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April 2019

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## INDUSTRIAL BLOWER & VACUUM SYSTEMS




## AERATION BLOWER SYSTEMS




## COLUMNS



# FROM THE EDITOR

This is an exciting time to work in sustainability and to understand blower and vacuum systems. If you are reading this, you'll know there are many excellent opportunities to improve plant/process profitability while reducing energy and/or water consumption. What's required is continued excellent application and process engineering-the technology is ready to go.

## Industrial Blower & Vacuum Systems

The chemical and oil refining industries have long required rental air compressors, at an amazing scale, to provide very valuable uptime assurances and to meet the variability of demand they face. The air compressors purchased have all produced compressed air in the 100 to 120 psig range. I'm very pleased firms like Aerzen are beginning to offer rental blowers to supply the 7 psig, 29 psig and 50 psig applications much more efficiently. This is exciting.

Water is a scarce resource and vacuum pumps, in some facilities, are a significant user. Mark Folsom has provided us with an excellent article on how a Oregon brewer was able to reduce water consumption by 5,000 gallons of water per day. The secret? Atlas Copco engineered what they say is the first waterless pump in the craft brewing industry, reliant upon a foam dampening water trap. This is exciting.

## Aeration Blower Systems

I hope you enjoy our interview article with Henryk Melcer, Senior Process Engineer and Vice President, from Brown and Caldwell. He works in the firm's Seattle office and leads a group of 9-10 process engineers doing work throughout the Northwestern United States. They are a perfect example of excellent application and process engineering.

I'm very grateful to Tom Jenkins, from JenTech, Inc., for his continued support and de-facto leadership of our efforts to provide valuable information to wastewater aeration process engineers and plant operators. In this issue, he provides us with another calculation-rich article on the invaluable aeration blower parameter known as "efficiency".

More exciting news! I'm very pleased to announce the Tennessee Department of Environment & Conservation has chosen to be a "Supporting Organization" of the 2019 Best Practices Expo & Conference, taking place October 13-16, 2019 at the Music City Convention Center in Nashville, TN. Please consider registering for the event!

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

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

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# BLOWER & VACUUM TECHNOLOGY PICKS

## Busch Launches VacTest Vacuum Measurement Equipment

Busch Vacuum Pumps and Systems launched the new series of VacTest vacuum measurement equipment to help users observe exact pressures and pressure curves in vacuum-assisted processes, and in turn, achieve optimum efficiency and product quality.

The new product lines meet all requirements for measurement, monitoring, control and regulation of a vacuum system or process in terms of accuracy, measurement range and functionality. The technologies allow a wide measurement range from 1,600 to 5 - $10^{10}$ millibar, effectively covering all vacuum levels with accuracy. VacTest equipment includes:

- VacTest Digital Transmitters. The high-end gauges come with a full range of options as standard. Smart micro-controller architecture allows an optimal sensor control, while many setting possibilities making them the ideal for many applications.
- VacTest Analog Transmitters. The transmitters feature a compact, rugged and functional design. With excellent measuring accuracy and stability, they are ideal for centralized monitoring and control systems.
- VacTest Mobile Gauges. The handheld solution is designed for service or vacuum process quality assurance. These battery-operated gauges offer various functions such as a USB interface for data export and visualization.

Busch offers its VacTest explorer as a software tool to provide fast and efficient visualization, analysis and comparison of process data on a computer or tablet. VacTest explorer is available in Lite and Pro versions and has numerous functions. These are used, for example, to calculate leakage rates, remotely control the active sensor controller, and compare pump-down curves, or to configure all digital transmitter parameters.

*Busch's VacTest vacuum measurement equipment includes VacTest Digital Transmitters, VacTest Analog Transmitters, and VacTest Mobile Gauges (left to right).*

### About Busch

Busch Vacuum Pumps and Systems is one of the largest manufacturers of vacuum pumps, blowers and compressors in the world. Our products are at the forefront of vacuum and low-pressure technology. For more information, visit www.buschusa.com.

## Pfeiffer Vacuum Introduces HiPace 700 H Turbopumps for HV and UVH Applications

Pfeiffer Vacuum has introduced the extremely high-compression HiPace 700 H turbopump, which is ideal for pumping light gases. With a compression ratio ≥ 2 · 107 for hydrogen, the pump is suitable for generating high and ultrahigh vacuum. Due to the high compression ratio, a low residual gas spectrum is created in the chamber, making it desirable for mass spectrometry applications.

An advanced rotor design gives the HiPace 700 H turbopump an exceptionally high critical backing pressure capability of 22 mbar. This allows the pumps to reach ultrahigh vacuum, even when operating with high backing pressures that occur when paired with diaphragm pumps.

"With the new HiPace H-family, we have the ideal turbopump for research and analytical applications as well as for other industrial applications. In terms of energy efficiency, this product is far ahead. Due to the integrated 'intermittent mode' function, the HiPace H switches a connected backing pump on only if the backing pressure is no longer sufficient. This reduces the energy consumption of the entire vacuum system by up to 90%," said Florian Henss, Product Manager at Pfeiffer Vacuum.

The HiPace 700 H features a robust hybrid bearing design, which combines a ceramic ball bearing on the fore-vacuum side with a permanent-magnet radial bearing. As a result, the bearings have a long service interval of more than four years.

### About Pfeiffer Vacuum

Pfeiffer Vacuum 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, measurement and analysis devices, components as well as vacuum chambers and systems. Ever since the invention of the turbopump by


*Pfeiffer Vacuum's HiPace 700 H turbopump is suitable for generating high and ultrahigh vacuum.*

Pfeiffer Vacuum, the company has stood for innovative solutions and high-tech products that are used in the Analytics, Industry, Research & Development, Coating and Semiconductor markets. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 3,100 people and has more than 20 sales and service companies as well as eight manufacturing sites worldwide. For more information visit www.pfeiffer-vacuum.com.

## Leybold's LEYSPEC Series Designed For Demanding Residual Gas Analyses

Vacuum specialist Leybold has launched its LEYSPEC Series of monitoring devices for all basic and extended residual gas analyses methods found in demanding high and ultra-high vacuum applications.

Available in six variants, the device combines uncomplicated handling with maximum detection sensitivity. Equipped with an integrated display, the LEYSPEC product range is easy and ergonomic to operate. At the touch of a button, users can display the partial pressures of relevant gases at any time. If a user is interested in an additional gas involved, another channel can be individually assigned to it. The device's compact size and flexible mounting capability allows it to be used in a variety of installation and measuring tasks encountered in research and industrial applications.

The LEYSPEC software, which is part of the product range, supports usability of the different models. It further enables a wide range of applications, from simple operations to complex analyses. The software always displays the total pressure. It also offers users a choice of analysis options. Additional test procedures and functionalities are pre-installed, such as the helium leak test, or the setting of warnings

# BLOWER & VACUUM TECHNOLOGY PICKS

and error limits for certain gases. Simple gas analyses can be performed without connecting the LEYSPEC to a computer.

The new series is also engineered for all applications in mass spectrometry. For residual gas analyses, the product range offers solutions for 100, 200 or 300 amu (atomic mass units), depending on process requirements. The LEYSPEC view version is particularly suitable for residual gas analyses in high-vacuum pumping stations found in research and development applications, as well as for environmental tracking and gas impurity analyses. Additionally, the LEYSPEC ultra variant is designed for sophisticated residual gas analyses with higher sensitivity, as well as reliable detection of very low partial pressures and higher bake-out temperatures.

### 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


*Leybold's LEYSPEC monitoring device offers efficient residual gas analyses.*

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.

### About Atlas Copco

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers through its innovative

compressors, vacuum solutions, generators, pumps, 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 2017, Atlas Copco had revenues of BSEK 86 (BEUR 9) and about 34 000 employees. For more, visit www.atlascopcogroup.com

## Gardner Denver Introduces CycloBlower VHX Series Blowers

Gardner Denver has unveiled the new CycloBlower VHX Series of rotary screw blowers, which feature a patent-pending variable helix 3 x 5 helical screw rotor profile for a high level of reliability and performance, as well as more efficient turndown capabilities across a across a wider range of flows and speeds when compared to other technologies. The first available model of the CycloBlower VHX Series is the 100CDL300A with additional sizes to follow.

*The CycloBlower VHX is designed with a patent-pending variable helix 3 x 5 helical screw rotor profile to deliver reliability and performance.*

Gardner Denver introduced the CycloBlower rotary screw technology in the 1950's and reimagined it in 2015 with a patented 3x 5 fixed rotor profile that improved efficiency, expanded the pressure capabilities up to 36 psig and widened application of the technology. Now it has

## BLOWER & VACUUM TECHNOLOGY PICKS

leapfrogged its rotor design with the patent-pending variable helix 3 x 5 helical screw rotor profile found in the CycloBlower VHX.

The CycloBlower VHX design integrates a variable helix pitch with its patented screw rotor profile, increasing efficiency in generating faster internal compression allowing for larger discharge porting that minimize air losses. In addition, it allows the achievement of energy savings up to 35% when compared to comparable sized technologies.

Available with three different discharge port options, the CycloBlower VHX optimizes efficiencies based on the pressures and performance of the application. It's built with a robust ductile iron shaft tested for strength, helical timing gears for smooth operation, Inpro/Seal® oil seals for superior leak protection and other premium parts backed by an industry leading, extensive warranty. The new blower is built at Gardner Denver's manufacturing facility in Sedalia, Missouri.

### Industrials Segment

The Gardner Denver Industrials Segment delivers the broadest range of compressors and vacuum products, in a wide array of technologies, to end-user and OEM customers worldwide in the industries it serves. The Segment provides reliable and energy-efficient equipment that is put to work in a multitude of manufacturing and process applications. Products ranging from versatile low- to high-pressure compressors to customized blowers and vacuum pumps serve industries including general manufacturing, automotive and wastewater treatment, as well as food & beverage, plastics and power generation. The Segment's global offering also includes a comprehensive suite of aftermarket services to complement its products.

### About Gardner Denver

Gardner Denver (NYSE: GDI) is a leading global provider of mission-critical flow control, compression equipment, associated aftermarket parts, consumables and services, sold in the industrial, energy and medical industries. Its broad and complete range of compressor, pump, vacuum and blower products and services, along with its application expertise and over 155 years of engineering heritage, allows Gardner Denver to provide differentiated product and service offerings for its customers' specific uses. Gardner Denver supports its customers through its global geographic footprint of 40 key manufacturing facilities, more than 30 complementary service and repair centers across six continents, and approximately 6,500 employees world-wide. To learn more, visit www.gardnerdenver.com

## Becker Pumps Introduces Two New Vacuum Pump Series for Primary Packaging

Becker Pumps Corp. unveiled its U 5 Series and Roots Booster Packages of vacuum pumps, which are specifically designed for primary packaging applications.

Becker also announced it is the first vacuum pump manufacturer to supply new IE3 (International Efficiency) Premium Efficiency standard motors in the United States on its complete line of pumps. Not only are the electric motors supplied on Becker pumps more energy efficient, the pumps draw down to a deeper end vacuum allowing users to run faster packaging lines for increased production.

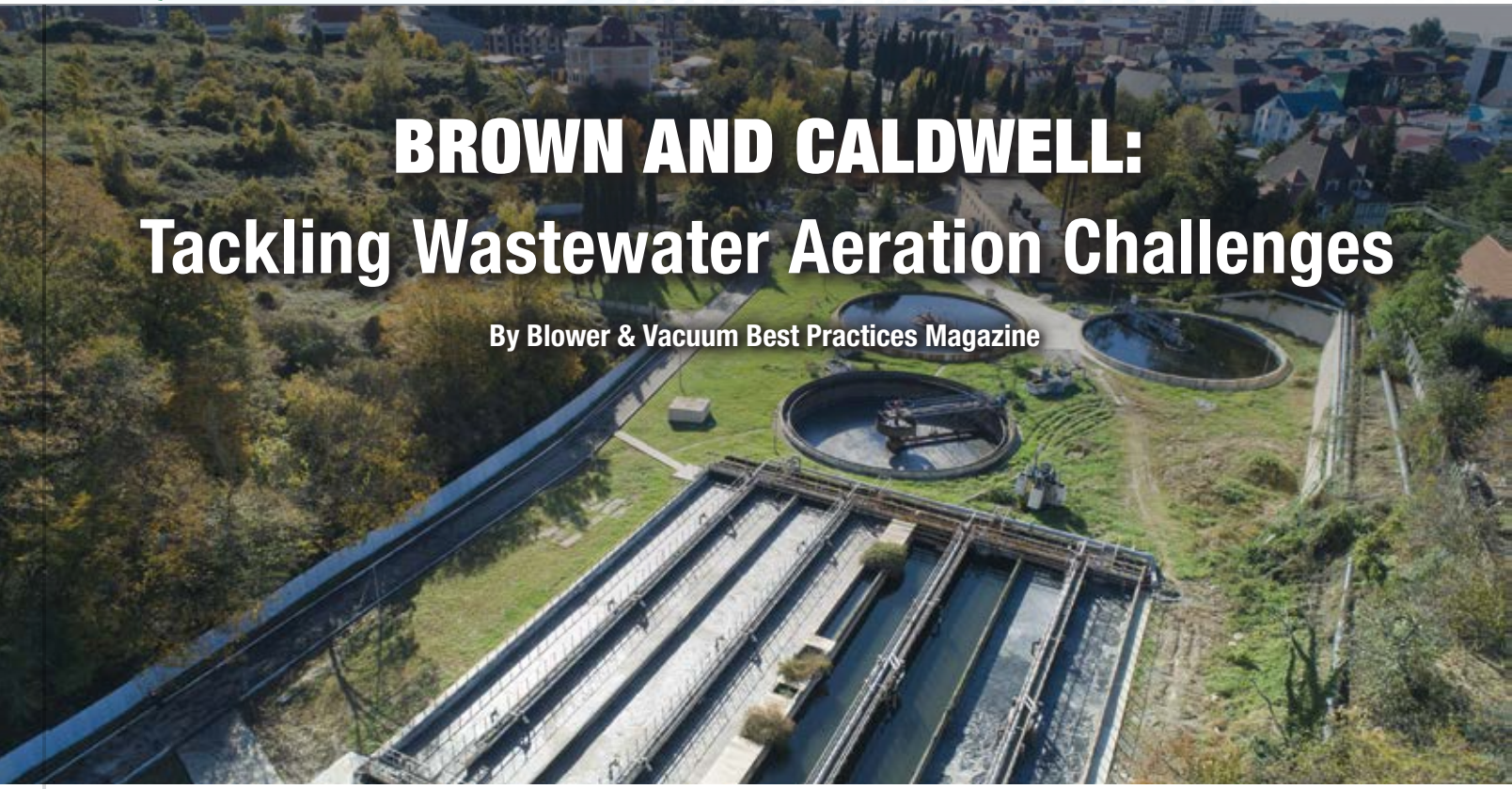
In addition to supplying its U 5 Series of stand-alone pumps, Becker can now offer booster pump packages as a plug and play option. It also has a large inventory of vacuum pumps in stock and ready for immediate shipment.

"Tests have proven that the new line of Becker oil-flooded vacuum pumps have a pump downtime of between five and seven percent faster than the competition's pumps. This sounds like a small percentage, but it translates into a dramatic increase when it comes to how much more product our customers can now produce," said Jason Rathbun, Managing Director of Becker Pumps USA.

"Thanks to these new series of Becker vacuum pumps, there are now more and better options available. Becker Pumps can insure customers they will increase production," said Jim Matuszak, East Regional Sales Manager for Becker Pumps.

For additional information, visit www.beckerpumps.com

*Becker Pumps' New Vacuum Pump Series are designed to deliver energy efficiency, while helping users increase production.*



# BROWN AND CALDWELL: Tackling Wastewater Aeration Challenges

By Blower & Vacuum Best Practices Magazine

**Blower & Vacuum Best Practices interviewed Henryk Melcer, Senior Process Engineer, Vice President, at Brown and Caldwell.**

**Good afternoon! Tell us about your background in water quality and wastewater treatment.**

I'm senior process engineer with Brown and Caldwell. I work in the firm's Seattle office and lead a group of 9-10 process engineers doing work throughout the Northwestern United States. I've been with the company since 1994.

I began my career in the industry in 1976 when I served as project engineer at AWARE, Dr. Wesley Eckenfelder's water resources engineering firm in Tennessee. I took on my dream job in 1980 as head of Biological Process Development at the Wastewater Technology Centre (WTC), Environment Canada. WTC was a federal government research laboratory dedicated to advancing

*Henryk Melcer, Senior Process Engineer, Vice President, Brown and Caldwell.*

"In order to save energy, we're using processes such as simultaneous nitrification-denitrification (SND), short-cut nitrogen control and Anammox®."

— Henryk Melcer, Senior Process Engineer, Vice President, Brown and Caldwell

technological solutions designed to address environmental challenges. It was recognized as one of the three top wastewater research laboratories in the world. WTC provided state of the art engineering knowledge and process data to enable industry to build systems that would comply with the federal water quality regulations.

I've also had the pleasure of serving on the ASCE-EPA technical committee that helped develop the Environmental Protection Agency's design manual for fine pore aeration systems. It was a great experience and I learned a lot from very well recognized people on that committee. I supervised two full-scale aeration demonstration facilities in the Midwest: in Monroe, Wisconsin, and Frankenmuth, Michigan. This was to demonstrate fine pore aeration and the newly developed (at that time) off-gas measurement of oxygen transfer efficiency.

I'm originally from England. While attending the University of Birmingham in Birmingham, England, I earned a Bachelor's degree in Chemical Engineering, followed by a Master's and Doctorate degrees in Chemical Engineering.

## Please describe Brown and Caldwell and the services it offers.

We're an employee-owned environmental firm offering a comprehensive range of engineering, scientific, consulting and construction services. Our expertise is in the design of progressive solutions that help municipal, federal and private organizations overcome some of their most complex environmental challenges.

We're headquartered in Denver, Colorado. In all, we have more than 1,700 professionals working in nearly 50 locations, primarily in mainland USA. About 45% of our work is focused on wastewater engineering now, having made a conscious effort to diversify into water treatment and industrial wastewater treatment. That was after we absorbed Dr. Eckenfelder's old company, which is ironic because it came full circle for me. We also carry out environmental impact assessments, water resources modeling, collection system and stormwater modeling, and a range of other services.

## What are the most common challenges with aeration blower systems at wastewater plants today?

It's in my interest as a process engineer to make sure I get what I want in the control of oxygen gradients in aeration basins, so over the last two to three years, I've become pretty heavily involved in aeration control systems and how they work. The need to control the rate of oxygen added to the aeration system has become particularly acute with the increasing application of nutrient control


*Aeration blowers continue to play an important role in helping treatment plants achieve energy savings.*

# BROWN AND CALDWELL: TACKLING WASTEWATER AERATION CHALLENGES

systems. In order to save energy, we're using processes such as simultaneous nitrification-denitrification (SND), short-cut nitrogen control and Anammox®. Plants are continuing to move from providing for Biochemical Oxygen Demand (BOD) removal only to nutrient removal processes.

A lot of people are struggling to figure out how to make SND work at low Dissolved Oxygen (DO) concentrations of 0.1 to 0.5 milligrams per liter (mg/L). It's not easy to do. Sometimes, it gets difficult to make the connection between the different players in aeration control: software programmers who put together the control algorithms, control engineers, systems integrators and process engineers.

## Does nutrient removal put more air demand on blowers versus BOD removal?

Definitely. When you nitrify one needs to supply approximately four-and-a-half parts of oxygen per one part of ammonia, compared to one part of oxygen per part of BOD. Allowing for the different concentrations of BOD and ammonia, the air demand increases by a factor of about two. As a result, a plant could end up doubling the number of blowers needed. More air, of course, equates to more energy cost.

This means treatment plants might be looking at significant additional expenses when they upgrade to nutrient removal. This also drives the need for many plants to find more efficient blowers to replace older models when they upgrade.

There are other ways of reducing overall demand for oxygen but there is still a very significant increase in the amount of air that needs to be delivered by the blower systems.

## Given these changes, what have you observed as far as aeration control strategies?

The provision of air in response to the oxygen demand in wastewater aeration systems varies diurnally and seasonally. This is a non-linear process and, therefore, a Proportional Integral Derivative (PID) control algorithm is not the best way of accommodating this need.

Instead, plants should be using floating control, which is a flexible algorithm that essentially monitors the aeration process and determines if a correction is needed and then

*An algorithm is required to control the amount of air supplied to each aeration zone along the length of the basin.*

makes the correction. This allows the blowers to ramp up more slowly and adapt to the process, which, in turn, minimizes power draw and saves on energy costs.

This gets back to programmers, control engineers, systems integrators and process engineers working closely together to determine the best method of control for the blowers.

### Are there other types of aeration control strategies showing success?

There are a number of successful strategies and they're all geared toward saving energy. These include ammonia sensor-based controls, ammonia versus nitrate (AVN) control, and Most Open Valve (MOV) control, among others.

Energy savings is the driving force behind all of these methods. Of course, nearly everyone looking to save energy first looks at the blowers themselves. And even though the system control strategies give you more energy savings than blowers do, treatment plants will continue to look at blowers to achieve savings.

I must admit there's been a lot of interest in using high-speed blowers because they're perceived to be a lot more efficient and therefore people can save energy, although there's still a huge category of folks who like the old Turblex type of blowers. There were a few stutter steps in introducing high-speed blowers. Overall, I think high-speed blower technology has become a lot more reliable and is delivering on the goods with respect to efficiencies and providing energy savings.

So yes, there are several ways one can manipulate the manner in which you control the airflow rate to the aeration basin. It's important to consider changes in oxygen uptake rate along the length of the basin. That means an algorithm is required to control the amount of air supplied to each aeration zone along the length of the basin.

### What is your view of new processes, like Anammox and their impacts on air demand?

I wish I were 30 years younger because Anammox is the biggest breakthrough in the industry in the last 25 years.

There's an organism that works in concert with ammonia oxidizing bacteria. In a reactor with alternating on-off aeration, when the air is on, the ammonia oxidizing bacteria will oxidize ammonia to nitrite. With the air off the Anammox bacteria are activated and convert

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# BROWN AND CALDWELL: TACKLING WASTEWATER AERATION CHALLENGES

the ammonia and the nitrite directly to nitrogen gas, which eliminates the need for carbon. About 40% of aeration demand is also eliminated.

Anammox is a new technology that's only been implemented within about the last two or three years. It's going to catch on quickly because of the savings it offers in capital and operational costs since it uses less air.

### What other trends will impact the industry in the next five years and beyond?

The EPA is going to continue to roll out its mandate for ammonia removal across the country as various regions establish the scientific basis for implementing nutrient controls. I think that, as more EPA regions complete their Total Maximum Daily Loads (TMDLs) investigations, they will have the scientific basis for implementing nutrient controls, and we're going to be faced with more and more plant upgrades to nutrient removal. I imagine it's going to go on for the next five to ten years; requiring extensive expansion in aeration basin capacity.

I also think the complexity of treatment processes that will be implemented will be more challenging. For example, SND works very well in some cases but it's not very well understood. If regulatory authorities induce the adoption of more of these types of processes on the industry, there will be increasing pressure on control systems to ensure compliance, while achieving process reliability. And blower systems are clearly linked to this need.

Of course, there is also the challenge posed by the increasing shortage of engineers in this field in the coming years since it's well known that half of the professionals in this industry will be retiring in the next 10 years. It's a major concern.

### Would you encourage young engineers to get into the field of water resource recovery?

I would, especially since it offers a significant opportunity for a rewarding career in many regards. I've got to believe some folks have an interest in contributing to an improved environment and to the public good by harnessing the newer and emerging technologies. We mentioned Anammox; there is other emerging technology that is pretty interesting and revolutionary that will make our systems more reliable, more efficient, and improve the quality of effluent discharge and certainly the quality of water we drink.

### Thank you for sharing your insights. BP

*For more information, please contact Henryk Melcer, email: hmelcer@brwncald.com, tel: 206-749-2219, or visit www.brownandcaldwell.com*

To read similar Aeration ***Blower System Assessment*** articles, visit www.blowervacuumbestpractices.com/system-assessments/blower-systems

# CHOOSING THE RIGHT BLOWER RENTAL

## Technology for Low-pressure Air Applications

By Matthew Piedmonte, Aerzen USA


*Decision-makers can come out ahead by carefully evaluating available technologies when renting blowers that deliver continuous airflow at pressures of 50 psig or below.*

Blower systems designed to deliver continuous airflow at pressures of 50 psig or below are critical to the operation of many processes including wastewater treatment, pneumatic conveying, fluid catalytic cracking, and fermentation to name a few. Many circumstances could arise that require an operator to require a rental blower for a period; a few examples include:

- *Upgrade project:* a plant needs to maintain operations throughout a project to remove their existing blowers and install new ones.
- *Rebuild:* a plant needs to replace the functionality of a machine taken out of service for repairs (proactively or reactively).
- *Supplemental needs:* a plant experiences a shortage in blower capacity during

> "The best solution is the one that delivers the needed flows at the needed pressures and with the right combination of speed and total project cost."
>
> — Matthew Piedmonte, Aerzen USA

summer months, or during a specialized production run and requires additional blowers to supplement the capacity of the existing system.

- *Capital avoidance:* a plant needs additional blowers but cannot get capital funding for a project, so they rent units.

The rental industry for compressed air was developed in response to the needs of many industries including petrochemical, road construction, and industrial manufacturing. Many rental air compressors built to serve these industries are rotary screw machines designed to deliver compressed air in the 1,600 cfm range with pressures at 90 to 150 psig. And because there is an abundance of these machines available, they are often used to fulfill temporary needs in applications that require the air at far lower pressures. However, there are numerous factors to consider when considering the use of rotary screw air compressors as rentals.

## Cost Analyses A Must

The biggest drawback of applying rotary screw air compressors in applications that require lower operating pressures is the inefficiency in compressing the air to 90-plus psig and then regulating it down to the needed pressure. Whether it's a diesel- or electric-drive unit, it is by far the least energy efficient method within the rental industry to deliver air at less than 50 psig as shown in Figure 1. Cost analyses are a must.

The need to examine the true costs for any given technology can be further illustrated using a hypothetical example involving a water reclamation plant that relies on 14,000 diffusers, pushing air through nines zones in four different aeration basins.

In this example, the plant requires 5,500 cfm at eight psig, but it needs to take the blowers offline to carry out urgent maintenance, and it doesn't have the ability to provide electrical power to rental machines. In order to continue processing water, the plant requires rental equipment to supply air during the maintenance project.

If the plant chooses to rent four diesel drive rotary screw air compressors with a regulator to reduce the discharge pressure down to eight psig, this option would be expected to consume around 12,000 gallons of diesel fuel per week. However, if the plant chooses to rent one or two positive displacement blowers powered by a diesel generator it can expect to consume around 2,400 gallons of diesel fuel per week. A rough comparison of the total cost of the two solutions shows the rotary screw air compressors would cost more than three times as much as positive displacement blowers powered by a generator.

## A Closer Look at Technologies for Rent

There are numerous examples of plants choosing rotary screw units in situations like the one at this hypothetical wastewater treatment plant. Why would they do that is the question? The answer lies in a lack of awareness of more appropriate rental technologies.

Here's an overview of various technologies available that deliver air at 50 psig and below in the rental market – and how the right choice in blower technologies can have a tremendous impact on the total cost of a blower rental project.

### Rotary Screw Air Compressors

A positive displacement rotary screw machine is designed to deliver airflow at 90-150 psig.

| TECHNOLOGY | APPLICATION – 1,600 CFM | | |
|---|---|---|---|
| | WASTEWATER TREATMENT @ 7 PSIG | PNEUMATIC CONVEYING @ 29 PSIG | PNEUMATIC CONVEYING @ 50 PSIG |
| Gear Driven Centrifugal Blower (Electric drive) | Flows too low for a typical rental | | |
| Multi-stage Turbo Blower (Electric drive) | $1,700 | n/a | n/a |
| Positive Displacement Blower (Electric drive) | $1,100 | n/a | n/a |
| Single Stage Oil Free Screw Blower (Electric drive) | n/a | $2,500 | $3,700 |
| Rotary Screw Air Compressor (Oil-free or oil-flooded, electric) | $5,500 | $5,500 | $5,500 |
| Rotary Screw Air Compressor (Oil-free or oil-flooded, diesel) | $8,000 | $8,000 | $8,000 |

*Figure 1: Outlined are energy costs for three different types of technologies during one week of operation at three different pressure levels and the same 1,600 cfm flow requirement. Calculations assume the cost of electricity is $0.11 per kWh and cost of diesel fuel is $2.75 per gallon. Additionally, the energy efficiency levels achieved with a multi-stage turbo blower, positive displacement blower, or single-stage oil-free screw blower are only possible when the units are equipped with a Variable Frequency Drive (VFD) or the rental provider has the perfectly geared machine in stock.*

# CHOOSING THE RIGHT BLOWER RENTAL TECHNOLOGY FOR LOW-PRESSURE AIR APPLICATIONS

These machines can be Class 0 oil-free air (two-stage), or oil flooded (single stage) units. Within the rental industry, these machines are air-cooled, portable, and typically include an aftercooler, which allows for reduced discharge temperatures. A standalone regulator is usually required to adjust the discharge pressure below 50 psig. Rental rotary screw compressors are easily installed and started using local resources.

Often when a rotary screw air compressor is being applied in an application that only requires airflow at 50 psig or below, the power requirements of the unit are so much greater than the equipment being replaced that adequate power is not available. This causes the rental provider to offer diesel drive units as an alternative.

### Gear Driven Centrifugal Blowers

A gear driven centrifugal blower is a dynamic machine designed to deliver Class 0 oil-free air. These machines can be built to operate across a wide range of flows and pressures including 50 psig and below.

This technology can be the most energy efficient option if the pressure and flow requirements are very close to the design point of the specific rental machine. However, these machines have a limited range of efficient operation once set up and commissioned. If the plant has needs that vary from the


*Shown is an Aerzen DV038 positive displacement rental blower rated to deliver 2,200 scfm at 14.5 psig.*

rental machine design point, throttling the inlet valve and/or opening the bypass valve to discharge compressed air to atmosphere will prevent surge. Yet either of these flow-regulating actions will impact the efficiency of the machine considerably. It's why gear driven centrifugal blowers are a viable option when the system pressure is stable, but the units may experience operational issues in an application like pneumatic conveying where pressures typically fluctuate.

There are also complexities involved in renting gear driven centrifugal blowers. They typically require permitted loads for shipping and specialized technicians to be on site for commissioning and start-up. In addition, many are water-cooled, which could necessitate the rental of a cooling tower. The likelihood that gear driven centrifugal blowers are the best technology for a rental project increases as the expected project length increases to approximately three to six months or longer. The same is true if the necessary flows increase in the range of 10,000 cfm and higher.

### Multi-stage Turbo Blowers

A multi-stage turbo blower is a dynamic machine designed to deliver Class 0 oil-free air across a wide range of flows and pressures in the range of 14 psig and below. This technology has limited ability to deliver airflow at pressures between approximately 14 and 22 psig.

These machines are typically air-cooled and without an aftercooler. Multi-stage turbo blowers are viable options when system pressure is stable, but may have operational issues in an application like pneumatic conveying. The rental units are easily installed, commissioned, and started using a plant's local resources. In most applications, a multi-stage turbo blower will not be the most energy efficient rental option available and the efficiency can degrade considerably if the machine is not outfitted with a VFD.

### Positive Displacement Blowers

A positive displacement blower is a machine designed to deliver Class 0 oil-free air up to approximately 15 psig and it typically utilizes

# CHOOSING THE RIGHT BLOWER RENTAL TECHNOLOGY FOR LOW-PRESSURE AIR APPLICATIONS

rotary lobe technology. These machines are typically air-cooled and without an aftercooler. Positive displacement blowers are resilient to a wide range of flows and operating conditions. Rental machines are easily installed, commissioned, and started using a plant's local resources. In many rental applications, a positive displacement blower equipped with a VFD will offer the best combination of versatility, energy efficiency, ease of installation and operation for oil-free applications below around 15 psig.

### Single Stage Oil-free Screw Blowers

A single stage oil-free screw blower is a machine designed to deliver Class 0 oil-free air between approximately 10 and 50 psig and utilizes oil-free rotary screw technology. These machines are typically air-cooled without an aftercooler. The machines are resilient to a wide range of flows and operating conditions. Rental single stage oil-free screw blowers systems are easily installed, commissioned, and started using a plant's local resources. In many rental applications, this type of unit outfitted with a VFD will offer the best combination of versatility, energy efficiency, and ease of installation and operation for oil-free applications between 10 and 50 psig.

## Factor in Overall Project Costs

For any rental project to commence, the technology selected must do the job reliably and has to be commercially viable for the plant. The best solution is the one that delivers the needed flows at the needed pressures and with the right combination of speed and total project cost. Yet it's also important to examine other factors the impact costs. For example, large freight costs coupled with long shipping times for the most energy efficient solution could wipe out any potential energy savings for a short duration rental project. Here are additional factors to consider when determining what technology to utilize:

- Cost of downtime while implementing the rental project.
- Freight costs (both ways).
- Installation and commissioning/decommissioning costs, such as specialty technicians, contractors, electricians, riggers, etc.
- Risks if the technology selected for the rental does not operate reliably across the range of needed flows and pressures.
- Energy costs (electricity or diesel fuel).
- Expected length of the rental.

Selecting the right rental solution can be challenging, especially if the decision is made while under pressure in an emergency situation without adequate time to study the various technologies. Selecting the wrong technology could dramatically increase the total cost and effectiveness of the rental project. The best solution may not be the one that delivers the quickest, is the cheapest to rent, is the most energy efficient, or the easiest to install.

The best advice is to carefully consider each aspect of a rental project to determine the overall project cost and how that rental system can help the plant achieve its objectives in a timely and fiscally responsible manner. BP

***About Aerzen Rental USA, LLC***

*Aerzen Rental USA, LLC 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. Established in 2018, Aerzen Rental USA, LLC is based in Atlanta, Georgia. For more information About Aerzen Rental USA, LLC, contact Matthew Piedmonte, Director, Aerzen Rental; email mpiedmonte@aerzenusa.com; tel: 404-673-1826, or visit www.aerzenrental.com.*

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"Selecting the right rental solution can be challenging, especially if the decision is made while under pressure in an emergency situation without adequate time to study the various technologies."

— Matthew Piedmonte, Aerzen USA

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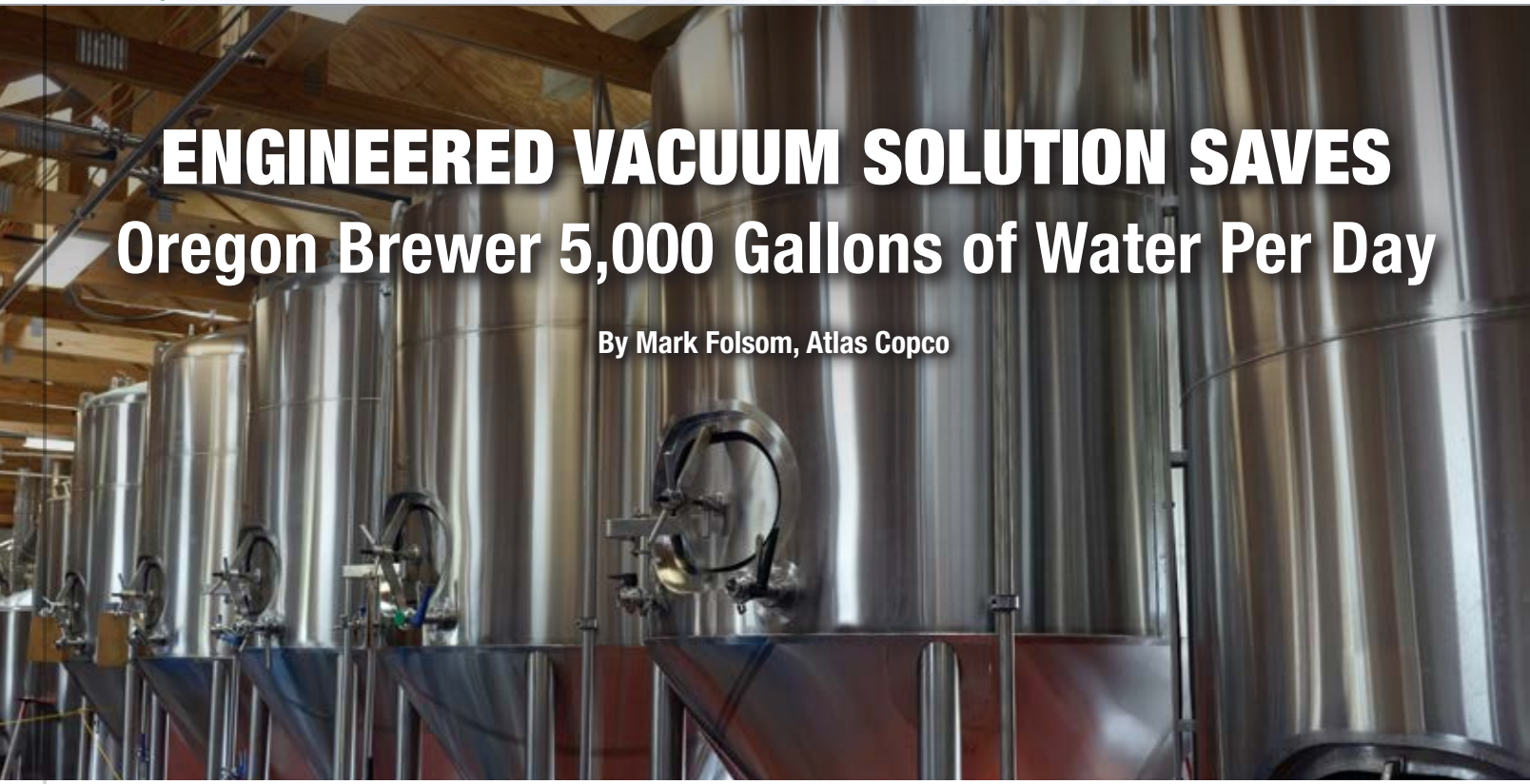


# ENGINEERED VACUUM SOLUTION SAVES
## Oregon Brewer 5,000 Gallons of Water Per Day

By Mark Folsom, Atlas Copco

When Craft Brew Alliance (CBA) set a goal to dramatically reduce water consumption at its Widmer Brothers Brewery in Portland, Oregon, it focused its efforts on its bottling process – and implemented a solution engineered by Atlas Copco that saves 5,000 gallons of water per day. In addition, it saves the craft brewer $39,000 per year, thanks to the elimination of water treatment costs and reduced energy use.

The heart of the solution is comprised of an Atlas Copco GHS350 VSD+ rotary screw vacuum pump and a Foam Dampening Water Trap. The first-known waterless pump in the craft brewing industry, in combination with a redesigned air piping system, is as an example


*An Atlas Copco GHS VSD+ rotary screw vacuum pump is the first known waterless pump in the craft brewing industry.*

> "Water is taken from the city water source, and we pay to bring it into our facility. We pay again when it leaves our facility as wastewater. For that reason, whenever we reduce water consumption, we reduce our costs twice."
>
> — Julia Person, Craft Brew Alliance Sustainability Manager

of how ingenuity and the willingness to go the extra mile goes a long way toward helping water-reliant operations achieve higher levels of sustainability.

## Setting a Water-free Goal

CBA strives to conserve resources wherever possible since sustainability is a top priority. A main resource it wanted to address is water, especially when there is more water involved in bringing a beer to market than what's in the beer itself.

"As part of our ongoing focus on sustainability, we've significantly reduced water usage," said Julia Person, Craft Brew Alliance Sustainability Manager. "Many people don't realize how much water is used during the bottling process, and since bottles are essential to getting our product to customers, we decided to focus there. As CBA's largest production facility, the Widmer Brothers Brewery was the ideal location to set an ambitious goal of making our bottling process water-free."

Widmer Brothers (www.widmerbrothers.com) opened its first brewery in 1984, and in 1990, it built a new 40-barrel (bbl) brewing system. By 1996, it completed the installation of a state-of-the art 250-bbl brew house, increasing its capacity to 220,000 barrels per year. It also installed a bottling line capable of producing 550 bottles per minute. In 2008, it added six new 1,500-bbl fermentation tanks that increased its capacity to 450,000 bbl per year, and added a new keg filling line capable of filling 300 kegs per hour.

## Moving Past Liquid Ring Vacuum Pumps

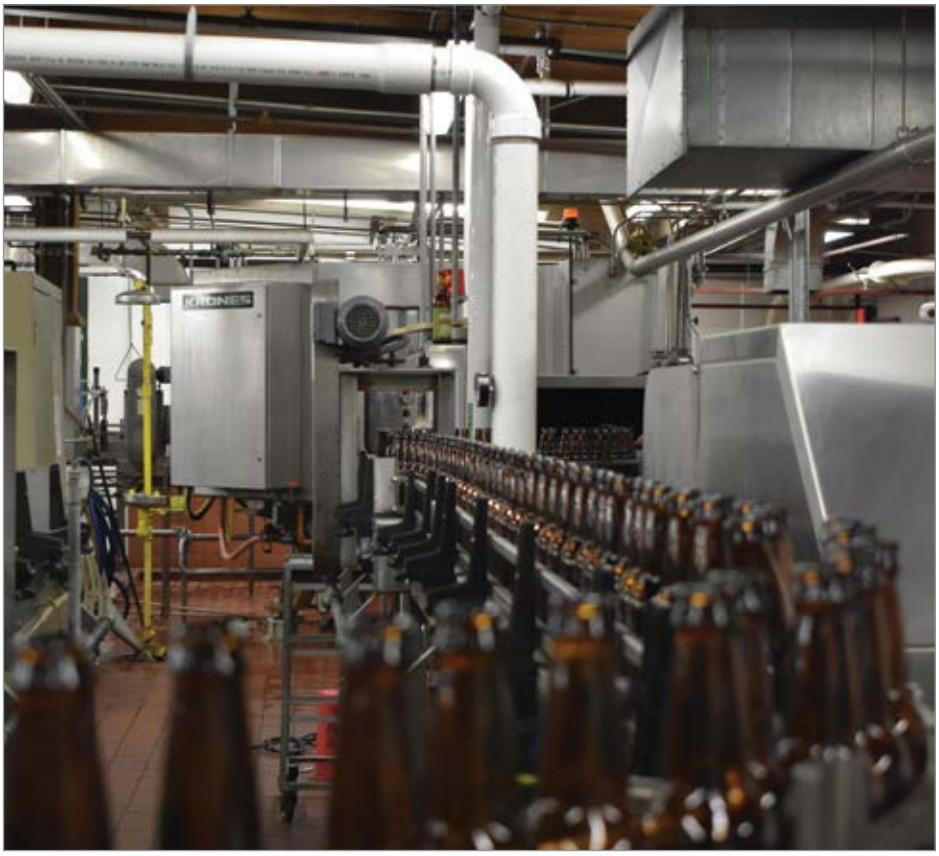
An important utility for bottling is vacuum pressure, which evacuates air from inside the bottle to create an airtight seal that retains the beer's brewery-fresh taste. Widmer Brothers was using a traditional liquid ring pump for the process, which has long been the industry standard because the pump's performance is not compromised by water.

However, liquid ring vacuum pumps use water as their coolant. As such, a single pump can consume a lot of water – up to 5,000 gallons per day in the Portland brewery's bottling operation. The reason for large water consumption is because water passes directly through the pump and is then discharged. It's not an ideal solution for operations looking to reduce water use.

"Water is not only becoming a scarce natural resource, it is also an increasing expense – particularly in the Pacific Northwest," said Person. "Water is taken from the city water source, and we pay to bring it into our facility. We pay again when it leaves our facility as wastewater. For that reason, whenever we reduce water consumption, we reduce our costs twice."

Rather than simply minimizing water usage and recycling the water before it is discharged, the team at CBA set a goal to make the bottling process water-free. To help realize its goal, it turned to Atlas Copco.

"When we're looking for new, innovative solutions, we always start with our trusted vendors," said Person. "For many years Atlas Copco has serviced our compressed air operation in the Portland facility, so we were excited to partner with them to pioneer the first waterless vacuum pump in the craft beer industry. It's been great seeing how this innovation will lead to new energy-saving and water-saving technologies we can share with others in the brewing industry."



*Widmer Brothers' bottling line produces up to 550 bottles per minute.*

# ENGINEERED VACUUM SOLUTION SAVES OREGON BREWER 5,000 GALLONS OF WATER PER DAY

## Engineering a Sophisticated Knock-out Pot

The first thing the team needed to do was to understand the application and how vacuum is used in the bottling process. In addition, it knew that in a wet application there would be challenges given the high volume of water and beer foam generated from the bottling process. The goal when introducing rotary screw technology was to eliminate water from the process, but also protect the pump from trace amounts of moisture carryover.

The biggest challenge was to remove all liquids, primarily beer foam and water from the vacuum application. The team initially explored a solution that involved a simple water separator stationed before the vacuum pump to capture liquid carryover. Although the water separator reduced some moisture, the team still saw small trace amounts (primarily beer foam) overwhelming the separator and potentially damaging the pump.

Undeterred by this initial setback, Atlas Copco decided to install a Foam Dampening Water Trap after the bottling fill machine in order to eliminate the risk of moisture and beer foam being sucked into the pump. The trap captures and discards all liquids before it has a chance to enter the vacuum pump, protecting it from moisture.

The technology is based on what can be classified as a Knock-Out Pot, which is normally used to remove bulk liquids and particles from gas streams based on gravitational separation at optimum vapor velocity. But since the traditional device didn't work, Atlas Copco developed a more sophisticated solution that incorporated multiple components, including:

- A built-in foam dampening mechanism to account for foam variations in different brews.
- Low-level and high-level sensors to activate the drain sequence.
- An automatic drain.
- A vent line.
- A purge tank with isolation, vent and drain valves that allow gravity drain under vacuum.
- A secondary failsafe using in-line liquid separator with ball float.

*In addition to water savings, the Atlas Copco 350 GHS VSD+ rotary screw vacuum pump saves the brewery $4,000 per year in energy costs.*

Given the challenging process, the team didn't get it right first time. The first Knock Out Pot was undersized, which then drove the realization that the existing piping layout played a significant role in reducing foam and managing airflow. Subsequently, it built a true working partnership and worked in conjunction with the brewery to overcome the challenges.

To address the challenges, the team took a number of corrective actions. It increased the diameter of the trap from 16 to 30 inches to allow for adequate expansion. It also reversed airflow to reduce the air velocity entering the trap. As another step, it increased the diameter of the piping from 2 to 4 inches to allow for additional expansion and reduce rise from the filler outlet to the trap inlet. The revised approach enabled the removal of all fluids on the air return to the pump.

## Water and Energy Savings Realized

The engineered solution resulted in the first-known waterless vacuum pump in the craft brewery industry. Since the pump uses no

water it saves 5,000 gallons of water per day. It also eliminates the cost of water treatment for an annual savings of $35,000. Additionally, the waterless pump keeps foam and water off the production floor, eliminating a potential safety issue.

While reduced water consumption was the main goal, the new pump solution allows CBA to achieve additional cost savings. The use of the 7.5 horsepower (hp) GHS VSD rotary screw vacuum pump with a variable speed drive in place of a 15-horsepower liquid ring vacuum pump saves more than $4,000 per year in energy costs. In addition, the new vacuum system produces much deeper vacuum, so bottles no longer have to be overfilled to compensate for losses.

"This project made sense on so many levels," said Person. "Our new waterless process made possible by our Atlas Copco vacuum pump cuts water consumption and related costs, reduces our energy bill, reduces product waste, cleans up the bottle area, and eliminates a safety concern. We calculated that our investment in new equipment would pay for itself in 14 months and then continue to save us money whenever we bottle beer, which is pretty much whenever this brewery is operational. The project was a journey for all of the parties involved who were committed to finding the best-engineered solution. We did it together." BP

***About the Author***

*Mark Folsom is AVR Sales Manager – Industrial Vacuum Division, Atlas Copco Compressors, LLC, West Region PNW, email; mark.folsom@us.atlascopco.com; tel: 206-641-4906.*

***About Atlas Copco***

*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.*

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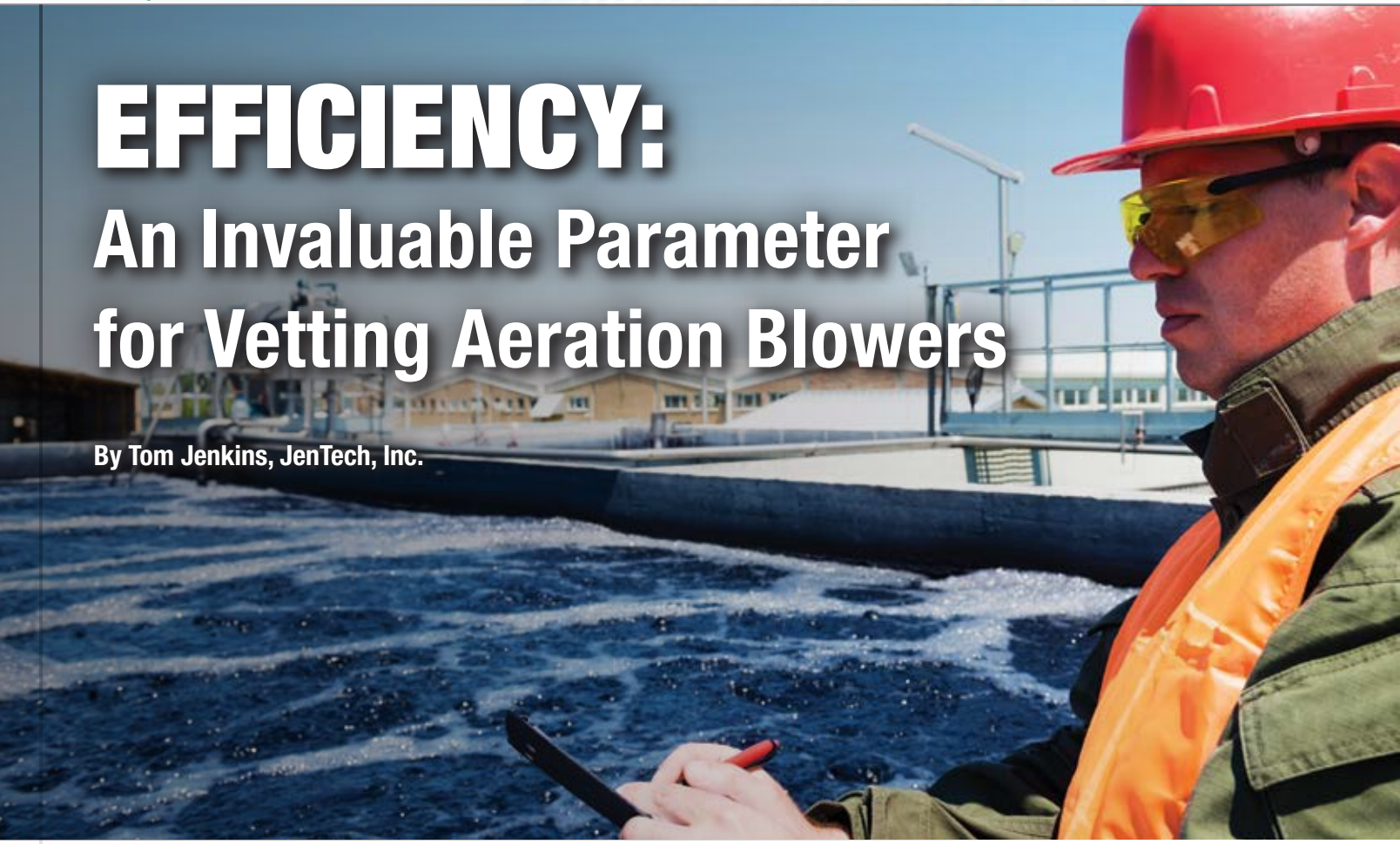

# EFFICIENCY:
## An Invaluable Parameter for Vetting Aeration Blowers

By Tom Jenkins, JenTech, Inc.

Efficiency compares the inputs used by a system to the outputs produced. It is a commonly used concept, but one which is prone to a great deal of misuse in many industries. This article provides insight into the parameter known as "efficiency," how it's calculated, and importantly, it's uses and limitations in predicting blower energy consumption and comparing alternate system designs.

### What is Efficiency?

In engineering, efficiency usually refers to the ratio of the work done or the energy developed by a machine, engine, etc., to the energy supplied to it. It is usually expressed as a percentage, although in most calculations it is used as a decimal. Efficiency is always less than 100%.

For any system, efficiency can be calculated simply:

$$\%\ \text{Efficiency} = \frac{\text{Energy Out}}{\text{Energy In}} \times 100 = \%\eta$$

This simplicity is deceptive. The discussion of blowers encompasses many different types of efficiency:

- Isentropic efficiency
- Polytropic efficiency
- Design point efficiency
- Average efficiency
- Wire-to-Air efficiency
- Bare blower efficiency

"Efficiency is often used to compare blowers from different suppliers, or to compare different technologies for blowers or the controls."

— Tom Jenkins, JenTech, Inc.

The frame of reference, the calculation method, and the operating point have a bearing on the value of efficiency. It's easy to see that it's important to define terms and parameters clearly in discussions or comparisons of blower efficiency.

The most common method for evaluating aeration blowers is isentropic efficiency. Isentropic compression is an ideal, reversible process. It is an adiabatic process; i.e., no heat transfer occurs. Real compression never meets these conditions, of course. However, if all calculations and comparisons for a given blower system are made based on the assumption of an isentropic process then comparisons will be accurate. Power calculations will also be correct if parameters are the same for calculating efficiency and calculating power.

The isentropic efficiency of a bare blower is the isentropic power of the discharge air divided by the input power.

$$\%\eta_s = \frac{P_s}{P_{in}} \cdot 100 = \frac{q_m \cdot \frac{k}{k-1} \cdot R_{air} \cdot T_i \cdot \left[\left(\frac{p_d}{p_i}\right)^{\left(\frac{k-1}{k}\right)} - 1\right] \cdot \frac{1hp}{33{,}000\frac{ft \cdot lbf}{min}}}{P_{in}} \cdot 100$$

Where:

$\%\eta_s$ = isentropic efficiency, percent

$P_s$ = isentropic power of air stream, hp

$P_{in}$ = actual power input to the blower or blower system, hp

$q_m$ = mass air flow rate, lbm/min

$k$ = ratio of heat capacities, cp/cv, = 1.4 for air at standard conditions

$R_{air}$ = specific gas constant for air/water vapor mixture, = 53.51 ft · lbf/lbm · °R for air at standard conditions

$T_i$ = inlet temperature, °R = °F + 460

$p_{d,i}$ = discharge and inlet pressure, psia = psig + barometric pressure

$$q_m = \rho \cdot q_v$$

Where:

$\rho$ = density, lbm/ft³

$q_v$ = volumetric flow rate, ft³ /min

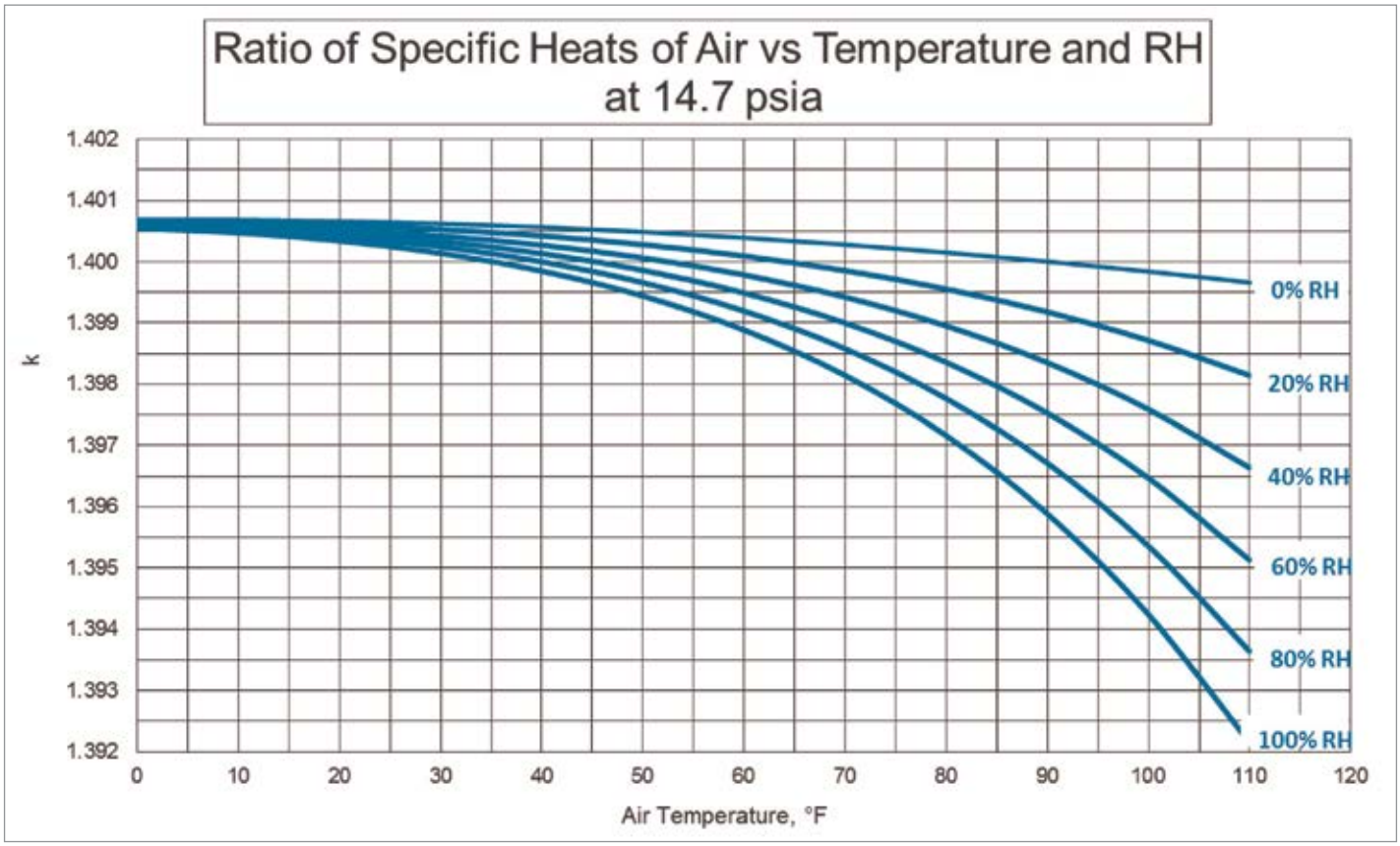


*Figure 1: Variation of k with temperature and humidity.*

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| 3:00PM–6:00PM | Conference Registration Open |
| 6:00PM–8:00PM | Welcome Reception |

### MONDAY, OCTOBER 14, 2019

| | |
|---|---|
| 7:00AM–11:00AM | Exhibitor Registration and Move-in |
| 8:30AM–10:00AM | Opening Session |
| 10:15AM–12:15PM | Conference Session #1 |
| **12:00PM–6:00PM** | **EXPO FLOOR OPEN** |
| 1:30PM–2:30PM | Energy Treasure Hunt Workshop #1 |
| 2:45PM–4:45PM | Conference Session #2 |
| TBD | Networking Event!! |

### TUESDAY, OCTOBER 15, 2019

| | |
|---|---|
| 8:00AM–9:30AM | Plenary Session |
| 9:45AM–11:45AM | Conference Session #3 |
| **12:00PM–6:00PM** | **EXPO FLOOR OPEN** |
| 1:30PM–2:30PM | Energy Treasure Hunt Workshop #2 |
| 2:45PM–4:45PM | Conference Session #4 |
| 5:00PM | Energy Treasure Hunt Raffle Winners Announced!!** |

### WEDNESDAY, OCTOBER 16, 2019

| | |
|---|---|
| 7:00AM–12:00PM | Exhibitor Move-out |
| 8:00AM–10:00AM | Conference Session #5 |
| 10:15AM–12:15PM | Conference Session #6 |


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# EFFICIENCY: AN INVALUABLE PARAMETER FOR VETTING AERATION BLOWERS

In the wastewater industry standard conditions are defined as 68 °F, 14.7 psia, and 36% relative humidity. The thermodynamic properties of air will differ at any other conditions. This will change the value of k as shown in Figure 1 and the specific gas constant as shown in Figure 2. The calculation of isentropic power normally uses the values of thermodynamic parameters at the blower inlet.

The method and location of the power measurement must be identified to make the efficiency value useful. For example, power may be measured at the blower shaft to determine bare blower efficiency. Wire-to-Air efficiency, on the other hand, requires measurement of the electrical power preceding any drives, motors, or controls.

The isentropic efficiency of a bare bower may be calculated using basic measurements of temperature and pressure at the blower inlet and discharge:

$$\%\eta_s = \frac{\left[\left(\frac{p_d}{p_i}\right)^{\left(\frac{k-1}{k}\right)} - 1\right] \cdot T_i}{T_d - T_i} \cdot 100$$

Where:

$T_d$ = discharge air temperature, °R

Polytropic efficiency compensates for the non-ideal behavior of real-world blowers. Instead of k, the polytropic exponent "n" is used in calculations.

$$n_{polytropic} = \frac{\ln\left(\frac{p_d}{p_i}\right)}{\ln\left(\frac{p_d}{p_i} \cdot \frac{T_i}{T_d}\right)} \cdot 100$$

Where:

$n_{polytropic}$ = polytropic coefficient, percent

Although polytropic efficiency is theoretically more accurate than isentropic efficiency, isentropic efficiency is used more often. In most cases the difference in projected power and performance is insignificant compared to measurement errors, assumptions, and other inaccuracies.

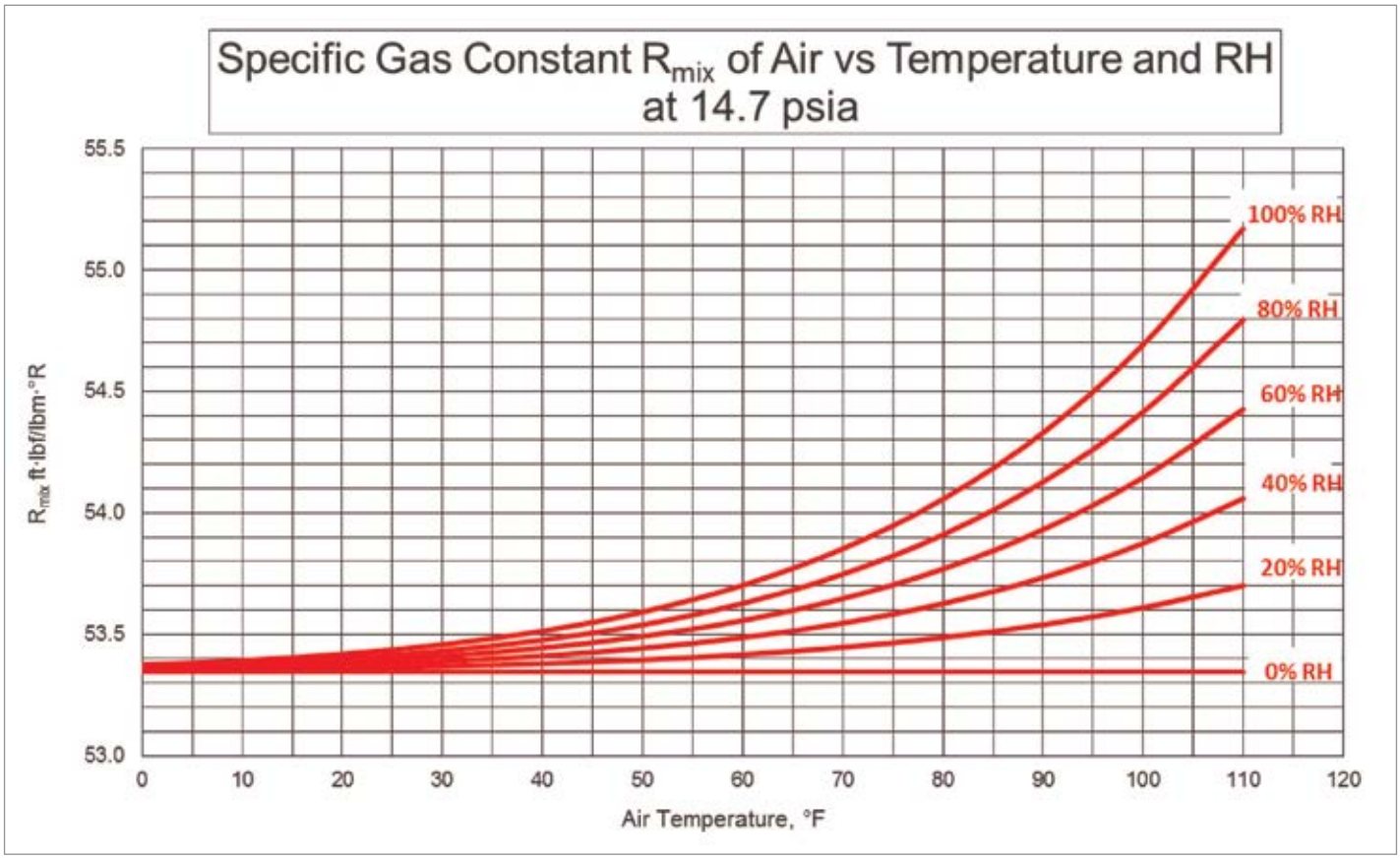


*Figure 2: Variation of $R_{mix}$ with temperature and humidity.*

# EFFICIENCY: AN INVALUABLE PARAMETER FOR VETTING AERATION BLOWERS

## Uses of Efficiency

It is often necessary to estimate the power consumption of a blower system under varying operating conditions. For example, determining the cost effectiveness of increased aeration diffuser submergence requires estimating the increase in power consumption at higher discharge pressure. Aeration systems typically operate over a wide range of airflows due to seasonal and diurnal load changes. Variations in flow normally generate variations in blower discharge pressure too.

If the blower system efficiency at an evaluation point is known, it is a simple matter to calculate the power.

$$P_{in} = \frac{q_m \cdot \frac{k}{k-1} \cdot R_{air} \cdot T_i \cdot \left[\left(\frac{p_d}{p_i}\right)^{\left(\frac{k-1}{k}\right)} - 1\right] \cdot \frac{1hp}{33{,}000\frac{f\cdot lbf}{min}}}{\%\eta/_{100}}$$

The calculation of total system power consumption should use Wire-to-Air efficiency.

$$\%\eta_{wa} = \left(\%\eta_s/_{100} \cdot \%\eta_m/_{100} \cdot \%\eta_{VFD}/_{100}\right) \cdot 100$$

Where:

$\%\eta_{wa}$ = wire to air efficiency of system, percent
$\%\eta_s$ = isentropic efficiency of bare blower, percent
$\%\eta_s$ = efficiency of motor, percent
$\%\eta_s$ = efficiency of variable frequency drive (VFD), percent

Electric power is measured in kW and electric energy is billed in kilowatt hours (kWh). Power draw must be converted from horsepower (hp) to kW and multiplied by the number of hours in the period to determine cost.

In many evaluations it is sufficient to use average flow rate, average pressure and composite (average) power cost to determine the annual energy expense. For more exact cost determinations the values of on-peak, off-peak, and demand charges for electric power should be used. Exact evaluation also requires using flow rates expected for these various billing periods. Additional information about duty cycle variations can be obtained in a previous article, Control Efficiency

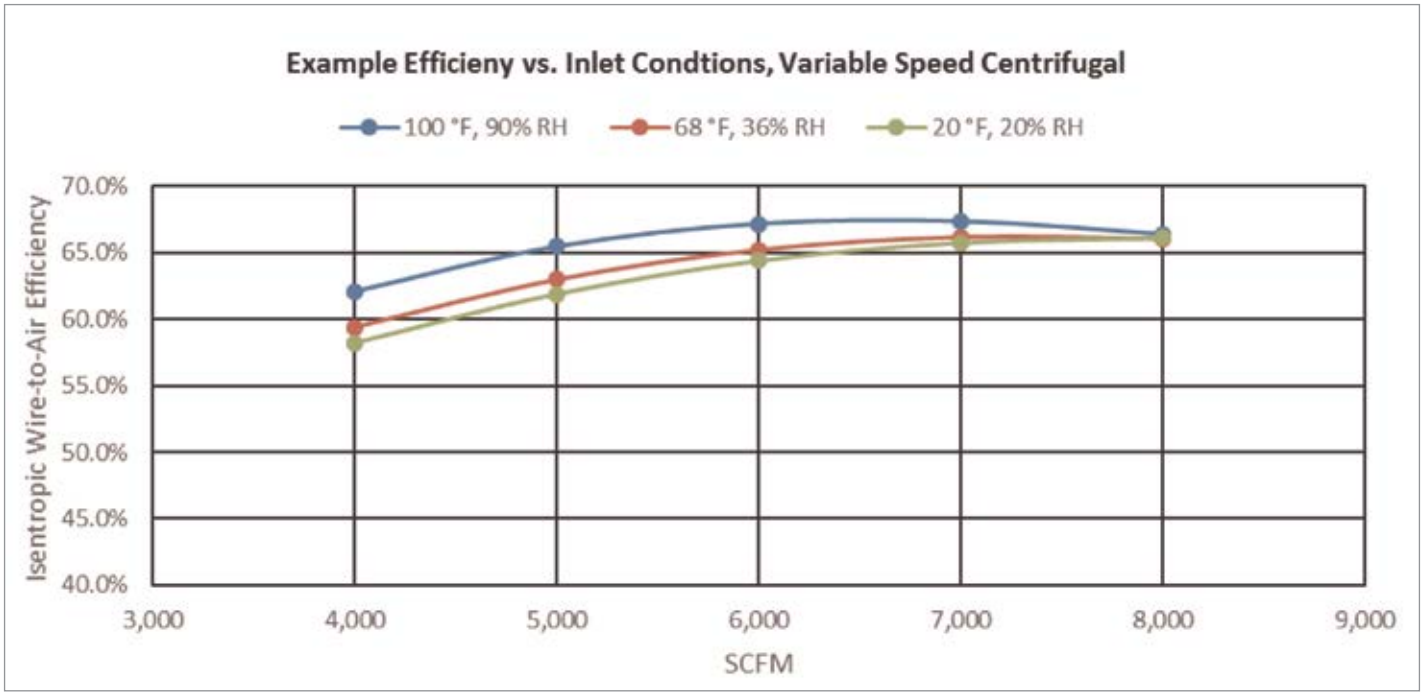


*Figure 3: Blower efficiency varies with flow, temperature and humidity.*

Article (https://www.blowervacuumbestpractices.com/technology/aeration-blowers/aeration-blower-control-efficiency.)

Efficiency is often used to compare blowers from different suppliers, or to compare different technologies for blowers or the controls. The blower system with the highest efficiency will have the lowest power cost, **all other things being equal.**

It is all too common for an efficiency comparison to be skewed by invalid procedures. For example, Wire-to-Air efficiency should not be compared to bare blower efficiency. If a blower has high efficiency but insufficient turndown the actual power consumption over the process operating range may be higher than a more flexible system with lower efficiency. In that case the most efficient blower may not provide the lowest power consumption. Ultimately the owner's energy cost is based on energy consumption, not efficiency. Comparing average efficiency to design point efficiency can also result in false conclusions.

Using efficiency correctly for both power projections and blower comparisons requires engineering judgement. Calculation results should be taken as approximations if the factors that affect efficiency aren't identical or well defined for all evaluations.

## Factors that Affect Efficiency

There are many factors that affect efficiency. Mechanical design and quality, of course, are significant influences. However, even for a given blower, efficiency is not a constant.

One of the most common, yet often overlooked influences on efficiency is the variation in inlet air conditions. Inlet air temperature changes air density, affecting efficiency. Relative humidity, which affects the air's molecular weight, also has an effect. Both factors change the relationship between volumetric airflow, which is the key parameter for determining blower efficiency, and oxygen delivered to the aeration system, which is the key parameter for determining aeration process performance.

The efficiency of a blower system will change as the airflow rate changes. Dynamic blowers often have the best efficiency point (BEP) near the design flow rate, and the efficiency drops as airflow decreases. The maximum efficiency a of lobe type PD blower occurs at maximum airflow rate. Screw type PD blowers, on the other hand, often have their BEP near the middle of the airflow range.

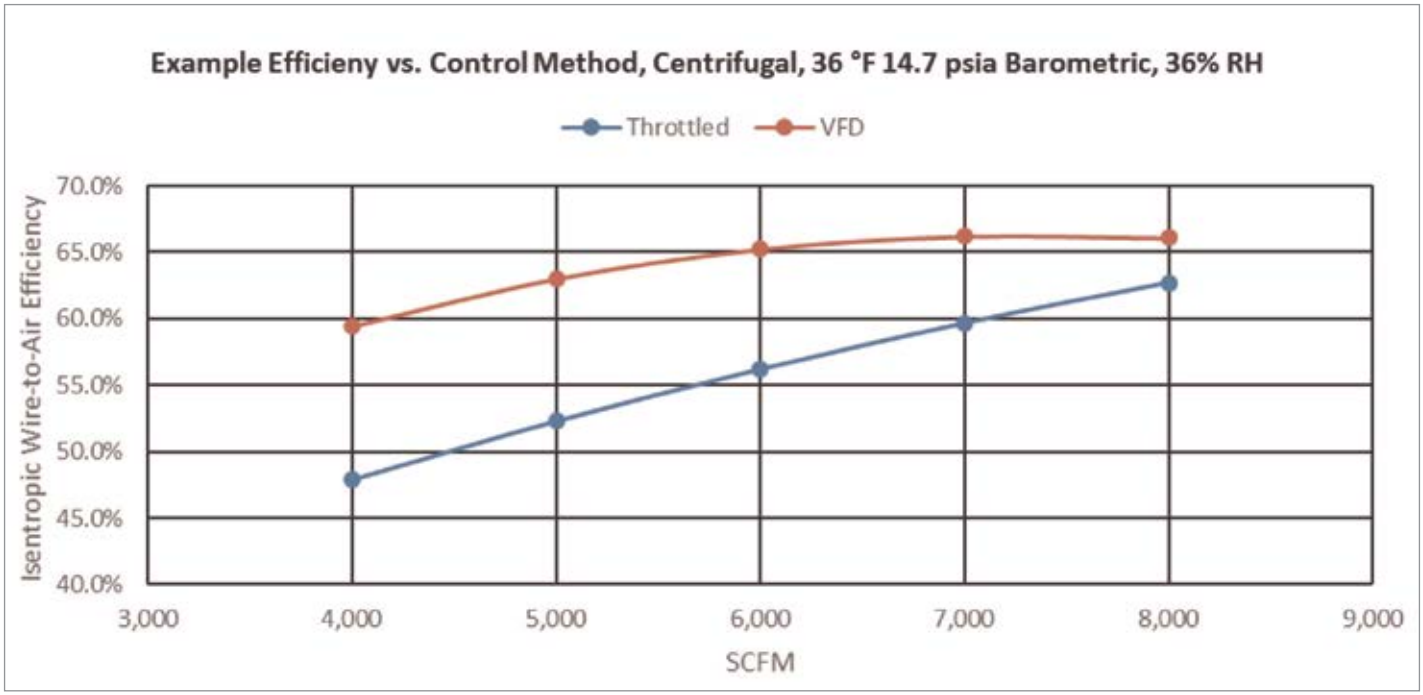


*Figure 4: Efficiency variation with control method.*

# EFFICIENCY: AN INVALUABLE PARAMETER FOR VETTING AERATION BLOWERS

Pressure also influences efficiency. For constant-speed centrifugal blowers the efficiency at a given volumetric flow rate is nearly constant, regardless of changes in discharge pressure. PD blowers decrease in efficiency when discharge pressure rises because internal leakage (slip) increases at higher pressure ratios.

## Importance of Control

Perhaps the most neglected influence on blower system efficiency is the control method used to modulate flow rate.

PD blower airflow can only be changed by varying speed. The influence of control method on PD blower efficiency is not a consideration. The efficiency of centrifugal blower systems, however, changes with control method. This is particularly evident at the low-flow segment of the operating range.

There are three methods in common use for controlling dynamic blower airflow. The oldest method is inlet throttling. Butterfly valves are used to create a pressure drop upstream of the blower inlet, shifting the performance curve. This is the least efficient control method as shown in Figure 4.

The most efficient method for modulating a centrifugal blower is variable speed, which is almost exclusively accomplished by using a Variable Frequency Drive (VFD). Much of the high efficiency attributed to turbo blowers (gearless single stage centrifugals) is due to the use of variable speed for control.

Guide vane controls, inlet and/or discharge, are the most common control method for geared single stage blowers. The efficiency of guide vanes is between that of throttling and VFD control. The use of VFDs on large blowers has historically been limited because of the economics associated with medium voltage ($600 < V < 6000$) VFDs. As technology and cost structures change, however, variable speed control of large geared centrifugal blowers will probably become more common.

VFD control can be used with any type of dynamic blower, including geared single stage and multistage designs. Any limitations on VFD application are due to economics, not thermodynamics.

## Summary

Blower system efficiency can be defined as the ratio of output power to input power. This is deceptively simple. The underlying thermodynamics and blower performance characteristics are actually complex.

The term "efficiency" is widely used and widely misused in blower evaluations. When properly defined and properly implemented efficiency can be a valuable parameter in predicting blower energy consumption and comparing alternate system designs.

When performing blower evaluations it is imperative to remember that no blower system has one "efficiency" value applicable across the entire operating range. Inlet conditions, relative air flow rate, and pressure variations all change the efficiency and the evaluation. Control method selection is particularly critical to optimizing system performance. BP

*For more information contact Tom Jenkins, President, JenTech Inc., 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" (visit www.wiley.com).*

To read similar articles on ***Aeration Blower Technology,*** please visit www.blowervacuumbestpractices.com/technology/aeration-blowers

"When properly defined and properly implemented efficiency can be a valuable parameter in predicting blower energy consumption and comparing alternate system designs."

— Tom Jenkins, JenTech, Inc.

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# BLOWER & VACUUM SYSTEM INDUSTRY NEWS

## Dekker Vacuum Offers Training for Vacuum Pump Maintenance

Dekker Vacuum Technologies is accepting applicants for its next annual rotating equipment service school, to be held at the company headquarters in Michigan City, Indiana. The service school is a free hands-on workshop providing participants a grounding in maintenance and repair, troubleshooting, vacuum theory, "tips and tricks" and more.

The service school program was developed to reinforce the importance of preventive and predictive vacuum equipment maintenance, improving the overall understanding of vacuum technology, said Wayne Zeman, Dekker After Sales Manager. "Extending our knowledge relevant to proper maintenance avoids run to failure, which leads to minimizing downtime and maximizing productivity," he said.

For more information, visit www.dekkervacuum.com or call (888) 925-5444.

## Aerzen USA Holds Atlanta Office Open House

Aerzen USA recently celebrated the launch of its Atlanta facility with a well-attended open house event. The new facility is designed provide better service to customers in the Southeast Region of the United States. The building houses a regional sales office, rental equipment and service depot. Many Aerzen employees from around the country, as well as local customers, vendors and representatives, attended the event.

Aerzen USA President Tony Morris said, "This facility is strategically located in Atlanta to ensure our closeness to customers in the region and to provide rental equipment throughout the country. We are growing and expanding into many industries. This facility complements the expansion at our Coatesville, Pennsylvania, headquarters and Houston office in working toward our vision for complete national coverage for Aerzen."

The 24,740-square-foot facility consists of 21,000 square feet of production/warehouse space and 2,800 square feet of office space. It provides space for rental machines and spare parts storage, work cells for machine setup, repair and overhaul, and state-of-the-art testing capabilities. The office is staffed and ready for business as Aerzen continues to grow and expand its national presence.

### Aerzen Rental

Aerzen Rental is a core component of the new facility, and the open house marks the official launch of the division in the United States. Aerzen Rental supplies 100 percent oil-free air solutions for emergency response and long-term capital avoidance. The best-in-class packages are engineered for rental environments with on-board Variable Frequency Drives (VFDs), remote monitoring, and outdoor builds with sound attenuating enclosures as standard. Rental units are available for immediate deployment in the event of a production failure or shortfall, as well as operational leasing and contracting needs.

"We provide complete turnkey rental solutions, on a 24/7 basis, for operating pressures of 50 psi and below. Our knowledge and experience assures our customers of in-depth technical

*Dekker Vacuum service technician school participants*


*Aerzen's sales & rental team provides solutions for process air applications throughout the southeast region.*

support and solutions that fits seamlessly with their processes," said Matt Piedmonte, Aerzen Rental's Director.

### Sales and Service

The strategic location in Atlanta allows for complete sales coverage of the Southeast region of the United States. With several sales professionals based in Atlanta, the company is closer to its customer base for better responsiveness and connection to their business needs.

Recently hired Director of Southeast Operations, Greg Snyder said, "We are very excited and energized to have a new facility with a sales force focused on servicing our existing customers and bringing on new customers. By bringing our high-quality equipment and solutions to customers in the region, Aerzen is positioned to help local customers be successful in their businesses."

### 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, Pennsylvania. For more information, visit www.aerzen.com/en-us

## Maple Syrup Company Honored with 2018 Busch Innovation in Vacuum Award

The 2018 Busch Innovation in Vacuum Award was recently awarded to the Canadian company Les Équipements Lapierre (Lapierre Equipment Inc.). By employing Busch's Mink dry claw vacuum pumps, the company revolutionized the way maple syrup is tapped directly from trees, significantly improving the effectiveness of the maple syrup production process.

Created by Busch Vacuum Pumps and Systems, the Busch Innovation in Vacuum Award honors individuals or businesses that find innovative ways to apply vacuum technology, while also benefiting the environment. The award was presented to Donald Lapierre and his family at Busch Vacuum Pumps and Systems' headquarters in Maulburg, Germany.

Les Équipements Lapierre, which was founded by Donald Lapierre in 1978, produces equipment and accessories required to tap, collect and cook maple sap and produce maple syrup. Lapierre also runs one of the world's largest organic maple syrup farms, tapping approximately 150,000 maple trees each year.

Until the 1970s, metal spiles (a kind of tap) were inserted into drilled holes on the maple trees; the sap would then drip out of the tree and collect in buckets. Unsatisfied with the traditional sap collecting methods, Lapierre decided to improve the process by changing to plastic tubing and spiles, and inventing patented extractors (sap releasers). The result is a network of pipes and vacuums

# BLOWER & VACUUM SYSTEM INDUSTRY NEWS

that extract sap from the trees instead of collecting it in buckets. As such, the maple sap can be collected much faster without having to change buckets several times a day. The spiles are also smaller than the traditional taps, allowing trees to more quickly regenerate.

The Maple Research Center at the University of Vermont tested the effects of using vacuum technology on trees and studied the quality of the syrup, revealing that neither the health of the trees nor the quality of the syrup suffers. The only weak spots in this system were the vacuum pumps (liquid ring vacuum pumps and oil-lubricated rotary vane vacuum pumps) initially employed by Lapierre. Experts from Busch found a solution to this problem by introducing Lapierre to Mink dry claw vacuum pumps. The pumps provide an efficient, clean and dry vacuum without the need for any water or oil as an operating fluid. Additionally, they are essentially maintenance-free.

### About Les Équipements

With its innovative concepts, Les Équipements Lapierre sets the bar for the maple syrup industry and is one of the leading producers of premium maple syrup that exceeds expectations when it comes to quality, flavor and environmentally friendly production.

### About Busch

Today's food packaging and processing industry uses vacuum in a very wide range of applications. Busch products guarantee the highest level of product quality and process safety. Busch has always focused on optimizing food processes, improving productivity with ongoing investment, and research and development for tomorrow's innovations. To learn more about Busch products and services, visit www.buschusa.com.

## Howden Completes Move To New Service Center In Houston

Howden has completed its move to a new state-of-the art, 35,000-square-foot service center in Houston, the heart of the oil and gas sector.

Howden is able to service centrifugal fans, cooling fans, air preheaters, reciprocating air compressors, blowers, centrifugal air compressors and screw air compressors. With years of knowledge and experience, Howden is the expert in the following legacy product lines:

- Roots
- Thomassen Compression Systems
- Turblex
- ČKD Kompresory
- American Fan
- Garden City
- Covent
- Buffalo Forge
- American Standard
- Westinghouse Sturtevant

For a full list of Howden brands visit www.howden.com/legacybrands. With the service center's increased footprint, it now contains three 20-ton overhead cranes, nine two-ton jib cranes, balancing equipment, a component repair bay, welding bay, paint booth and ample testing space.

"Our investment in this new service center is a clear indication that we at Howden are committed to providing the highest level of service to our clients. We understand in order to best serve the market we need to maintain our high quality standards, be responsive and be local. I am confident we will continue to do just that in 2019 and beyond," said Darryl Halter, Vice President – Aftermarket, Howden.

*Howden's new service center in Houston.*

### About Howden

Howden is a global engineering business focused on providing our clients with industrial products that help multiple sectors improve their everyday processes; from mine ventilation and wastewater treatment to heating and cooling. Our core focus is on providing quality solutions for air and gas handling, and with over a century of experience in doing so, it's no wonder that we are renowned for such projects across multiple sectors. For more information, visit www.howden.com

## Gardner Denver Acquires MP Pumps

Gardner Denver Holdings Inc., a leading global provider of mission-critical flow control and compression equipment, announced it has acquired MP Pumps, Inc. for a net purchase price of approximately $58 million funded by cash on hand.

Based in Fraser, Michigan, MP Pumps is a leading manufacturer of specialty industrial pumps and associated aftermarket parts for use in a variety of industrial end markets. MP Pumps will be part of Gardner Denver's Industrials Segment.

"MP Pumps complements and expands Gardner Denver's existing specialty industrial pump offering and provides increased access to and expertise in the market," said Vicente Reynal, Gardner Denver's CEO. "The acquisition of MP Pumps is another important step in our strategy to drive ongoing profitable growth by leveraging core, mission critical technologies in attractive end markets."

"Lionheart Industrial Group is pleased to have owned MP Pumps for the last decade and help guide its growth through strategic and operational value improvement. We are excited for the future of the company, and its employees, under the stewardship of Gardner Denver," said David S. Bovenizer, CEO of Lionheart.

Greg Peabody, President of MP Pumps, said, "As part of Gardner Denver, we will be able to leverage an expanded commercial and operational footprint as we continue to deliver high quality products and services to our customers."

### About Gardner Denver

Gardner Denver (NYSE: GDI) is a leading global provider of mission-critical flow control and compression equipment and associated aftermarket parts, consumables and services, which it sells across multiple attractive end-markets within the industrial, energy and medical industries. Its broad and complete range of compressor, pump, vacuum and blower products and services, along with its application expertise and over 155 years of engineering heritage, allows Gardner Denver to provide differentiated product and service offerings for its customers' specific uses. Gardner Denver supports its customers through its global geographic footprint of 39 key manufacturing facilities, more than 30 complementary service and repair centers across six continents, and approximately 6,700 employees world-wide. For more information, visit www.gardnerdenver.com.

## Röntgen Award Winner Dr. von der Wense Visits Pfeiffer Vacuum

The Justus Liebig University Giessen (JLU) has awarded the Röntgen Prize to Dr. Lars von der Wense, a research associate at the Faculty of Physics at the Ludwig Maximilian University in Munich. Dr. von der Wense, who received the award for his outstanding contributions in the field of nuclear physics, visited Pfeiffer Vacuum and reported on his research findings the day before the award ceremony.

The Röntgen Prize is awarded annually for outstanding work on basic research into radiation physics and radiation biology. The award is named in memory of Wilhelm Conrad


"Our vacuum solutions are also being used successfully in the Faculty of Physics at the Ludwig Maximilian University of Munich, and we are pleased that Dr. von der Wense was able to confirm his theoretical assumptions there."

— Dr. Ulrich von Hülsen, member of the Management Board of Pfeiffer Vacuum Technology AG

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*"Republic prefers to couple air knives with centrifugal or regenerative blowers. These blowers are energy-efficient and inexpensive,especially when compared to compressed air as an alternative."*

— Rich Leong, VP Sales & Marketing, Republic Manufacturing ("Republic Manufacturing Delivers Food Grade Blower & Air Knife Systems," April 2018 Issue)

*"Without sacrificing pump performance, recoverable energy levels of up to 75 percent are even possible in some applications."*

— Jerry Geenen, Atlas Copco Industrial Vacuum Division ("Rotary Screw Vacuum Pumps Benefit Meat Packaging Plants," January/February 2018 Issue)

### From WWTP Aeration Blowers to Centralized Vacuum Systems

Our readers have embraced energy management practices as the next step. Our diverse key subscribers work at multi-factory manufacturing organizations and are targets to consider options such as VSD vacuum pumps in newly centralized systems. On the municipal side, over 1,000+ operators at wastewater treatment plants (WWTP's) and blower sales channels receive the magazine. Lastly, a growing group of industrial blower and vacuum OEM design engineers are looking for technologies able to improve their machines.

*"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. ("Proper Blower System Design for Variable Wastewater Depth Processes," July 2018 Issue)

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# BLOWER & VACUUM SYSTEM INDUSTRY NEWS

Röntgen, who was a professor in Giessen from 1879 to 1888. The award primarily distinguishes the work of young scientists. Pfeiffer Vacuum, the Dr. Erich Pfeiffer Foundation and the Ludwig Schunk Foundation donate 15,000 euros for the prize.

"Many research institutions have been Pfeiffer Vacuum's partners for decades. Our vacuum solutions are also being used successfully in the Faculty of Physics at the Ludwig Maximilian University of Munich, and we are pleased that Dr. von der Wense was able to confirm his theoretical assumptions there," said Dr. Ulrich von Hülsen, member of the Management Board of Pfeiffer Vacuum Technology AG.

In the context of his dissertation, Dr. von der Wense has succeeded in directly detecting the thorium isomer Thorium-229m, which has been intensively searched for over 40 years. He laid the foundation for the future development of a nuclear clock. Dr. Lars von der Wense has also received dissertation awards for his work from the Ludwig Maximilian University of Munich and the German Physics Society.

### 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 Analytics, Industry, Research & Development, Coating and Semiconductor markets. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 3,100 people and has more than 20 sales and service companies as well as 8 manufacturing sites worldwide. For more information, visit www.pfeiffer-vacuum.com.




*Pfeiffer Vacuum welcomes Röntgen Award winner Dr. von der Wense.*

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