiller.

So, how does one reduce vacuum demand in a plant? This is the knowledge we need to get to the plants. Tim Dugan, from Compression Engineering Corp., provides us with a well-organized article splitting vacuum demand into three segments to be examined; controlled demand, false/uncontrolled demand at the end use and distribution leakage. An example of false/uncontrolled demand is a CNC routing table in a furniture plant where flow is variable "by accident." I like this article as it can help an auditor or vacuum user start to organize where to look to reduce demand.

Wastewater treatment plants can also see significant variations in water level. Tom Jenkins, from JenTech Inc., provides us with an interesting article on how to design aeration blower systems for variable wastewater depth processes in both equalization (EQ) basins and in Sequencing Batch Reactors (SBRs).

Come learn these things in-person at the inaugural 2018 Best Practices Expo & Conference, September 17-19, 2018 at the Chicago O'Hare Crowne Plaza. Please consider visiting us and registering for the event!

Thank you for investing your time and efforts into **Blower & Vacuum Best Practices.**


**ROD SMITH**
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Join Tom Jenkins P.E., President of JenTech Inc. and Sponsor APG-Neuros on August 2nd, to learn about aeration blower turndown strategies.

Register and view our 2018 Webinar Calendar at www.blowervacuumbestpractices.com/magazine/webinars

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## TECHNOLOGY PICKS

### Pfeiffer Vacuum ASM 390 and ASM 392 Mobile Leak Detectors

The Pfeiffer Vacuum ASM 390 and ASM 392 are leak detection solutions adapted to the semiconductor and display industries as well as to other demanding applications where rapid pump down and high sensitivity is key. Both models are Semi S2 compliant.

The leak detectors are fitted with a dry frictionless backing pump and a powerful high vacuum pump, making them the ideal tools for leak testing of various components in clean environments.

Equipped with an additional turbopump, the ASM 392 will speed up the leak detection process to reduce the downtime of the production equipment.

The ASM 390 and ASM 392 have been developed to provide full confidence in leak testing regardless of operator knowledge. They deliver accurate results in minimal time, making them highly efficient in the field.


*Pfeiffer Vacuum mobile leak detectors ASM 390 and ASM 392 for rapid pump down and short response times on large test objects.*

ASM 390 and ASM 392 are uniquely ergonomic with a convenient size and height, a secondary handle in the front, a fully rotatable, removable display, an inlet in the front for easy connection to test ports and maneuverability for access to all testing areas, even in tight spaces.

Thanks to a wide, clear color touch panel display, an integrated toolbox with modular compartments and storage space for vacuum bellows, leak detection can be very easy.

#### About Pfeiffer Vacuum

Pfeiffer Vacuum (stock exchange symbol PFV, ISIN DE0006916604) is one of the world's leading providers of vacuum solutions. In addition to a full range of hybrid and magnetically levitated turbopumps, the product portfolio comprises backing pumps, leak detectors, measurement and analysis devices, components as well as vacuum chambers and systems. Ever since the invention of the turbopump by Pfeiffer Vacuum, the company has stood for innovative solutions and high-tech products that are used in the markets Analytics, Industry, Research & Development, Coating and Semiconductor. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 2,900 people and has more than 20 subsidiaries.

For more information, please visit www.pfeiffer-vacuum.com

### Pro-Pack Blower Packages from Hardy Pro-Air

Hardy Pro-Air Systems & Service has over 50 years of experience in custom processing equipment and systems, including their standard blower package Pro-Pack. Pro-Pack standard blower packages are available for a wide variety of positive pressure and vacuum applications. This includes: pneumatic conveying, dust collection systems, industrial vacuum systems, aeration, gas pressure boosting, combustion air pressurization & metering, spot cooling of machinery and equipment and mine & tunnel ventilation.

Standard package options offer a wide variety of capabilities. Custom packages for applications requiring larger volumes, pressure or vacuums are also available. Computerized blower selection provides the most efficient and economical selection of blower, motor and

## TECHNOLOGY PICKS

*Pro-Pack standard blower packages provide multiple options of inlet/outlet connections to suit installation requirements.*

drive, keeping purchasing and operating costs to a minimum. Factory authorized installation and service in your plant or in the field is available through Hardy Pro-Air's network of independent service companies.

### Pro-Pack Features and Benefits

- Single-supplier responsibility from blower package design to construction and warranty work.
- State-of-the-art CAD systems allow for quick, accurate availability of drawings for layout and piping.
- Quality components throughout all blower packages ensure efficient operation and maximum service life.
- Reliable sturdy construction – Heavy gauge, continuously-welded frames provide rigid framework, eliminating sway and minimizing vibration.
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- Multiple options of inlet/outlet connections are available to suit installation requirements.

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## TECHNOLOGY PICKS

- Heavy duty belt guard is easily removed for service and inspection, and meets all OSHA requirements.
- Vibration isolations is provided with all blower packages, reducing noise, as well as wear and tear.
- A wide variety of options and accessories ensures maximum flexibility in standard or custom designed blower packages.

### About Hardy Pro-Air

Hardy Pro-Air is the Dynamic Result of the merger and integration of independently successful systems design and sales of Hardy Systems with the service & manufacturing expertise of Pro-air Service. Organized as a division of Meyer Machine & Equipment, we are focused on Sales and Service of air and material handling equipment for companies and municipalities nation-wide. Our Systems group brings to the table the ability to take projects from concept all the way to start-up. With our veteran staff we can consult on possible solutions to meet the most demanding applications. We have a wide range of products to meet the needs of any situation. We take pride in offering the service to support your organization for the equipment that we sell in addition to other manufacturers. For more information, please visit www.hardyproair.com.

## Leybold Presents Four Advanced Vacuum Technologies for Laboratories

Leybold is focusing on four advanced vacuum technologies for laboratories: SOGEVAC NEO D, SCROLLVAC, ECODRY plus and TURBO. CONTROL i

Today, innovations for vacuum-based applications in laboratories, analytics and research and development are the drivers for a healthier and safer life. Modern vacuum technology must therefore convince in daily operations with properties such as cleanliness, low noise and sustainability.

When processes are based on a permanent vacuum, the choice of suitable components is all the more important. Reliable, high-performance vacuum technology not only does the job; the working environment also benefits from more peace, less distraction and higher air quality. These factors of ergonomics significantly increase the general well-being. The result: employee productivity, motivation, but also the precision in demanding applications improve significantly.

### SOGEVAC NEO D

With its new vacuum pumps for both industrial and high vacuum applications, Leybold takes this development into account. The new two-stage SOGEVAC NEO D rotary vane pump offers a whole range of advantages, especially for these general challenges. The pump offers benefits in three very decisive areas: it is cleaner, quieter and practically maintenance-free.

*The new two-stage SOGEVAC NEO D rotary vane pump*

The compact SOGEVAC NEO D is equipped with a high-quality exhaust filter inside the oil casing. Built-in filtration reduces the required integration volume of the pump and ensures a clean environment without oil smoke or loss while pumping down. The acoustic properties also set new standards: it is 3 dB(A) quieter than conventional models on the market. SOGEVAC NEO D is designed for maximum uptime through state-of-the-art shaft sealing technology and the use of durable mineral oils. This results in maintenance-free operating intervals of up to three years.

### SCROLLVAC

The SCROLLVAC series is characterized by low power consumption and high pumping speed. In addition, the SCROLLVAC plus with its extremely light, compact design takes up very little space in plants and equipment. This makes it easy to integrate into both new and existing vacuum systems. Their low level of vibration and noise (less than 55 dB (A)) increases the circle of potential users, especially as these factors play a central role in today's ergonomically designed work environments.

*The SCROLLVAC series is characterized by low power consumption and high pumping speed.*

## TECHNOLOGY PICKS

Their functional and design features simplify daily use of the backing pump. For example, the hermetic sealing of the rotating parts from the pump chamber reduces the risk of contamination. By dispensing with shaft seals, which are susceptible to wear, the developers have achieved a higher degree of tightness. This ensures economic efficiency and predestines the SCROLLVAC plus for universal use in robust processes.

### ECODRY plus

The ECODRY plus is a clean, compact and low-maintenance pump in the size class 40 to 60 m3/h, developed to meet the requirements in analytical or research laboratories. This pump class lies exactly in the transition area between small laboratory instruments and large machines. The most important innovation, however, undoubtedly lies in the reduction of the noise level, which the Leybold developers have succeeded in achieving: "We have managed to build the pump as compact, easy to operate and quiet as is otherwise only known from significantly smaller devices," explains the responsible product manager, Alexander Kaiser, the positioning features of the novelty.

*The ECODRY plus was developed exactly according to the requirements of systems such as mass spectrometers and electron microscopes*

The ECODRY plus was developed exactly according to the requirements of systems such as mass spectrometers and electron microscopes. It is therefore also suitable for large accelerators because there is no contamination by dust or oil. It offers users a high degree of comfort, pumping speed performance and flexibility.

### TURBO.CONTROL i

The future-oriented TURBO.CONTROL i controls and monitors the turbo molecular pump product line TURBOVAC i(X) and is suitable for use in high vacuum applications and integration into compact system solutions. The Leybold innovation can be operated intuitively and precisely via the display and the front keys or via the pre-installed web server interface. Via the web server, all pump parameters can be easily viewed and set using PC or mobile devices. The most important parameters are written to the log file; various special data queries are possible depending on the requirements.

The device is generally mounted in the rack, yet a desktop case is available separately. The TURBO.CONTROL i can operate one TURBOVAC i(X) each and can be connected to all TURBOVAC i(X) models for on-site control and data reading. Two communication channels (RS 485 and USB) are included in

# RESOURCES FOR ENERGY ENGINEERS

## TECHNOLOGY PICKS


*TURBO.CONTROL i controls and monitors the turbo molecular pump product line TURBOVAC i(X)*

the controller for pump control and connection of up to two vacuum gauges. Users can easily view the log file with the TURBO.CONTROL i Data Viewer software tool, which can be downloaded free of charge from the Leybold website. This MS Windows software tool analyses the data and event logs and monitors the status and the most important parameters. The software tool TURBO.CONTROL i is characterized by intuitive operating menus and simple operation and thus offer a completely new, comfortable user experience.

All development steps and resulting advantage of these innovations are based on decades of experience that Leybold can draw on, especially in the field of analytics. "As a pioneer in vacuum technology with our comprehensive application know-how, we know exactly what our customers in this segment need. Our new vacuum pumps not only offer innovative concepts and a productivity advantage for our customers. In most cases, we are able to optimize vacuum-based processes in advance through our consulting," explains Dieter Müller, Global Business Development Manager Analytics.

### About Leybold

Leybold is a part of the Atlas Copco's Vacuum Technique Business Area and offers a broad range of advanced vacuum solutions for use in manufacturing and analytical processes, as well as for research purposes. The core capabilities center on the development of application- and customer-specific systems for the creation of vacuums and extraction of processing gases. Fields of application are secondary metallurgy, heat treatment, automotive industry, coating technologies, solar and thin films such as displays, research & development, analytical instruments, as well as classic industrial processes. For more information, visit www.leybold.com

### About Atlas Copco

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum technique 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 2016, Atlas Copco had revenues of 11 Billion Euros and more than 45 000 employees. For more information visit www.atlascopco.com

## New EXAIR Threaded Line Vac

EXAIR's new aluminum 2-1/2 NPT and 3 NPT Threaded Line Vac Air Operated Conveyors convert ordinary pipe into a powerful conveying system for parts, scrap, trim and other bulk materials. Their larger size makes them perfect for conveying bigger parts and large volumes of material over long distances. The Threaded Line Vac is designed to attach to standard plumbing pipe couplers. This makes it easy to build a complete system, using pipe and fittings available from any home center, hardware store or plumber supply.

Threaded Line Vac Conveyors eject a small amount of compressed air to produce a vacuum on one end, with high output flows on the other. Response is instantaneous and regulating the compressed air pressure provides infinite control of the conveying rate. Applications include scrap trim removal, material conveying, part transfer, fiber tensioning and filling operations.

Aluminum Threaded Line Vacs are CE compliant and meet OSHA pressure requirements. Smaller sizes down to 3/8 NPT are available in stock. Threaded Line Vac models are also available in type 303 and type 316 stainless steel for more demanding high temperature, corrosive and hygienic environments. Line Vacs also come with smooth ends for use with hose and tubing. Heavy Duty Line Vacs provide abrasion, resistance, while producing maximum power for high bulk density material. If a

## TECHNOLOGY PICKS

secure pipe connection is required where the Line Vac will be frequently removed for cleaning, Sanitary Flange Line Vacs are also available.

For more information, visit www.exair.com.

### Kice Industries Introduces New Compact Filter

Kice Industries announced it has introduced a new compact filter to its product line. The new compact filter is for direct mounting to bins, drags, legs and other equipment where access or mounting options are limited.

"This new filter features an integrated fan and cleaning system that is designed for simple installation, operation, and maintenance," said Andy Forrester, Director of Sales, Kice Industries. "We designed this for various cartridge configurations and lengths to handle a wide range of applications, materials, and air volumes."


*The new Kice compact filter is for direct mounting to bins, drags, legs and other equipment.*

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### Often Over-looked Energy Conservation Measures for Blower & Vacuum Systems.

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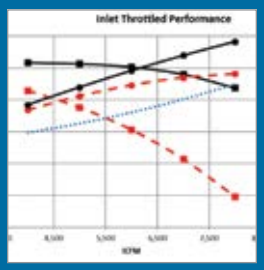
*Vacuum Demand Reduction Projects*

*Blowers & Air Knives for Blow-off Air*

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**Doug Barndt**
*Manager Demand Side Energy & Sustainability, Ball Beverage Packaging*

**Dana Bolton,**
*VP Customer Solutions, ComEd*

**Leslie Marshall**
*Corporate Energy Engineer Lead, General Mills*

**Walt Tunnessen**
*National Program Manager, ENERGY STAR for Industry*

**Kurt Kniss**
*Innovation Engineer, Shaw Industries*

# RESOURCES FOR ENERGY ENGINEERS

## TECHNOLOGY PICKS

The tool-free cartridge replacement feature will minimize maintenance and down-time for users. The new filter is available in carbon or stainless steel to meet specific application requirements.

"We also have some accessories such as mounted transitions and a mounted starter for a fan available to users with this new filter," said Forrester.

### About Kice Filters

Spanning over half a century, Kice experience in designing and building filter systems provides an insight unique in the market. Kice has studied filtration principles and developed some of their own, many of which are patented.

### About Kice Industries

Founded in 1946, Kice Industries is a fourth generation, family-owned business based in Wichita, Kan. with a team of approximately 300 employees. Kice Industries designs complete industrial air systems and builds most of the equipment specified for these systems. Applications include pneumatic conveying, dust control and aspiration systems. Kice's Automation division provides services which include power distribution, controls engineering design, PLC/HMI programming, UL® control panel fabrication, electrical installation, and 24/7 on-call support. Just north of Wichita, the manufacturing and office facility totals 200,000 square feet on 25 acres. CFM Corporation a subsidiary of Kice Industries is a gray and ductile iron foundry located in Blackwell, OK. The foundry and machine shop is 65,000 square feet on 20 acres.

For more information, please visit www.kice.com

### Endress+Hauser Release Memosens COS81D Dissolved Oxygen Sensor

Endress+Hauser releases the Memosens COS81D hygienic optical sensor for measuring dissolved oxygen in fermenters and bioreactors used in the food, pharmaceutical and biotechnology industries, as well in drinking water and boiler feedwater applications. It can be used in all measuring points from lab fermenters to production processes.

The Memosens COS81D measures dissolved oxygen, gaseous oxygen and temperature with accuracy up to ±0.2%. It works in process temperatures from 15 °F to 280 °F and pressures from 0 to 190 psi. The sensor also provides temperature and partial pressure, as well as raw measured values. The sensor connects to a transmitter via a cable transmitting an optical digital signal.

The sensor withstands CIP and SIP procedures. The sensor is a compact stainless steel 12mm design with lengths currently up to 220 mm. The sensor has a low sampling volume, making it well suited for residual oxygen measurement in water treatment and boiler feedwater.

The stainless steel sensor meets EHEDG (type EL class I) and ASME BPE (including USP class VI and FDA conformity) hygienic requirements to avoid product contamination, and meets the requirements of GMP and GLP. It also has a Certificate of Compliance for biological reactivity tests, as per USP (United States Pharmacopeia) part 87 and part 88 class VI, with batch traceability of materials in contact with product.

Two spot cap versions are available with the sensor: a C-shaped cap and a U-shaped cap. The first is particularly well suited to measurements in liquids, specifically in fermenters and bioreactors. The distinctive

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## TECHNOLOGY PICKS

*The Memosens COS81D is a compact stainless steel 12mm design with lengths currently up to 220 mm.*

design of the U-shaped cap protects the spot from abrasion occurring, for example, in gas measurements. The caps, specially designed for hygienic applications, reduce blockages and the adherence of air bubbles. Thanks to these caps, the sensor delivers extremely stable measured values across the entire measuring range. This stability is maintained even after dozens of CIP and SIP cycles.

The sensor can be replaced within seconds. The user simply calibrates the sensor in the lab, and then inserts it into the sensor holder assembly. It does not require any polarization time and is immediately ready to measure. The sensor has integrated electronics storing calibration data and other information, such as total hours of operation and operating hours under extreme measuring conditions. Once the sensor has been connected, the sensor data is transferred automatically to the transmitter and used to calculate the current measured value. Because calibration data is stored in the sensor, the sensor can be calibrated and adjusted independent of the measuring point.

Measured and calibration values in the sensor are sent to the transmitter using a non-contact connection free from potential interference. Memosens technology in the transmitter generates an automatic error message if the sensor fails, or if the connection between sensor and transmitter is interrupted.

The optical signals are continuously monitored and analyzed. The transmitter detects implausibly high or low measured values, irregular values due to incorrect measured values, and aging of the sensor cap. When errors are detected, the transmitter displays a warning and generates an error message.

For more information on the Memosens COS81D visit www.us.endress.com/COS81D.

### About Endress+Hauser in the U.S.

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering. Endress+Hauser provides sensors, instruments, systems and services for level, flow, pressure and temperature measurement as well as analytics and data acquisition. We work closely with the chemical, petrochemical, food & beverage, oil & gas, water & wastewater, power & energy, life science, primaries & metal, renewable energies, pulp & paper and shipbuilding industries. Endress+Hauser supports its customers in optimizing their processes in terms of reliability, safety, economic efficiency and environmental impact. The Group employs 13,000 personnel worldwide and generated more than 2.2 billion dollars in 2016.

### The Endress+Hauser Group

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering. The Group employs 13,000 personnel across the globe, generating net sales of more than 2.1 billion euros in 2016.

For further information, please visit www.endress.com/media-center or www.endress.com.


**"The sensor can be replaced within seconds. The user simply calibrates the sensor in the lab, and then inserts it into the sensor holder assembly. It does not require any polarization time and is immediately ready to measure."**

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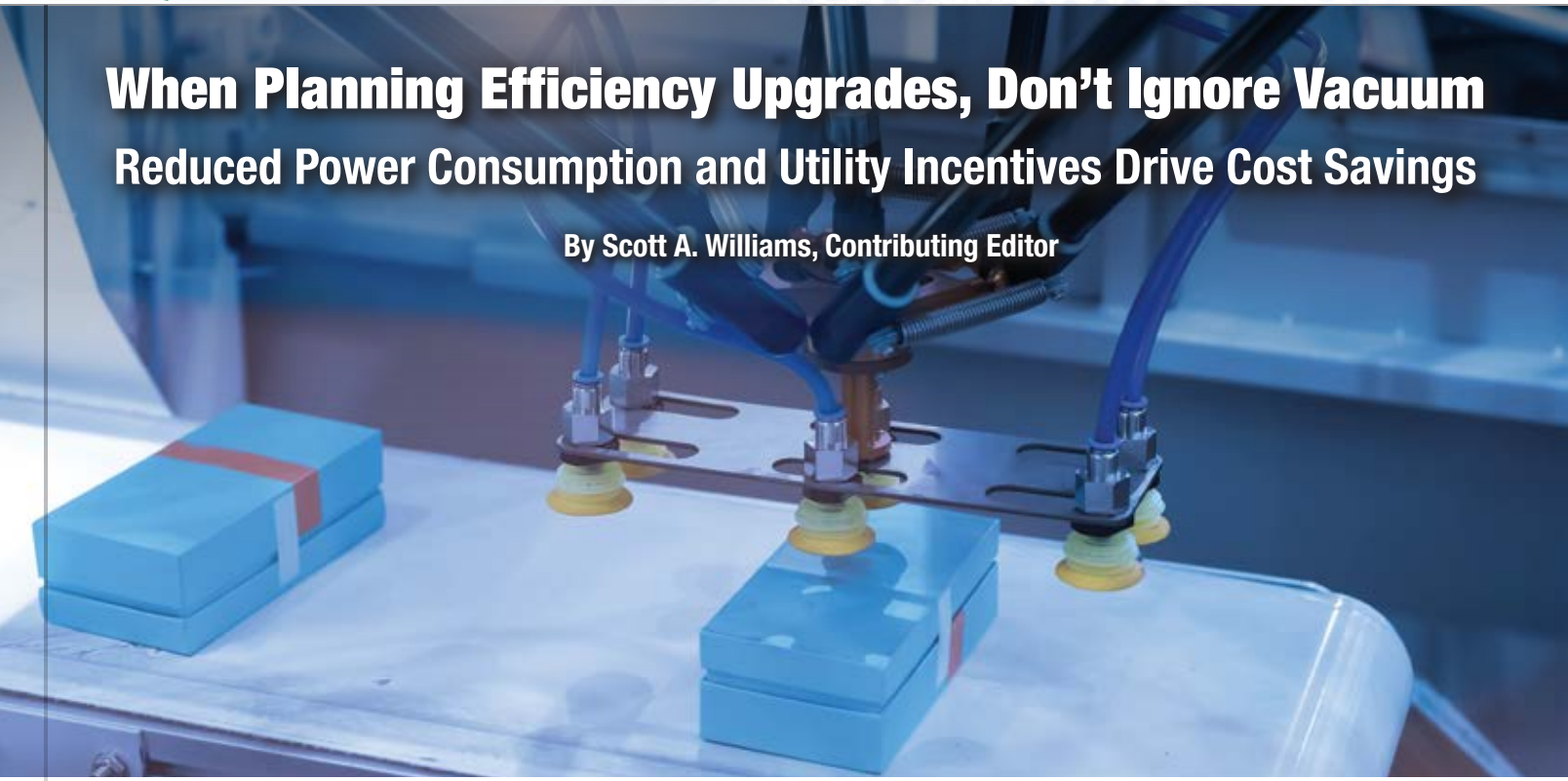
# When Planning Efficiency Upgrades, Don't Ignore Vacuum

## Reduced Power Consumption and Utility Incentives Drive Cost Savings

By Scott A. Williams, Contributing Editor



➤ Electric utility incentive programs encourage industrial and manufacturing companies to reduce power consumption by paying part of the cost to upgrade to more efficient equipment. It's a great concept, but many customers only go after low-hanging fruit, such as upgrades for lighting or air compressors, and go no further.

But don't ignore vacuum. When a vacuum system is centralized, operates at uniform pressure plant-wide, and employs cutting-edge technology to match production with demand, the energy savings can quickly pay for the upgrade. Utilities are typically willing (and often eager) to provide businesses with financial incentives so efficiency upgrades pay for themselves even sooner.

### Project Overview

This story looks at a vacuum system upgrade project completed by a Pennsylvania-based manufacturer of decorated packaging. The customer uses vacuum primarily for pick-and-place operations, such as feeding tin or aluminum sheets into printing, stamping and forming machines. Vacuum operates continuously 24/5, although during peak demand periods it runs 24/7. During normal operations, workers set up a production batch, run the process, then break it down and set up the next batch, run the process, and so on. Material and process variables are involved in making different products, so there are fluctuations in vacuum demand.

> "Too many people don't want to mess with something that isn't broken or that works well enough, and they close their eyes to technology that works better and saves money."
>
> — Bud Fogleman, Senior Market Outreach Specialist for CLEAResult, a PPL partner

The previously installed vacuum system included two 30 HP (22 kW) water-cooled vacuum pumps (one running full-time, the other a spare), and one 16 HP (12 kW) water chiller, for total installed horsepower of 46 HP (34 kW). After the upgrade, the vacuum system now includes one 20 HP (15 kW) Atlas Copco GHS 900 VSD+ air-cooled vacuum pump with Variable Speed Drive. Power savings were achieved by a reduction in installed horsepower of 26 HP (19.4 kW), as well as improved pump performance that enabled a plant-wide reduction in vacuum pressure from 25 in Hg to 21 in Hg.

These efficiency improvements reduced the customer's annual power consumption from 177,752 kWh/yr to 57,660 kWh/yr, a savings of 120,092 kWh/yr, or 68 percent. The utility rebate, based on $.06/kWh, totaled $7,205.52 and effectively doubled the first year's energy savings. The upgrade to Variable Speed Drive technology paid for itself in just over a year when compared to the cost of a fixed speed vacuum pump replacement.

Significantly, the entire cost of operating and maintaining the water chiller was eliminated by upgrading to an air-cooled vacuum pump. One existing pump and the water chiller were kept online as backup so production is won't be interrupted if the new pump is offline for service.

## Enabling Efficiency Upgrades

Electric utilities welcome projects that reduce power consumption because they reduce the need to expand production capacity to meet increasing market demands. This customer's power supplier, PPL Electric Utilities, considers rebates for vacuum system upgrades under their Custom Incentive Program. CLEAResult, a PPL partner that serves customers across 29 counties in central Pennsylvania, facilitated the customer's vacuum upgrade project to ensure that it complied with the program's guidelines and qualified for the rebate.

"Too many people don't want to mess with something that isn't broken or that works well enough, and they close their eyes to technology that works better and saves money," said Bud Fogleman, Senior Market

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# WHEN PLANNING EFFICIENCY UPGRADES, DON'T IGNORE VACUUM



*Atlas Copco GHS 900 VSD+ Vacuum Pump installed and operating at customer location.*

Outreach Specialist for CLEAResult in Wyomissing, PA. "Very often discussions about efficiency upgrades start with lighting and progress to compressed air, and that's great, but now we are starting new conversations about vacuum. We'd like to see even more."

While PPL's Prescriptive Incentive Program offers set rebates for specific equipment upgrades, their Custom program calculates upgrade incentives individually through measurement and verification. "When a custom project is identified, we collect metering data on the existing equipment to use as a baseline," Fogleman explained. "We look at conditions as they exist and then project the estimated savings created with the new equipment so we're able to reserve funds for the project incentive. The project is cleared, installation takes place and when it's complete we collect metering data with the new equipment and compare that to the baseline. We actually go a step further, when possible, and collect actual production data to normalize for vacuum usage over an entire production year. We have done several vacuum system upgrade projects to date and other projects are in the works right now."

## Key Project Considerations

When there is one vacuum pressure requirement plant-wide, it is possible to centralize the system to take advantage of production efficiencies and energy savings. "With a uniform pressure requirement across the plant with constantly changing demands, a centralized system with a Variable Speed Drive vacuum pump can provide a substantial reduction in operating costs," said Eric Slaymaker, Sales Manager for Atlas Copco Compressors LLC Oil-free Air Division in Reading, PA. "That's the approach we took with this customer."

To justify the investment in more efficient equipment, the customer conducted a technical analysis with the help of Atlas Copco. "Our team performed a V-Box analysis on the customer's vacuum systems," said Slaymaker. "The V-Box is a data logger that captures power consumption data. We installed it on the existing vacuum system, which literally took only a couple minutes, and let it collect data for a week while the customer ran their process normally. Using that data, we ran computer simulations of pressure function and power, and compared the performance and efficiency of existing equipment to the proposed upgrade."

With hard evidence to validate reduced electrical consumption, CLEAResult secured the utility's commitment for a financial incentive to support the project. Once the new equipment was operating, Atlas Copco installed the V-Box and logged energy consumption data for the new vacuum pump for two weeks. Using this actual production data, the utility calculated the customer's reduction in power consumption as 120,092 kWh/yr, and paid the incentive of $7,205.52, based on $.06/kWh.

## Vacuum Pump Efficiency Gains

The rotary screw element in Atlas Copco's vacuum pumps is fundamentally the same as the one in their rotary screw air compressors. It actually runs in the same direction, but the outlet and inlet are switched. Instead of pulling air in to compress it, air is pushed out to form vacuum.

Though compression and vacuum systems share some characteristics, their approaches to efficiency are distinct. To appreciate why, consider that the horsepower curve for vacuum is the continuation of the horsepower curve for compressed air. As the curve transitions from


*The entire cost of operating and maintaining the 16 HP (12 kW) water chiller was eliminated by upgrading to an air-cooled vacuum pump*

compression into vacuum, the horsepower requirement continues to drop because the air contains fewer and fewer molecules. This creates a challenge in operating efficiency for a vacuum pump because the highest horsepower requirement comes at atmospheric pressure, when the system is first turned on, and then decreases as vacuum pressure increases.

Consider a system that needs a 20 HP vacuum pump to start up. A fixed-speed pump must provide that power level initially, but then it continues to operate at the same speed even when less than 20 HP is needed to provide the required flow at the required pressure. When demand decreases, a fixed-speed vacuum pump typically runs unloaded, but still consumes up to 80 percent of the energy of a loaded pump. That energy is wasted.

Atlas Copco's Variable Speed Drive technology automatically varies the speed of the vacuum pump to match demand and manages vacuum pressure at the outlet head so flow remains constant. This capability

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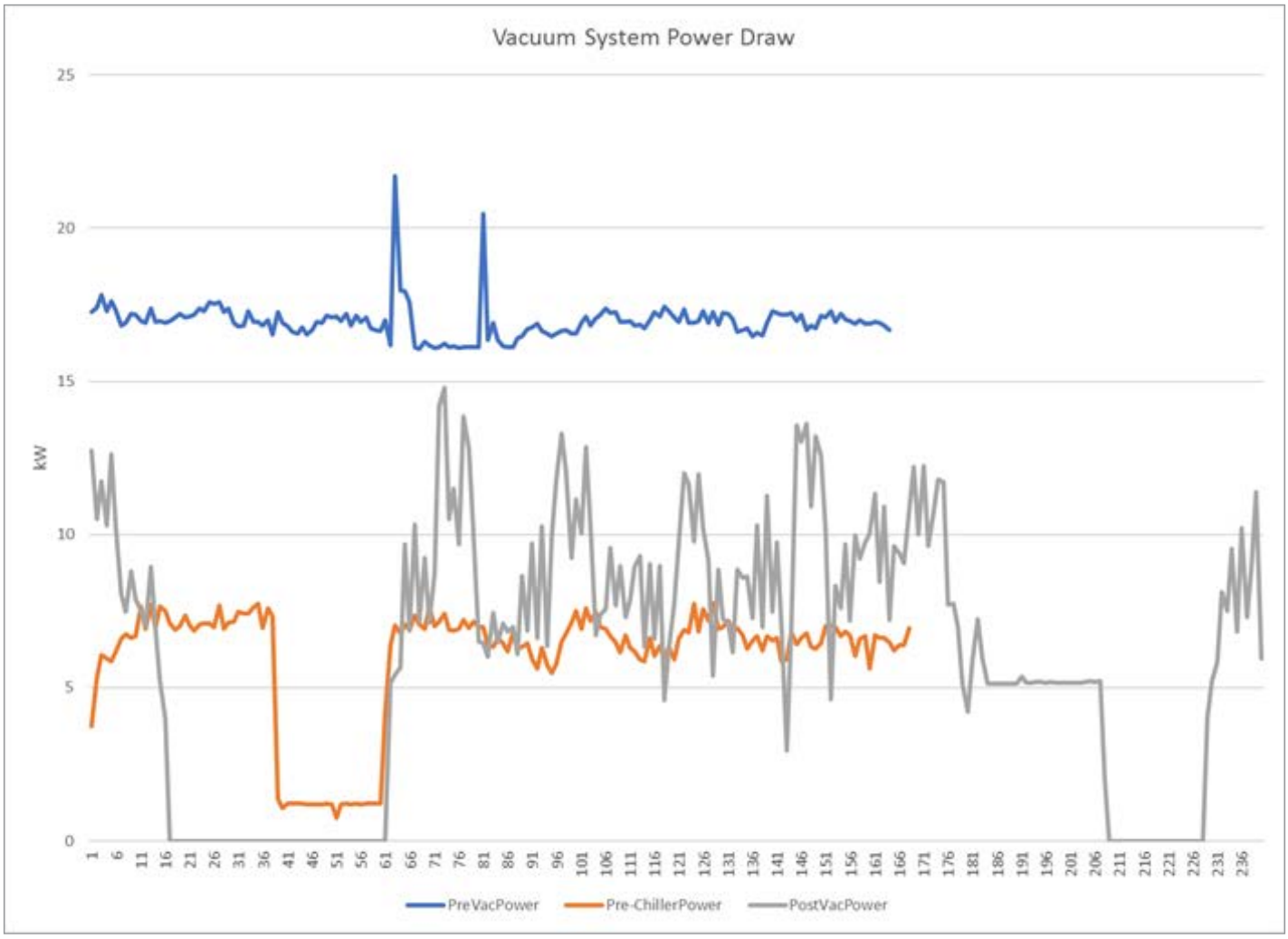
# WHEN PLANNING EFFICIENCY UPGRADES, DON'T IGNORE VACUUM

| REALIZED EFFICIENCY GAINS | |
|---|---|
| **INITIAL POWER SAVINGS @ 25 IN HG SYSTEM PRESSURE:** | |
| Previous vacuum system: | average 27 amps and 28 HP |
| Atlas Copco vacuum system: | average 23 amps and 20 HP |
| **AFTER FINE-TUNING PRESSURE LEVEL @ 21 IN HG SYSTEM PRESSURE:** | |
| Atlas Copco system: | average 11.5 amps and 10 HP |
| **TURNING OFF THE CHILLER:** | |
| Additional reduction: | 18 amps |
| Maintenance cost: | Eliminated |
| **UTILITY REBATE CALCULATION:** | |
| 120,092 kWh/yr reduction x $.06/kWh = $7,205.52 to customer | Annual Reduction in Power: 120,092 kWh/yr (67% savings) |

reduces energy consumption. That savings, along with a utility rebate, makes the investment in a more efficient vacuum system pay for itself quickly.

"Atlas Copco views vacuum as a huge energy saving opportunity," said Slaymaker. "A fixed-speed pump has to cover the worst case, but Variable Speed Drive has significant turndown capability and matches production with demand. That also means a customer can size a new vacuum pump for future growth without having to pay the ongoing operating expense for that reserve."

With the Atlas Copco VSD+ pump operating, the customer was able to reduce vacuum pressure plant-wide from 25 in Hg to 21 in Hg.



"The customer arrived at that figure by reducing pressure one step at a time to determine the minimum pressure that would satisfy all user demands plant-wide," Slaymaker said. "At 21 in Hg, they could keep everyone happy."

## Reduced Sound Level

The previous vacuum pumps were open machines with extremely high noise levels. The Atlas Copco pump operates much more quietly, plus the equipment is surrounded by a compact, six-sided enclosure. As a result, the sound level is dramatically reduced compared to the previous system. "Sound level didn't drive the purchase for this customer," according to Slaymaker, "but they did want it to be quieter. They're happy with the reduction in sound, absolutely."

## Conclusion

"Upgrading a vacuum system isn't rocket science, but it takes people who understand how vacuum works and who offer equipment to deliver vacuum more efficiently," said Slaymaker. "When Atlas Copco works with customers who appreciate the value of investing in the best technology, and with organizations like CLEAResult that help make the investments pay for themselves even sooner, together we help customers improve their production technology. Before this vacuum project began, this customer already received a rebate for a compressed air upgrade earlier in the year through CLEAResult that resulted in a 772,693 kWh/yr reduction and an incentive in the amount of $46,361.58, so we did not have to sell the concept of power savings. As soon as this customer started up the new vacuum pump, like the new air compressor, they started bringing money back into their company. The new pump has cutting-edge technology that's much more energy efficient. It has a new warranty, it's quieter, and it'll be more reliable. Best of all, someone else is helping them pay for it." BP

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# Reducing Demand in INDUSTRIAL VACUUM SYSTEMS

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

## Introduction

Vacuum systems are just compressed air systems in reverse. A vacuum pump is a compressor. The system is just on the inlet side of the vacuum pump, and it squeezes rarified air up to atmospheric pressure. Just as in compressed air systems, the "demand-side" matters just as much as the "supply-side." Meaning, the way air is "used" (drawn into the system) is as important as how efficiently and reliably it is compressed. However, just as in compressed air systems, without adjustments or modifications of "supply-side" (vacuum pumps and controls), little savings will result. See my article on "on-demand" vacuum systems for ways to optimize the supply-side after demands are reduced, "Industrial Dust Collection Vacuum System Audits."

## Background

Refer to the previous article "Vacuum System Fundamentals for 'Compressed Air People'" for terminology, mainly "icfm," "scfm," "system resistance" and "choked flow." In a nutshell, icfm is always way higher than scfm in vacuum systems. Recall each sub-system usually requires a velocity at a pressure differential, equating to a mass flow. Add up the mass flows and this is the real "demand." Convert it to the vacuum level at the pump inlet, and you arrive at the volume flow required. The vacuum pumps are sized by volume at intake, and they will balance against the system if sized too large, at a lower absolute pressure (higher vac) than needed. This balances the "system" and "vacuum pump curve" at the same point. Typically, this results in wasting a lot of energy by causing you to install and run vacuum pumps that are way too large.

"System resistance" is the behavior of the system as a big "hole," or an orifice. Double the flow, and the pressure difference quadruples. "Choked flow" is the condition where a standing shock wave exists at a point of rapid expansion, resisting further flow from going through the point at a higher-pressure differential.

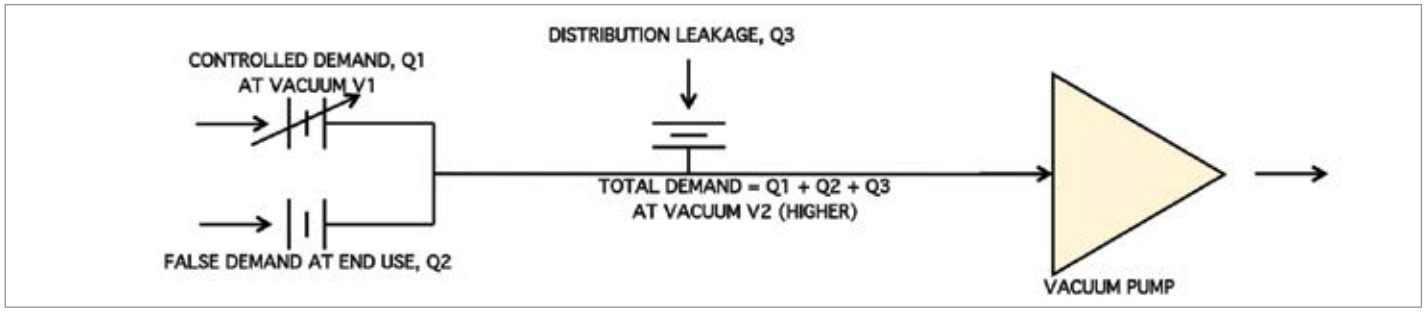


*Figure 1. Typical Vacuum System, Showing Types of Demands*

## Typical Vacuum System Demand-Side

This article will focus on optimizing the demand-side so the centralized "supply-side" (the vacuum pumps and controls) can then run at a lower energy and maintenance cost. First, I will start with a simplified model of a vacuum pump system demands. See Figure 1 for a one-pump/one-demand simplified system. See Figures 2-6 for some typical controlled and uncontrolled demands. The symbol with the three lines is an orifice, a hole essentially. I am defining three types of system demands adding up to the total demand on the vacuum pump:

1. Controlled demand at production equipment or process: This could be a damper in a dust-collection or vapor-handling system, an orifice or control valve in a process system, a pick-up point for a material handling system, or an engineered part of a material handling equipment like a suction cup. It might be controlled by the PLC on the vacuum system, either on-off, variable % open, etc.
2. False demand at production equipment or process: This could be a hose leak, unnecessary open nozzles or orifices, etc.
3. Distribution leakage: This can be from leaky ducts, fittings, hose clamps, open hoses, etc.

Distribution ducting/piping is an important part of the demand-side of a vacuum system. However, it is out of the scope of this article. We will be focusing on the flow and vacuum level issues related to end use.

In summary, we will discuss the following demand reduction methods in this article:

- Methods to reduce demand by adjustment:
  - Control vacuum at optimal level at end use.
  - Control vacuum at optimal level at vacuum pump inlet.

*Figure 2. Typical Controlled Vacuum Demand – Furnace Pull-Down. A butterfly-valve controls flow to the furnace, to pull down a vacuum at the start of the heating cycle. It is closed when the furnace is open. Typically, there is no proportional control, just on-off.*


*Figure 3. Typical Uncontrolled Vacuum Demand – Routing Table. The table is a porous series of tiny holes, and vacuum is always being pulled on the bottom. As larger pieces cover the table, flow decreases. So, flow is variable, not by control, but "on accident."*

# REDUCING DEMAND IN INDUSTRIAL VACUUM SYSTEMS

*Figure 4. Typical Uncontrolled Demand at End Use – Clean-Up Wands. These types of demands are on all the time, even if the machine center is off and controlled air is off.*

*Figure 5. Typical Excessive Demand at End Use – Large Area Pick-up Point. These demands are often in trim-collection and dust-collection systems, and have high-flow and low-effectiveness due to poor design at pick-up point. Due to high-area, the velocity is not high enough at the point the material needs to be entrained in air.*

- Methods to reduce demand by re-design:
  - Optimize design of end use.
  - Interlock-flow-consumers with system-served.

## Control Vacuum at End Use

As shown in Figure 1, the vacuum level drops significantly in the distribution system, so this measure is to control it at the process, in order to get it to the required level. Typically, this would be via a throttling-valve or damper. It can also be done by a bleed-in valve, but is not efficient. See Figure 7. As described in my Fundamentals article, the mass flow is "choked" (constant, insensitive to pressure differential) at vacuum levels below about 16" Hg, so this method is only effective for vacuum levels below about 16" Hg.

The reduced flow at the end use results in lower total flow at the vacuum pump. However, it will also increase the vacuum level at the inlet if the pump is not controlled. See the next section for more information on vacuum pump adjustments.

## Control Entire System Vacuum at Vacuum Pump

As discussed earlier, reducing the vacuum set point at the vacuum pump reduces flow in the system at non-choked-flow vacuum levels. It has the additional benefit of reducing the ifcm to achieve the required mass flow. If vacuum is reduced 10% and mass flow is kept the same, the inlet flow drops 10%. Further reductions might be enough to run a smaller vacuum pump, if one was available. See Figure 8.

Although this is an article on demand-side reductions, this one measure is essentially a simple "supply-side" measure impacting the demand-side. Reducing inlet vacuum level on a

vacuum pump is done differently with different types of vacuum pumps. We recommend a vacuum audit be conducted to determine what vacuum levels are actually required at each process, and if the flow and vacuum level is already more than adequate. If so, the entire vacuum system can be reduced by adjusting the vacuum pumps. Below are some methods:

1. Positive-displacement rotary screw vacuum pumps, and throttling controls: These typically have an inlet throttling-valve, just like a lubricated screw compressor. A proportional pilotm, or I-P, gets a vacuum signal from the system, near the vacuum pump inlet. Based on the set point, it adjusts the inlet valve to regulate and change flow to stabilize vacuum at the desired level. See Figure 9. Unfortunately,

*Figure 6. Typical Distribution System Leak*

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# REDUCING DEMAND IN INDUSTRIAL VACUUM SYSTEMS

power doesn't drop much in this control mode, no more than 30% from atmospheric pressure intake to dead-headed. Thus, for a dedicated, single-vacuum pump system, savings are minimal for this mode of control. However, if there are two vacuum pumps, and the modulating screw vacuum pump can act as the "trim," reducing the vacuum might reduce system flow enough to allow another smaller vacuum pump to be shut off.

2. Positive-displacement rotary screw vacuum pumps, and VFD control: These are very efficient at full and part-load, and are roughly proportional to flow (icfm) down to about 30% demand.

3. Belt-drive vacuum pumps (all types): The driven pump speed can be reduced by sheave and belt changes, reducing both vacuum and power. If a vacuum audit has determined the peak flow can be met by a reduced flow, and the pump curve supports a reduced speed to match the reduced peak flow, this can be an alternative. Vacuum pumps respond to speed reduction differently, so there will be a minimum speed. Liquid ring vacuum pumps lose their liquid seal at some point, and centrifugal types lose head dramatically with the square of speed.

4. Centrifugal vacuum pumps: Impellers can be trimmed in these types of vacuum pumps to deliver less flow (icfm) at the required lower vacuum. As with belt-changes, a sufficient engineering assessment needs to go into understanding the peak flow requirement and the vacuum pump curve at alternate impeller trims. Head reduces by the square of impeller diameter, as it does with speed.

## Optimize End Use Design

In our experience, nowhere is excess flow by poor design more evident than in dust-collection central-vacuum systems in wood-processing plants. As shown in Figure 5, no real design went into most pick-up points. This example shows a huge area larger than the duct area itself. This is the opposite of what should be designed. To demonstrate this, remove the brush from your vacuum cleaner wide fitting, and try vacuuming your rug with the hose and fitting sitting parallel with the rug, rather than snugly fitting at a right angle to the rug with a very low area for the air to pull into the system. The goal in pick-up point design is to develop the necessary velocity, pressure differential, or mass flow, to do the job. We will summarize these three categories and some design issues to address:

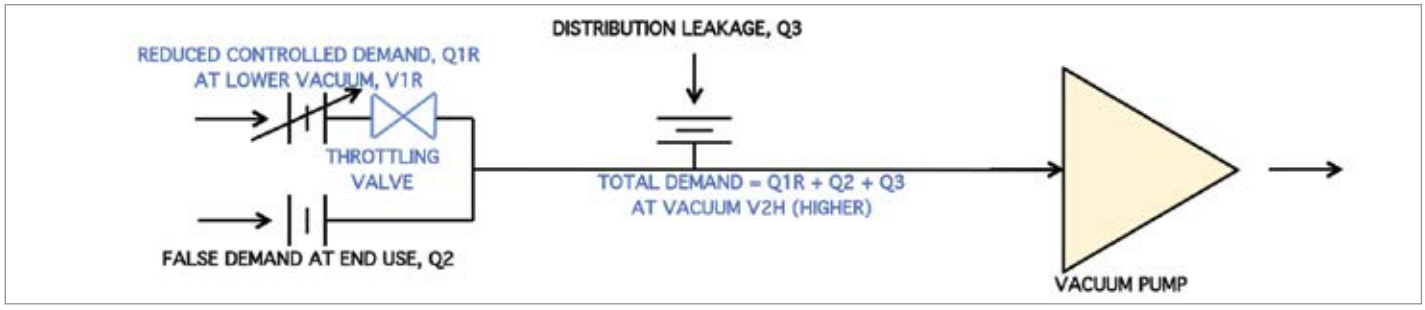


*Figure 7. Reduced Demand by Vacuum Control at End Use*

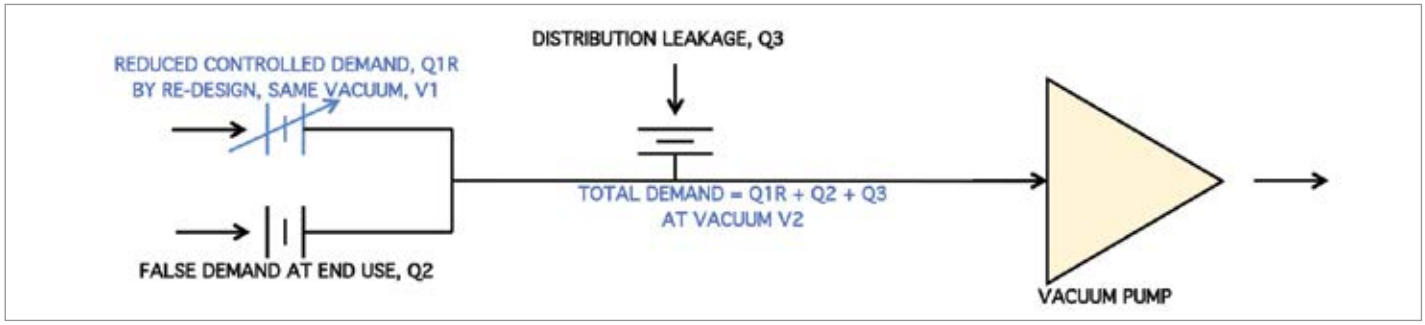


*Figure 8. Reduced Demand by Vacuum Control at Vacuum Pump Inlet*

1. Velocity-sensitive Applications:

   Any time a solid material needs to be moved it is going to be a velocity-based application. The physics is basically Bernoulli's law, turning velocity into force (force proportional to the velocity squared). The force keeps an air foil up in the air or creates drag. The particles of dust, paper, etc, don't "care" what the vacuum level is. The vacuum is only the means to the end of creating a velocity sufficient to get the particle moving. Then, the ducting velocity needs to be sufficient to keep it moving in the "dilute phase" of conveying, usually 3,000 to 5,000 fpm, dependent on material. See Figure 10 for an example of a poor pick-up point design for a saw, requiring up to 9,000 fpm to capture the chip. Typical designs only work because centrifugal, or gravity force, throw the particles into the duct. They are not intentionally sucked in. The open area used is up to 10 times what is needed, requiring far more flow at the vacuum blower to sustain the vacuum level required for other parts of the system.

2. Pressure Differential (Vacuum)-Sensitive Applications:

   These are typically vacuum applications physically holding-down a part being machined, or lifting one being moved. See Figure 11 for an example. They are commonly static-flow if working correctly, at least while the product is in contact with the end-use device. If the seal is good, no change to the "vacuum cup" is recommended. However, the flow demand when the product does not need force is wasted. This is where internal controls modifications


*Figure 9. Typical Inlet-Modulating Rotary Screw Vacuum Pump*

*Figure 10. Poor Saw Pick-Up Point Design*

# REDUCING DEMAND IN INDUSTRIAL VACUUM SYSTEMS

shutting air off between cycles would save average flow. It is essentially an "interlock" concept, usually provided by the OEM of the equipment. Some are supposed to be designed in this way, but can open. See the next section for interlocks easily added to an existing piece of equipment.

3. Mass-Flow-Sensitive Applications:

   These are typically in a system pulling gas through a separator in a chemical process in an evaporative, or thermal application. Vacuum level only needs to be what is necessary to develop the mass flow. Redesigning the end-use components and piping for less restriction can allow the vacuum system to operate at a lower vacuum, and thus, a lower icfm for the same mass flow. See the vacuum pump adjustment section for information about vacuum pump adjustments.

*Figure 11. Static Vacuum Application – Lifting*

## Interlock Demands with Process

This is merely the installation of reliable isolation valves/dampers shutting off air flow when a process doesn't need it. Usually, the only wiring needed is a pair of control wires triggered by a normally-closed auxiliary contact on the process machinery opening when it is running. Those wires should power a normally-open valve closed when the process is not running. This is a fail-safe design. An interposing relay might be needed if the contact is normally-open. See Figure 12.

## Conclusion

The demand-side of a vacuum system has many opportunities for flow reduction, vacuum reduction, and percent tie (average flow) reduction. All of these can be done in isolation or as a combined custom project. They also need to be combined with some form of supply-side project. It might be as simple as a vacuum adjustment, or as complex as an on-demand system integration project. In any case, a qualified vacuum expert should perform an audit first to determine where the opportunities are and what practical project can be implemented. BP

*For more information, contact Tim Dugan, tel: 503-520-0700, email: Tim.Dugan@comp-eng.com, or visit www.comp-eng.com*

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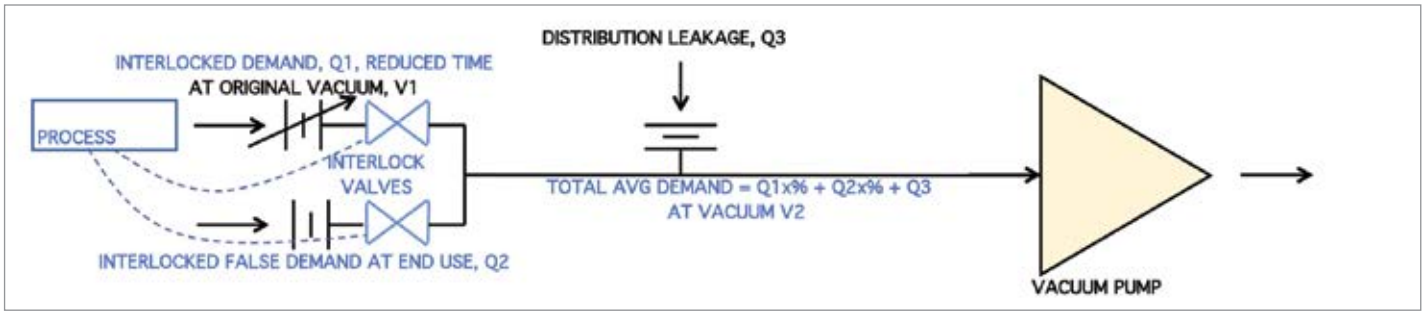


*Figure 12. Reduced Demand by Interlocked Demands*

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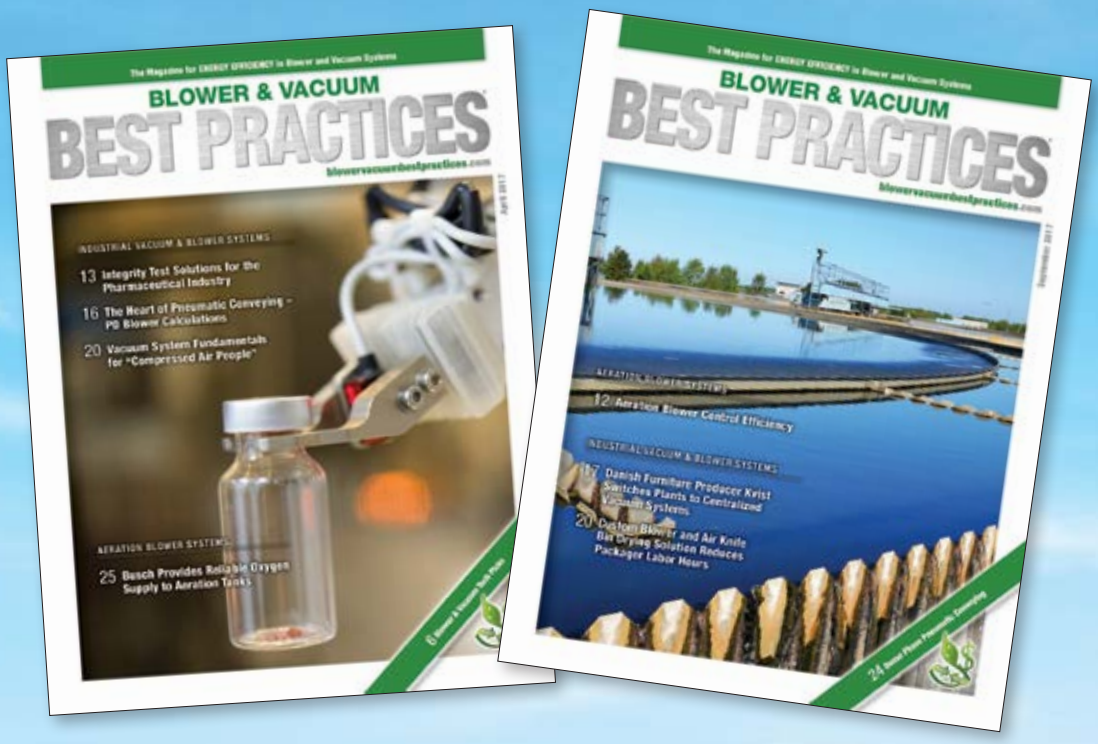


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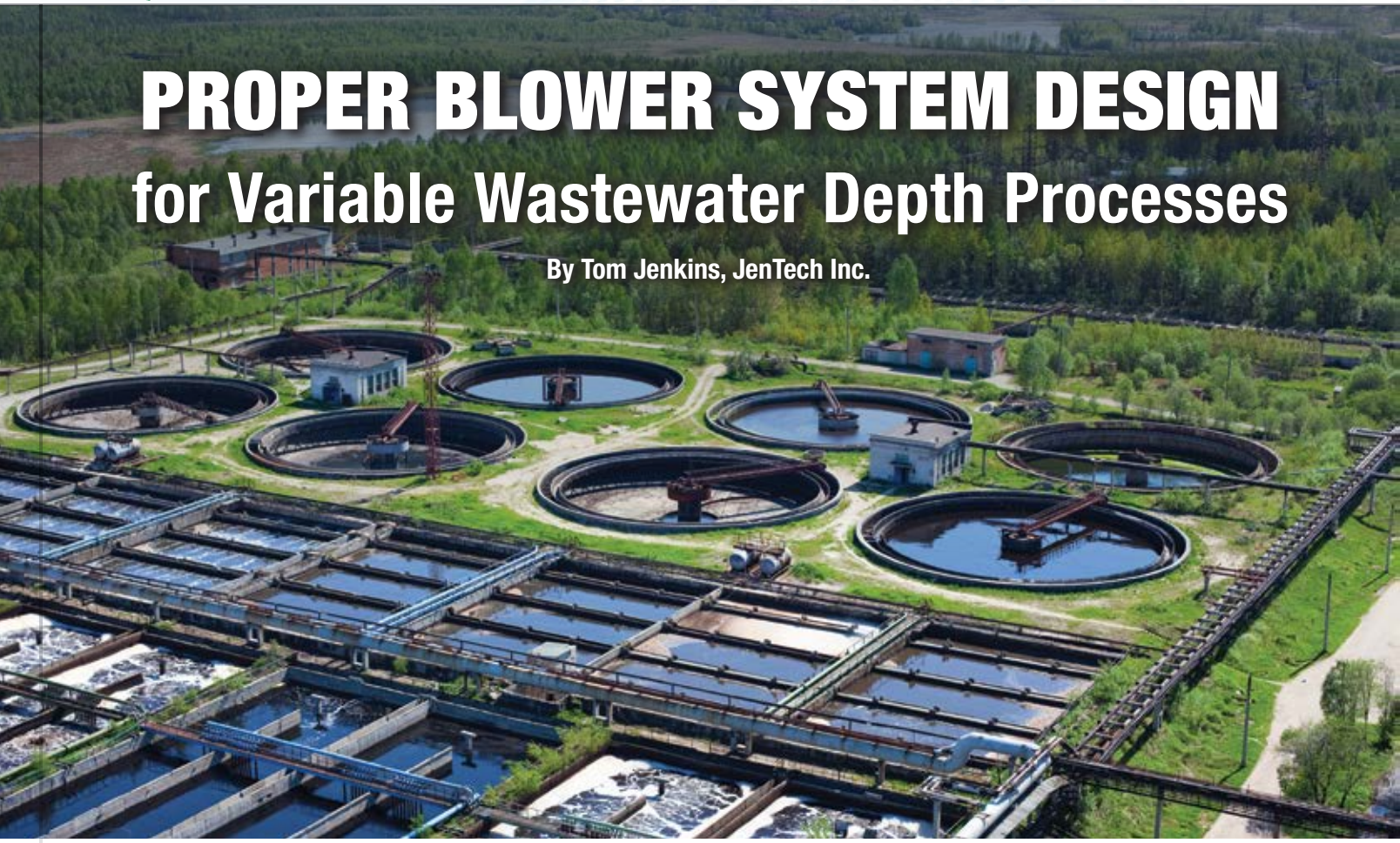
# PROPER BLOWER SYSTEM DESIGN
## for Variable Wastewater Depth Processes

By Tom Jenkins, JenTech Inc.



Most blower applications for wastewater treatment are for conventional activated sludge aeration. The water level is typically constant, and pressure variations are usually less than one psi. There are other applications, however, that undergo significant variations in water level. These processes present challenges, but they can be accommodated with proper blower system design.

### Types of Processes

There are a variety of processes in wastewater treatment that routinely change in water level. These include most areas of the treatment facility: preliminary, secondary, and sludge treatment.

Many plants employ equalization (EQ) basins to attenuate the variations in wastewater flow from diurnal load changes and peak flows from storm events. The EQ basins start out nearly empty and are gradually filled as flow is bypassed from the main wastewater processes. Ideally the EQ basin is at maximum level at the end of the day, when flow is pumped from it to the plant. Aeration is employed to prevent septicity and to keep solids in suspension.


"The savings in power obtained by using variable speed instead of throttling centrifugal blowers are significant. Throttling creates a parasitic pressure drop, with the pressure ratio across the blower remaining essentially constant."

— Tom Jenkins, JenTech Inc.

Sequencing Batch Reactors (SBR) are a secondary treatment process that employs variable level. From a minimum after decanting to maximum level before the settling phase often represents a 2:1 level change. SBRs can also pose a special challenge because aeration is stopped for settling and decant periods.

Waste sludge processes often employ variable depth aeration. Sludge holding or storage tanks are similar to EQ tanks – they serve to reduce slug loading to digestion. Aeration is used to prevent septicity and promote mixing. The sludge level changes as waste sludge is added or pumped to digesters.

Many treatment plants, particularly small facilities, use aerobic digestion to reduce sludge volume and stabilize the sludge. In batch operation, the aerobic digester volume changes as supernatant is decanted and sludge is withdrawn or added.

Changes in depth can affect the required air flow rate, since mixing and oxygen demand may be proportional to the wastewater or sludge volume. However, the most significant impact of variable depth processes on blowers is the change in system pressure that must be accommodated.

## Pressure Requirements

The discharge pressure at the blower always equals the system's resistance to air flow, the system pressure. This consists of two components:

Static pressure is created by the submergence of the aeration diffusers in the wastewater or sludge:

$$p_{static} = 0.433 \times d$$

Where:

$p_{static}$ = static pressure, psig
$d$ = depth of submergence, feet

Friction losses are created by the movement of air through pipe, fittings, valves, and diffusers:

$$\Delta p_f = 0.07 \times (Q_s^{1.85})/(d^5 \cdot p_m) \times T/528 \times L_e/100$$

Where:

$\Delta p_f$ = pressure drop due to friction, psi
$Q_s$ = air flow rate, SCFM
$d$ = actual pipe inside diameter, inches
$p_m$ = mean system pressure, psia
$T$ = air temperature, °R
$L_e$ = equivalent length of pipe and fittings, feet

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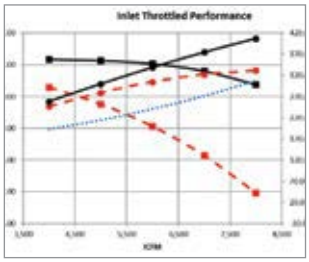


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# PROPER BLOWER SYSTEM DESIGN FOR VARIABLE WASTEWATER DEPTH PROCESSES

Once pressure drop for one flow rate is determined it can be calculated for other flow rates:

$$p_{friction} = k_f \times Q^2$$

$$k_f = ((p_{des} - p_{static}))/(Q_{des}^2)$$

Where:

$k_f$ = constant of proportionality for friction losses, psi/SCFM$^2$

$p_{static}$ = static pressure, psig

$p_{friction}$ = friction pressure, psig

$p_{des}$ = total system pressure at design flow, psig

$Q_{des}$ = design system air flow rate, SCFM

The sum of these two pressures is plotted against the air flow rate to create the system curve.

$$p_{total} = 0.433 \times d + k_f \times Q^2$$

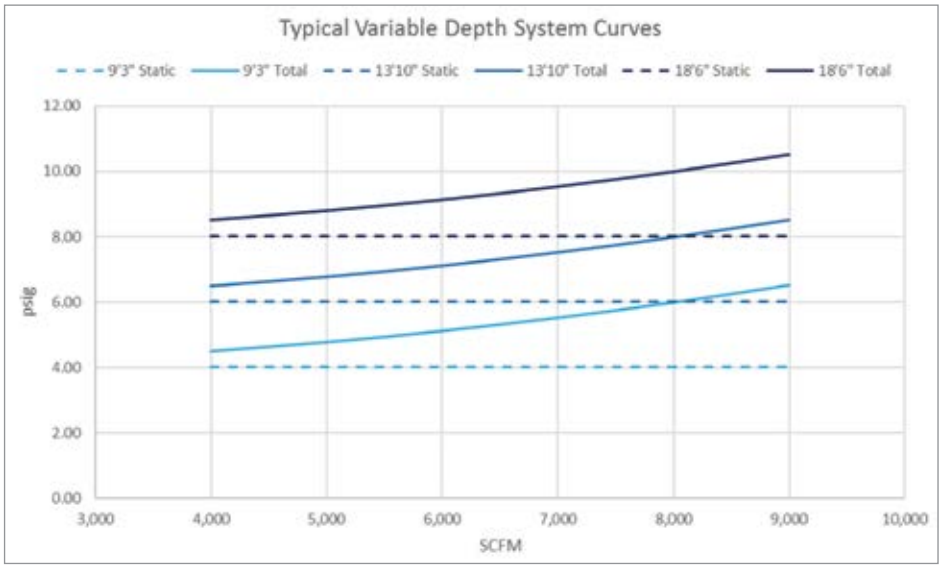


*Figure 1 Typical System Curves*

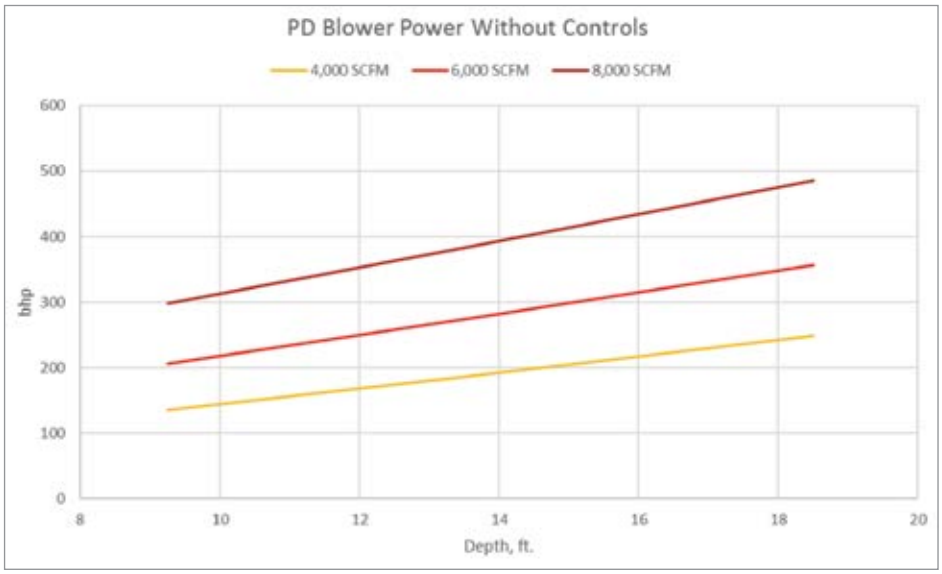


*Figure 2 PD Power as a Function of Flow Rate and Pressure*

When the water level and submergence vary the result is a family of system curves. Generally plotting a system curve at maximum, minimum, and one intermediate level will provide a good idea of the variations in discharge pressure that the blower system must deal with. (See Figure 1.) It is important to remember that the blower does not determine the discharge pressure – rather, the system establishes the pressure the blower must overcome to produce air flow.

## Positive Displacement (PD) Blower Performance

There are two types of PD blowers in aeration applications, the older lobe type and the newer screw type units. Both deliver a fixed volume of air with every revolution, essentially independent of pressure. Controlling air flow rate requires controlling blower speed. With both types the blower efficiency changes with speed and discharge pressure. The variation in efficiency is more pronounced with screw types, since they have an internal pressure ratio that is optimized for one discharge pressure.

The discharge pressure for a PD blower inherently matches the system pressure. Consequently, the blower accommodates changing water levels without operator or control system intervention. This results in simple operation, and in early applications only PD blowers were used with variable level processes.

With PD blowers a rising water level causes an increase in discharge pressure, even if there is no control system. Because power is a function of both flow rate and pressure, the blower power draw will also increase. (See Figure 2.)

## Centrifugal Blower Performance

Centrifugal blowers, also referred to as dynamic blowers, are variable volume variable pressure machines. There are three types commonly employed in aeration applications: geared single stage, multistage, and high speed gearless (commonly called turbo blowers). The details of mechanical and electrical configuration vary considerably between them, but the thermodynamics, analysis, and application considerations are essentially identical for all three types.

Centrifugal blowers exhibit performance curves that show the operating characteristics of flow vs. pressure and flow vs. power. Because air is a variable density fluid the performance curve shifts with inlet pressure, inlet air temperature, and relative humidity. Further changes in the curves result from changes in speed or from modulating inlet guide vanes or throttling valves.

All centrifugal blowers will experience unstable pulsating flow if the flow rate falls below a minimum value. This unstable flow regime is called "surge", and it can result in mechanical damage to the blower.

The operating flow of a centrifugal blower under any specific set of conditions is determined by plotting the curve at those conditions with the system curve. The intersection of the two curves establishes the operating air flow rate, and from this the power can be determined. If the water level and static pressure increase, the intersection point shifts to lower flow, assuming the blower control system is not modulated. (See Figure 3.)

If a variable level application requires reduced flow at low water level it is possible to modulate the blower to achieve the reduced flow. If the blower is not modulated as the water level rises, operation may fall below the minimum surge flow. (See Figure 4.)

## Control System Performance

In the past the potential for developing unstable flow in variable level processes led many engineers to avoid applying centrifugal blowers to these applications. With today's technology and using good design practices the efficiency and flexibility of centrifugal blowers can be used in applications where the discharge pressure will vary dramatically.

Regardless of blower type, the control system should continuously measure the blower air flow rate. If the flow rate changes the control system should modulate the blower to restore the set flow rate.

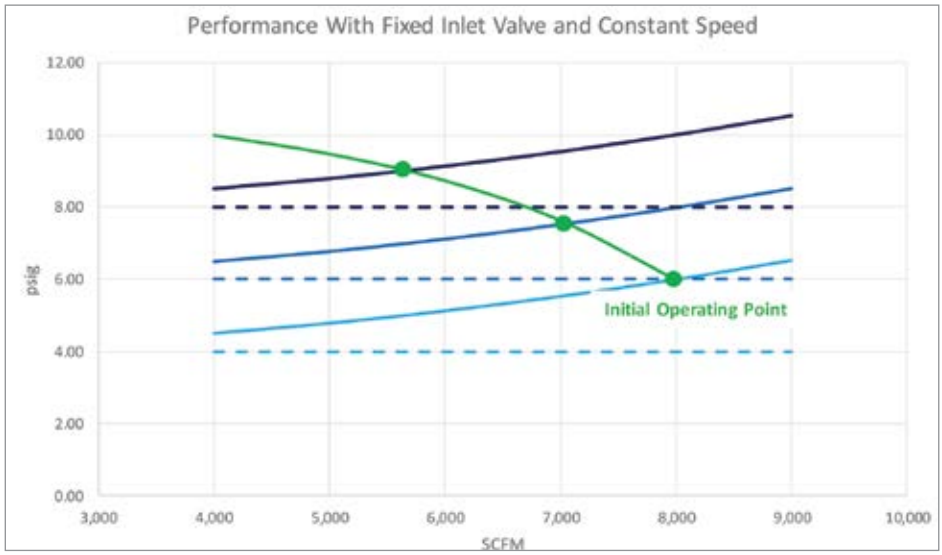


*Figure 3 Change In Flow for Dynamic Blowers with Variable Level*

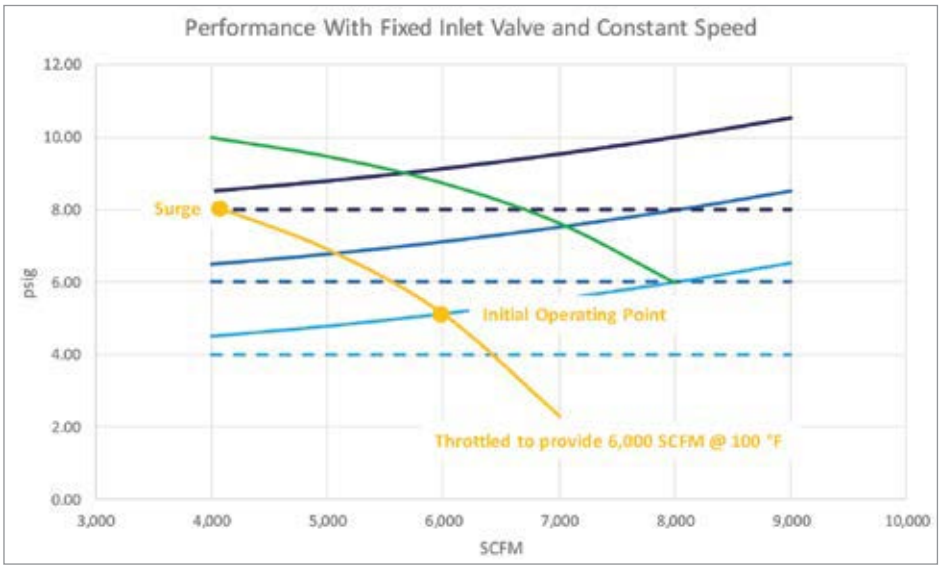


*Figure 4 Fixed Inlet Valve Operation on Rising Water Level*

# PROPER BLOWER SYSTEM DESIGN FOR VARIABLE WASTEWATER DEPTH PROCESSES

There are a variety of techniques available for modulating centrifugal blowers. Inlet throttling and variable guide vanes are common on older systems. However, for any type of centrifugal, the most efficient method is variable speed operation, typically using a variable frequency drive (VFD).

The blower performance curve for a given set of inlet conditions shifts as the speed changes. The shift in the curve resulting from a speed change follows the affinity laws:

$$Q_a = Q_c \times N_a/N_c$$

$$X_a = X_c \times (N_a/N_c)^2 \; X = (p_d/p_i)^{(((k-1)/k))}\text{-}1$$

$$P_a = P_c \times (N_a/N_c)^3$$

Where:

$N_a$, $N_c$ = actual and original curve speed
$Q_a$, $Q_c$ = flow rate at actual and original curve speed
$p_i$, $p_d$ = absolute pressure at inlet and discharge
$P_a$, $P_c$ = power draw at actual and original curve speed
$k$ = ratio of specific heats, ≈ 1.395

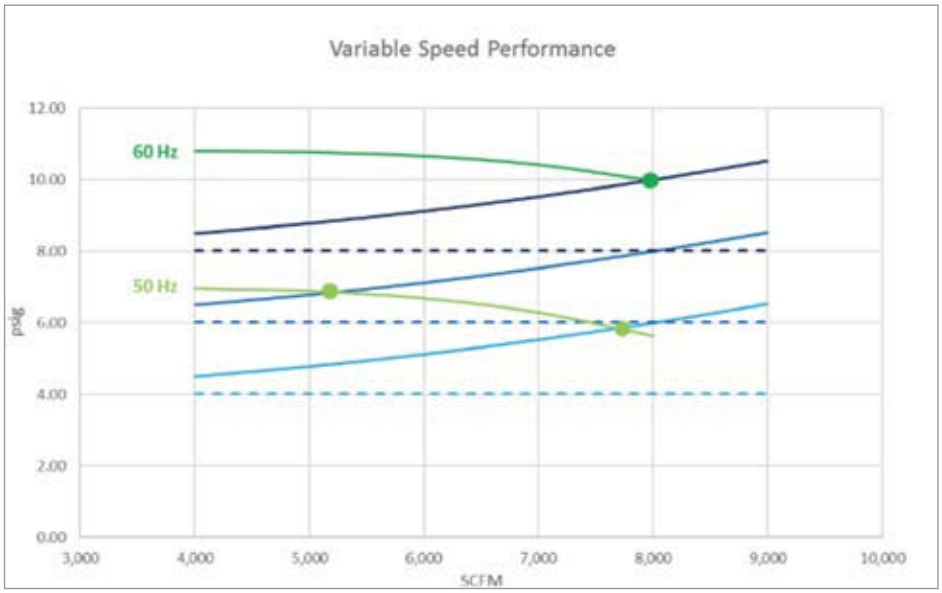


*Figure 5 Response of Centrifugal Blower to Changes in Speed and Level*


*Figure 6 Power Variation for Variable Speed and Level*

The intersection of the new curve with the appropriate system curve identifies the operating point. (See Figure 5.)

The savings in power obtained by using variable speed instead of throttling centrifugal blowers are significant. Throttling creates a parasitic pressure drop, with the pressure ratio across the blower remaining essentially constant. By reducing the speed, the pressure ratio is changed, eliminating the losses. (See Figure 6.)

## Summary

Variable level processes cause changes in the discharge pressure demand for blowers. In the past this created challenges for some types of blowers and restricted some applications.

Modern control technology and systems have eliminated these concerns. The details of the design and the blower performance must be matched to the type of blower in each application. By using VFDs for controlling flow and pressure, both PD and centrifugal blowers can provide flexibility and high efficiency. BP

*For more information contact Tom Jenkins, President, JenTech Inc. at email: info@jentechinc.com or visit www.jentechinc.com. Mr. Jenkins has texts now available in hardcopy and electronic versions titled Aeration Control and Facility Design at www.riley.com and www.e-wef.org/store.*

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# BLOWER & VACUUM SYSTEM INDUSTRY NEWS

## Aerzen USA to Open Atlanta, GA Office

Aerzen USA continues to grow and expand its presence nationally. After recently adding-on to the Coatesville, Pennsylvania headquarters, and opening a regional sales office in Houston, Texas in 2017; a new facility is coming online in Atlanta to provide better service to customers in the south-east region of the United States. The building will support both a regional sales office, rental equipment and service depot.

The 24,740 sq. ft. facility consists of a 21,000 sq. ft. production/warehouse area and 2,800 sq. ft. of office space. It will feature several areas including space allocated for rental machines and spare parts storage, work cells for machine setup, repair and overhaul, and state-of-the-art testing capabilities.

"We are excited about the opportunity to be more closely connected to our customers throughout the southeast," states Aerzen USA President, Tony Morris. "This facility will allow us to better support key end-use markets and applications with a high degree of responsiveness and efficiency."

The Atlanta office is presently staffed by salespeople with additional resources to recruit. Aerzen USA expects to ramp up operations and bring the office to full strength later this fall.

### About Aerzen USA

Aerzen USA is a wholly-owned division of the German manufacturer, Aerzener Maschinenfabrik GmbH, and has been a recognized world leader in the production of rotary positive displacement machines since 1868. Aerzen USA is based in Coatesville, PA. For more information, visit www.aerzenusa.com

## New Chapter for Pfeiffer Vacuum in China

Pfeiffer Vacuum signed a strategic cooperation agreement with Lanzhou Institute of Physics (LIP) in Asslar, Germany. As one of the founders of the Chinese Vacuum Society, the Lanzhou Institute of Physics is a pioneer in vacuum technology in China. LIP is also one of the first institutes in China directly engaged in satellite and spacecraft development, and is therefore a part of the China Academy of Space Technology (CAST) since 1968. Pfeiffer Vacuum and LIP will cooperate in research and development to create vacuum solutions for aerospace applications, vacuum metrology, vacuum calibration and other applications.

The strong cooperation between the two companies is in line with the common interests of both sides. Pfeiffer Vacuum is contributing with its extensive line of solutions, products and services ranging from vacuum pumps, measurement and analysis equipment to complex vacuum systems and its global sales and service network, while LIP is introducing its leading position in the China vacuum industry. On October 17, 2017, the LIP-Pfeiffer Vacuum Joint Center for Vacuum Technology was established in Lanzhou, Gansu province. The center will provide the platform for future projects and joint developments. As mentioned by LIP during the opening ceremony, it will connect 'Made in China 2025' and the German 'Industry 4.0' initiatives.

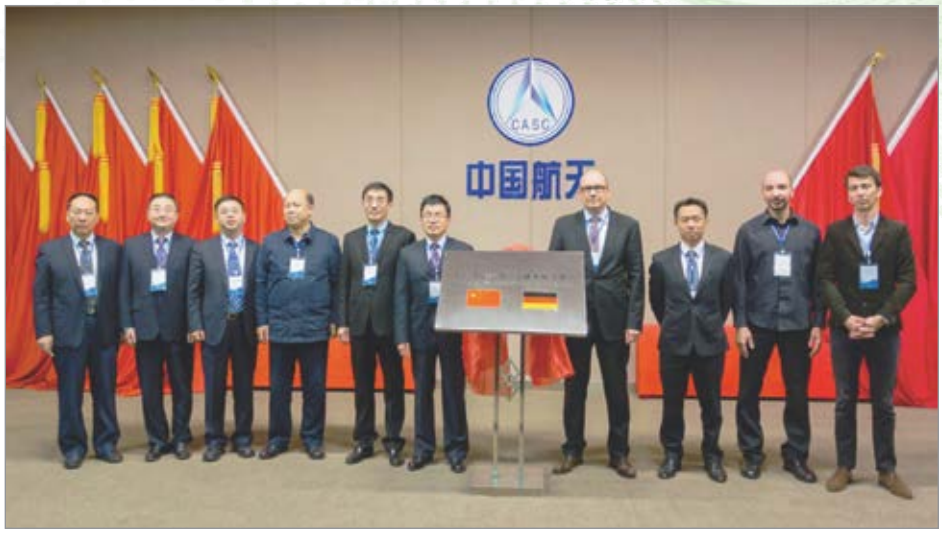
The start of the cooperation between Pfeiffer Vacuum and the Lanzhou Institute of Physics is in conjunction with the 10th anniversary of Pfeiffer Vacuum in China – 10 years of committed dedication in China. "We hope that with our experience and advanced technology we can provide leading vacuum solutions and first-class service to create a bright future for our Chinese customers," said Vic Chen, general manager of Pfeiffer Vacuum (Shanghai) Co., Ltd.

### About Pfeiffer Vacuum

Pfeiffer Vacuum (stock exchange symbol PFV, ISIN DE0006916604) is one of the world's leading providers of vacuum solutions. In addition to a full range of hybrid and magnetically levitated turbopumps, the product portfolio comprises backing pumps, leak


*The recently constructed facility in Atlanta for regional Aerzen support. Located at 5500 S. Cobb Dr. Suite 50, Atlanta, GA 30339*

detectors, measurement and analysis devices, components as well as vacuum chambers and systems. Ever since the invention of the turbopump by Pfeiffer Vacuum, the company has stood for innovative solutions and high-tech products used in the markets Analytics, Industry, Research & Development, Coating and Semiconductor. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 2,900 people and has more than 20 subsidiaries. For more information, please visit www.pfeiffer-vacuum.com.




*Unveiling ceremony of the LIP-Pfeiffer Vacuum Joint Center for Vacuum Technology in Lanzhou, Gansu Province, China.*

## Lone Star Blower and GL-Turbo Announce New Houston Manufacturing Facility

Lone Star Blower, Inc and GL-TURBO have announced a new manufacturing facility. The new location will be 8733 West Monroe Houston, Texas 77061, USA. Conveniently located near Hobby Airport, and encompassing nearly 14 acres, the property will include an initial build out of more than 50,000 square feet of manufacturing space. Construction is expected to be completed by end of Q3, 2018. This move allows for growth as Lone Star plans to create 20 - 30 new jobs in the next two years.

*The new property includes an initial build out of more than 50,000 square feet of manufacturing space.*

Lone Star, and it's parent company GL-TURBO, are a manufacturer and service company for blower and blower control systems with locations around the world. Products include the GL-Series single stage geared turbo blowers (100 to 6,000 HP), DT-Series of gearless "high speed" turbo blowers (20 to 500 HP) and the LS-Series multistage turbo blowers (20 to 3,500 HP). Combined with CS-Series controls, Lone Star can offer a total solution well beyond just the blower. Lone Star also supports many other brand blowers with Lone Star manufactured parts and service that are a step above the OEM offerings.

Industries served include Water and Wastewater, Power, Petro-Chemical, Oil and Gas Mining, and many others using compressed air or gas, in pressure or vacuum applications.

"The blower market has responded well to our innovative and energy efficient products, as well as our unparalleled service for both our products and servicing our customer's existing blowers," said Andrew Balberg, President, and CEO of Lone Star. "The new facility provides opportunity to bring many of our outsourced processes in house, allowing for faster deliveries and improved quality control. The new test stand will be able to run all of our products at full power and to any performance test requirement, including the new ASME PTC-13 test code published this year."

James Jin, President and CEO of GL-Turbo, stated, "We are excited about this large

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step forward and our global position is strengthened by adding significant production capacity in Houston. The new facility provides for our needs now with enough available land to expand for continued growth for many years. With 10 years of installed base and products installed around the globe, the market has responded well to our proven track record of performance and reliability."

### About Lone Star Blower

Lone Star is a manufacturer, master distributor, packager, and service company for blower and blower control systems located in Houston, Texas. Products include single stage turbo blowers (both gear driven with variable inlet and discharge guide vane and gearless driven with a permanent magnet motor), vertically split multistage centrifugal turbo blowers, and related blower control systems. Lone Star also services many other blower brands. Industries served include water and wastewater, power, petro-chemical, oil and gas mining, and many others using compressed air or gas, in pressure or vacuum applications.

For more information, visit www.lonestarblower.com Email: info@lonestarblower.com or call +1 832-532-3112

## Kice Appoints Dave Link Regional Sales Manager

Kice announced the appointment of Dave Link as a new regional sales manager. In this role, Link will be responsible for the oversight of sales throughout the Pacific Northwest territory, providing support for this customer base for the diverse product lines offered by Kice.

Link is a graduate of The University of Wisconsin. Link joins Kice from EMW Industrial, a Canadian Maintenance/Service company, where he was CEO. Prior to this, Dave spent 27 years in the Cargill organization where he held a variety of operational and leadership roles.

*As regional sales manager, Dave Link will be responsible for the oversight of sales throughout the Pacific Northwest territory.*

"Dave is a great fit for this position, his experience and knowledge will be a great asset for us as we support our customers in this region," said Andy Forrester, Kice Industries' director of sales. "We are excited for him to join our sales and support team and I know he will build strong partnerships and add tremendous value to the customers in this region."

### About Kice Industries

Founded in 1946, Kice Industries is a fourth generation, family-owned business based in Wichita, Kan. with a team of approximately 300 employees. Kice Industries designs complete industrial air systems and builds most of the equipment specified for these systems. Applications include pneumatic conveying, dust control and aspiration. A multi-industry company, Kice Industries serves the grain, plastics, food, feed, wood and minerals industries. Just north of Wichita, the manufacturing and office facility totals 200,000 square feet on 25 acres. CFM Corporation a subsidiary of Kice Industries is a gray and ductile iron foundry located in Blackwell, OK. The foundry and machine shop is 65,000 square feet on 20 acres. For more information, please visit www.kice.com.

## Coperion Middle East Celebrates Opening of New Service Center

Coperion Middle East Co., Ltd., Al Jubail, Kingdom of Saudi Arabia, opened a new facility in the Jubail 2 district with a two-day customer event in early February 2018. This new facility, with a footprint of over 1,400 sq. m., including an over 800 sq. m. workshop, Coperion Middle East will be able to provide even faster services around its customers' extrusion and compounding plants. Kevin Buchler, Coperion Division president service, inaugurated the new Service Center on the first day in a formal and festive ceremony in the presence of Government officials of the Royal Commission, the Deputy Head of Mission of the German Embassy to the Kingdom of Saudi Arabia, the CEO of Coperion's parent company Hillenbrand, Inc., representatives of customers and suppliers, employees and Coperion Management Team members.

On the second day, customers were invited to an Open House with technical presentations on extrusion & compounding, bulk material handling, as well as high-precision feeding technology. The customers had the chance to take a closer look at the service offerings of Coperion Middle East and the workshop set-up with its state-of-the-art equipment.

The facility opening marked the completion of the new construction and the relocation from the old office to the new one. The new facility will provide enough space for a well-equipped workshop for services like die plate, extruder barrel and screw elements overhaul, rotary and diverter valves maintenance and spare parts inventory. With the support of Royal Commission and Coperion Middle East shareholder Mr. Adel Kurdi, Coperion was able to find a new site in the Jubail 2 area. The company moved to the new site in September 2017.

With a footprint of more than 1,400 sq. m., the new service site will continue to focus on providing service for extrusion and compounding lines, bulk material handling equipment and feeders for the Kingdom of Saudi Arabia, as well as the entire GCC area. With a workshop of over 800 sq. m, equipped with high-end machinery and a large spare parts inventory, Coperion Middle East is


*Coperion Middle East's new facility with more than 1,400 sq. m, equipped with the most advanced machinery and a workshop tailored to deliver fast and efficient maintenance, overhaul and spare parts.*

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meeting the increasing demand for fast overhaul and maintenance of process-critical parts for local and regional customers.

"We have moved to this new location in Al Jubail in response to customer demand in Saudi Arabia and the entire Gulf region. I would like to thank everyone responsible for this strategic project and wish our colleagues in Al Jubail much success," explained Kevin Buchler during his opening speech. He also mentioned Coperion's 30-year history in the Kingdom and talked about how Coperion Middle East has grown from just a few employees since the establishment of the joint-venture in 2011 to more than 20 employees today.

"Coperion's new Al Jubail service facility is another step forward for Coperion and reflects the importance of Coperion Middle East to our business" says Mr. Buchler. "We see it as an investment in the future and a clear commitment to our customers. Coperion Middle East will continue to play an important role in our network. We are grateful to the Royal Commission, who actively supported us in finding a new site that perfectly matches our needs. Furthermore, we believe that we are well-positioned with this facility to support the Kingdom's vision 2030."

Hans-Peter Neuberger, Coperion Middle East's general manager adds: "With this new facility, equipped with state-of-the-art manufacturing technology, we further strengthen our footprint in the Gulf region. The new workshop supports our efforts to offer our customers best-in-class services – from the stock of spare parts to the maintenance of the process-critical parts of extruders, feeders as well as rotary, diverter and slide valves. Our new facility clearly displays Coperion's flexibility and commitment to our large customer base in the region and underscores high expectations for future development."

### About Coperion

Coperion is the international market and technology leader in compounding systems, feeding technology, bulk materials handling systems and services. Coperion designs, develops, manufactures and maintains systems, machines and components for the plastics, chemicals, pharmaceutical, food and minerals industries. Within its four divisions – Compounding & Extrusion, Equipment & Systems, Materials Handling and Service – Coperion has 2,500 employees and nearly 40 sales and service companies worldwide.

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**A Publication of:** Smith Onandia Communications LLC
37 McMurray Rd. Suite 106
Pittsburgh, PA 15241

Blower & Vacuum Best Practices is published quarterly and mailed together with Compressed Air Best Practices®. Compressed Air Best Practices® (USPS# 17130) is published monthly except January-February combined by Smith Onandia Communications LLC, 37 McMurray Rd., Suite 106, Pittsburgh, PA 15241. Periodicals postage paid at Pittsburgh, PA and additional mailing offices. POSTMASTER: Send address changes to: Compressed Air Best Practices®, 37 McMurray Rd, Suite 106, Pittsburgh, PA 15241.

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- Aeration Blowers
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- Vacuum Pump Systems
- Inlet Filtration/Oil Separators
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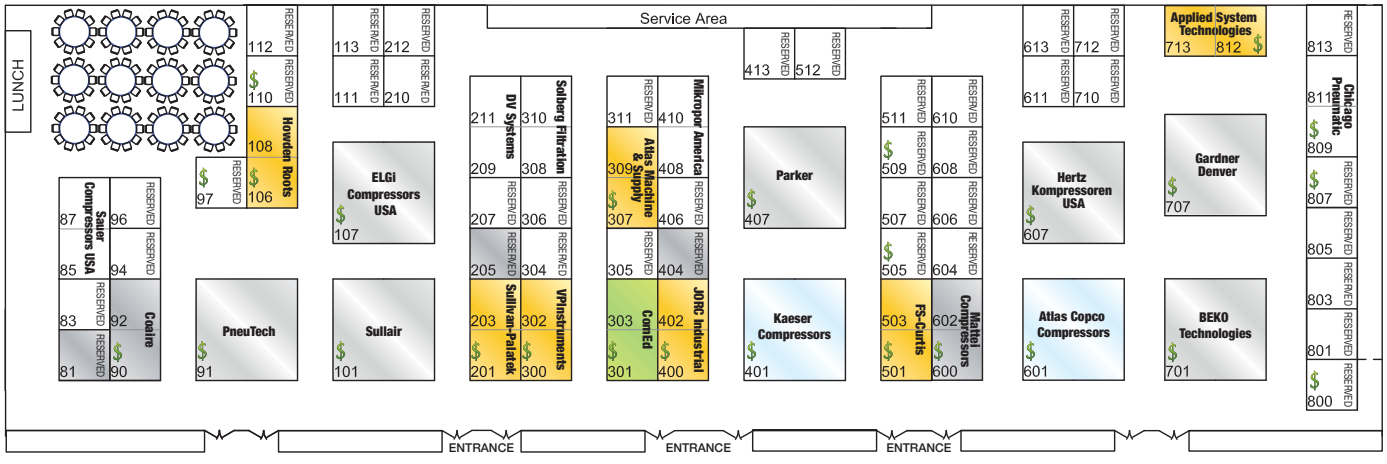


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