The Magazine for ENERGY EFFICIENCY in Blower and Vacuum Systems

BLOWER & VACUUM BEST PRACTICES

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September 2016

Aeration Blowers

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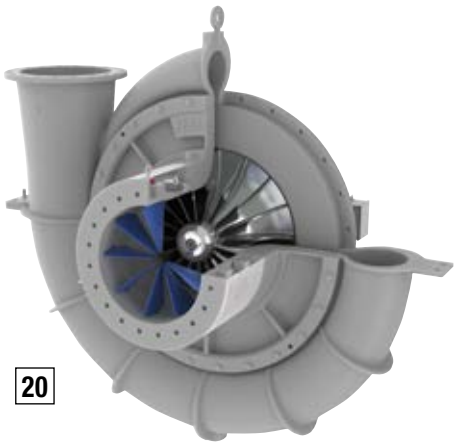


FROM THE EDITOR | Aeration Blowers

I had a very interesting meeting with Julie Gass and Patrick Dunlap, this summer at Black & Veatch's offices in Kansas City. In a fascinating conversation, we reviewed a host of technologies ranging from panel diffusers to aeration blowers. Somewhere in the middle we did a long, challenging, review of DO Control, Most Open Valve Control, Flow Control and even Ammonia Control strategies. Leading off this Issue, we hope you learn as much as I did and enjoy "Part 1: The Demand Side – Diffusers and DO Control".

The wastewater treatment plant in the Town of Hurlock, Maryland provides service to approximately 2,100 residences. However, the majority of the water treated comes from a nearby poultry processing plant, giving the plant influent a high organic content. That is why the Town of Hurlock replaced its two million-gallon-per-day (MGD) lagoon plant with a 1.65 MGD four-stage activated sludge facility ten years ago. Paul Petersen, from Atlas Copco, shares this story with us about how they reconfigured their aeration blowers to reduce energy consumption.

Tim Hilgart, from Howden Roots, writes about how their DO Control system was able to optimize the 180 MGD challenge at the Bird Island wastewater treatment plant in Buffalo, N.Y.. This article demonstrates expertise in Most Open Valve Control logic, an expertise for which there is growing demand. The project delivered an annual savings of 3.8 million kWh equaling $345,000 with an excellent ROI assisted by a NYSERDA rebate covering fifty percent of the cost.

Tom Jenkins is the President of JenTech and is an expert consultant on aeration blowers. He also explains things in a way I can understand! For those of you in the field, he has provided a very useful article (one for the files) with the steps to calculate the air flow rate, how to determine the best strategy for blower turndown, and the calculations to establish the required discharge pressure.

Last but not least, I hope you enjoy our Show Report on blower and vacuum technologies at AISTech 2016. Steel degassing processes are switching to mechanical vacuum systems, providing up to 97% energy reductions according to Edwards and Oerlikon Leybold booth personnel. Blow-off air processes are also being optimized with dedicated blower and custom air knife technologies and we enjoyed visiting with Sonic Air Systems and Silvent InTech. Our technologies really are helping the steel industry be more efficient.

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

Roderick Muñoz Smith
Editor
tel: 412-980-9901
rod@airbestpractices.com

▶ Join Tom Jenkins and Blower & Vacuum Best Practices Magazine to review aeration blower systems, designed around the goal of achieving 8 to 1 turndown, using four blowers at 50%, 50%, 25% and 25% of design load. Sign up for our free October 27th Webinar titled, "Designing for 8 to 1 Aeration Blower Turndown" at **www.blowervacuumbestpractices.com/magazine/webinars.**

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

APG-Neuros Celebrates 1000th Turbo Blower Delivery Milestone

It is truly a very proud moment for APG-Neuros, manufacturer of high efficiency turbo blowers, to highlight an important milestone this year with the achievement of the 1000th turbo blower delivery to the City of South San Francisco-San Bruno Water Quality Control Plant, United States. This accomplishment demonstrates our customers' strong confidence in our company, our team, the air bearing technology, our NX series high efficiency Turbo Blower product and the benefits it brings them.

"The operations team at the city of South San Francisco are very pleased with the innovative product and support we received over the past four years from APG-Neuros," said Mr. Brian Schumacker, the Plant Superintendent for the South San Francisco-San Bruno Water Quality Control Plant.

Year after year, APG-Neuros is experiencing success and growth with its High Efficiency High Speed Turbo Blower. APG-Neuros has built a state of the art Assembly and Test facility in the U.S., located in Plattsburgh NY, and a well-established head-office in Montreal with Administration, Engineering, Sales and Support network personnel. APG-Neuros also built a strong factory service team located within close proximity of customers across North America and in Europe that is dedicated to support the customers operating its Turbo Blower product line. Its network of direct sales and support staff are also assisted by sales representatives and a network of factory trained service technicians and control engineers located strategically in the proximity of its customers.

APG-Neuros CEO & President Mr. Omar Hammoud said, "We thank the City of San Francisco-San Bruno Water Quality Control Plant for their loyalty and the confidence they place in us. The repeat sales and the appreciation we receive from our customers give us encouragement to continue to work hard and strive to provide the wastewater treatment community with more product innovations and outstanding service."

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

APG-Neuros Celebrated the 1000th Turbo Blower Delivery

It all began in 2005 with only one person, Omar Hammoud, and has grown to a present total of 72 employees. Today, APG-Neuros has over 1,050 turbo blowers installed with over 250 customers in North America and the European Union; mainly in municipal and industrial wastewater treatment plants. APG-Neuros developed the Smart Connected Product solution, Filter Upgrades, Installation Design upgrades, Software upgrades and flexible Service Plans that address the customers' emerging requirements and significantly increase the operational flexibility availability level of its product. In 2013 and 2015, APG-Neuros ranked as one of the top 500 of Canada's Fastest-Growing Companies and received the Best Product award by Frost and Sullivan.

Mr. Hammoud continued, "We continue to be successful with our repeat customers; we are also seeing many new small and large municipalities across North America and Europe adopting the technology of the air bearing Turbo Blower and are selecting our product as their first choice. We are pleased with the positive impact our innovations are having on our customers and we will continue to do so in the future."

For more information about APG-Neuros products and services, please visit www.apg-neuros.com or send your inquiry to communication@apg-neuros.com.

CAGI Blower Section Announces New BL300 Blower Data Sheets

The Compressed Air and Gas Institute's (CAGI) Blower Section has announced plans to make Blower Package Data Sheets available in the near future. The sheets are based on testing conducted according to the CAGI/PNEUROP BL 300 standard, *Performance Test Code for Electric Driven Low Pressure Air Compressor Packages.* BL300 is a new joint standard developed through cooperative work by US and European trade associations. The CAGI/PNEUROP standard is designed to enable the collection and presentation of comprehensive and consistent performance data independent of blower technology.

In addition to the BL300 document, CAGI has established a standard means for manufacturers to report their machines' performance and efficiency in the form of data sheets. Blower Section Chair, John Conover, said "Members have committed to publishing data sheets for 75 hp, 100 hp, and 150 hp models in the second half of 2016."

CAGI®
Compressed Air & Gas Institute
www.cagi.org

John Conover serves as the CAGI Blower Section Committee Chair

The data sheets will cover fixed and variable speed drive units for both positive displacement and dynamic blower technologies. These data sheets will be accessible via a link on the CAGI website under the "Performance Verification" tab.

The joint standard enables the fair comparison of package performance on a level playing field. "BL 300 is a standard means of evaluating blowers which provides users with complete package performance data that was just not available before," according to Chris Johnson, Executive Director of CAGI. "It includes a reference to ISO 1217, the standard for testing positive displacement blowers, and to BL 5389, the standard for testing turbo blowers."

The development of BL 300 was initiated at the request of the wastewater treatment industry; however, the standard was expanded to make it suitable for use with blowers in general industry and other applications. When blower packages are compared using BL 300 results, plant managers, engineers, and technical advisors can use CAGI datasheets to access the following performance information:

- **Blower Data:** This lists manufacturer-provided information such as rated operating pressure, rated capacity at rated operating pressure, drive motor

nameplate rating, and compressor rated speed.

- **Performance Table:** A performance table shows delivered airflow for a range of discharge pressures.
- **Package Performance Chart:** This type of chart plots performance curves for specific power across a range of capacities.
- **Test Summary Report:** The test summary report provides a range of as-tested values, specified/guaranteed conditions, data corrected to specified conditions, and a comparison to guarantee.

A consulting engineer can use this information to evaluate whether positive displacement or dynamic blower technology makes better economic sense given the plant's process design and the variability of demand for air. This can lead to more confident recommendations.

About the CAGI Blower Section

The Compressed Air and Gas Institute Blower Section includes rotary positive displacement blowers and centrifugal blowers in air or gas applications developing up to 28" Hg vacuum or up to 30 psig discharge pressure.

CAGI Blower Section Members:

- Atlas Copco Compressors
- Gardner Denver
- Howden Roots
- Ingersoll Rand
- Kaeser Compressors
- Sulzer Pump Solutions
- Tuthill Vacuum & Blower Systems

About CAGI

The Compressed Air and Gas Institute is the united voice of the compressed air industry, serving as the unbiased authority on technical, educational, promotional, and other matters that affect compressed air and gas equipment suppliers and their customers. CAGI educational resources include e-learning coursework on the *SmartSite,* selection guides, videos, and the *Compressed Air & Gas Handbook.*

For more information, visit the CAGI web site at www.cagi.org

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

Tuthill Vacuum & Blower Systems Welcomes OEC Fluid Handling and Kevin Viau

Tuthill Vacuum & Blower Systems is pleased to announce that OEC Fluid Handling Inc. is part of the Tuthill sales network. OEC represents the KINNEY vacuum pumps line of products for Tuthill within North Carolina and South Carolina. OEC can be connected with online at www.oecfh.com or via phone at 800-500-9311.

Kevin Viau, Regional Sales Manager, Tuthill Vacuum & Blower Systems

Kevin Viau has joined Tuthill Vacuum & Blower Systems as Regional Sales Manager. Viau's career includes holding the positions of Sales Manager – Distribution Channels at Oerlikon Leybold Vacuum, Senior Sales Engineer at Pfeiffer Vacuum, and Technical Manager, PVD at Moen, Inc.

Viau has a Bachelor of Science in Chemical Engineering from University of Virginia and a M.B.A. in Operations/Finance from College of William & Mary. He also served in the U.S. Navy for four years.

About Tuthill Vacuum & Blower Systems

Tuthill Vacuum & Blower Systems, manufacturer of KINNEY® vacuum pumps and M-D Pneumatics™ blowers and vacuum boosters, is a leader in the design and manufacture of high performance, reliable positive displacement blowers, mechanical vacuum pumps, vacuum boosters and engineered systems ready to install and run. Since 1969, Tuthill Vacuum & Blower Systems has been manufacturing at its main facility located in Springfield, Missouri.

For more information, visit www.tuthill.com

Atlas Copco Expands GHS VSD+ Vacuum Pump Range

Atlas Copco has released a new addition to their line of GHS VSD+ oil-sealed rotary screw vacuum pump range. The newest model offers a range of 1300-1900 m^3/h with an ultimate pressure of 0.35 mbar(a) and a footprint of less than 2.3 m^3.

Atlas Copco's GHS 1300-1900 VSD+ is the newest addition to their range of GHS VSD+ oil-sealed rotary screw vacuum pump range. With an all-in-one vacuum pump featuring efficient variable speed drive (VSD) technology, the GHS 1300-1900 VSD+ offers average energy savings of up to 50 percent compared to alternative technologies.

The easy to install plug-and-play design comes with SMARTLINK connectivity for maximum uptime and Elektronikon for state-of-the-art monitoring.

Atlas Copco's GHS 1300-1900 VSD+ is the newest addition to their oil-sealed rotary screw vacuum pump range.

The new model offers a range of 1300-1900 m^3/h with an ultimate pressure of 0.35 mbar(a) and a footprint of less than 2.3 m^3. Market-leading oil retention means the quality of the exhausted air is optimal, ensuring a significantly cleaner work environment. Other optional features include water cooled versions, which could recover up to 100 percent of the used energy as hot water, and options for wet applications with a humid version suitable for high water content duties.

For more information visit www.atlascopco.us.

DEKKER Debuts Industry-Unique dekkervacuum.com Website

The future of vacuum is here today at www.dekkervacuum.com.

The website of DEKKER Vacuum Technologies has been updated and enhanced with an emphasis unique to the industry on vacuum education, training, knowledge and support.

Company CEO Rick Dekker said, "DEKKER is one of the world's leading authorities on the science of vacuum and the manufacturing of vacuum technology for industrial applications. We have accumulated an incredible storehouse of vacuum knowledge, and we add to it with every new project."

"It has been my goal for many years to make our knowledge and expertise available to everyone. We want our website to be the front door to this resource. Dekkervacuum.com will be beneficial for the seasoned vacuum professional as well as anyone who is simply curious as to what vacuum is all about."

Key homepage features include:

- Resource Library: A comprehensive archive containing a knowledge database, reference links, article and book listings, a cross reference of DEKKER pumps with other brand

pumps, and downloads of brochures and bulletins. The library will be expanded on a regular basis.

- Ask the Experts: Online contact with DEKKER's application engineers is made available through our "Ask the Experts" interface. Our experts are some of the most experienced in the industry. This section is primarily for customers and distributors, as well as anyone who works with industrial vacuum applications who have a vacuum question or issue of a highly technical nature.
- Industry/Application Listing: A reference guide shows the more than 30 major industries today, from aerospace to waste water with related applications. For example, the aerospace industry uses vacuum systems for altitude chambers, assembly, engine testing, holding/chucking, impregnation, material handling and wind tunnels.

A number of dekkervacuum.com features are exclusively for DEKKER customers and distributors:

- Pump Finder: Identify the correct pump based on a selection of the top five performance attributes.
- Products and Parts: An online catalog of pumps, systems, compressors and parts. A power grid search is available for research and comparative analysis.
- Quote request: Online quote form allows the customer to match an industry application when selecting a pump or system.
- Distributor Locator: Identify the nearest distributor by postal code or country.
- Warranty and Registration: Online warranty information and warranty registration.

DEKKER Vacuum Technologies, a world leader in vacuum systems and solutions, was established in 1998. DEKKER manufactures and packages liquid ring vacuum pumps and compressors, rotary piston and rotary vane vacuum pumps and systems for markets such as plastics, packaging, pharmaceuticals, laboratories, metal processing, food processing, chemical, power generation, aerospace and many others. DEKKER is ISO 9001:2008 certified, and can build to API 681(with exceptions), PIP 004 and NFPA 99 for healthcare and laboratories. DEKKER is

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

a privately held company with more than 60 employees, operating in a 81,000 square foot manufacturing, distribution and warehouse facility in Michigan City, Indiana.

For more information on DEKKER Vacuum Technologies visit www.dekkervacuum.com.

Busch Increases SECO Rotary Vane Pump Service Life

The service life for dry-running rotary vane vacuum pumps and compressors from Busch has been drastically increased. The proven oil-free Seco vacuum pumps and compressors are now equipped with new high performance

Seco SV 1025 C rotary vane vacuum pump from Busch: a new vane material drastically increases the service interval

vanes as standard. Newly developed, self-lubricating Aerodur 274 zircon material makes it possible to offer a service life that is at least three times as long as that of conventional materials. Furthermore, resistance to moisture is increased so that even damp gasses and vapors can be extracted or compressed. Busch offers dry-running rotary vane vacuum pumps with pumping speeds of 12 to 48 m^3/h (60 Hz operation), with the longest service intervals on the market.

Busch vacuum pumps and compressors in the various Seco series are tried and tested in many handling or pick and place applications. They are used during packaging processes in carton erectors, on tubular bag packaging machines, or with filling machinery. Additional application areas are in medical technology and electrical engineering, as well as the food industry. The Seco DC series, which simultaneously generates a vacuum of -0.6 bar and overpressure of +0.6 bar, was specifically designed for the transportation and supply of paper sheets or foils to printing or print processing machines. Seco DC models are available in two sizes with pumping speed or volume flows of 30 and 48 m^3/h at 60 Hz operation.

The Seco SV series includes vacuum pumps in sizes with pumping speeds of 12, 19, 30 and 48 m^3/h (60 Hz operation), with ultimate pressures from 120 to 150 mbar. The Seco SD series consists of the same increments for plain compressors creating overpressures of 0.6 bar.

Busch offers an exchange set for the Seco SV, Seco SD and Seco DC series so that conventional vanes can be exchanged for the new high performance Aerodur 274 zircon vanes. Vacuum pump or compressor operators can quickly and easily exchange the vanes themselves.

Visit www.buschusa.com

Pfeiffer Vacuum Introduces Modular Leak Detector for Industrial Leak Detection Systems

The Pfeiffer Vacuum ASI 35 modular leak detection solution is designed for use by leak detection machine builders, system integrators and end users. This unit combines high reliability and repeatability with maximum uptime. The ASI 35 provides excellent performance for the tracer gases helium and hydrogen in integral and localizing test procedures or a combination of both. It offers flexibility in testing demanding industrial samples with minimum signal background and crosstalk, providing for fast overall cycle times.

The modular design of the ASI 35 minimizes space requirements and maximizes integration options. The optional user interface can be controlled by PC or PLC. Only two cables are needed to connect the vacuum and electronic modules, making the ASI 35 leak detector easy to set up.

The ASI 35 features a low-maintenance turbopump for high helium pumping speed, dual independent long life filaments as well as its state-of-the-art electronics. These features ensure trouble-free operation. The leak detection system can be used in vacuum or sniffing test modes with the highest sensitivity. The ASI 35 sustains very high throughput and ensures the accuracy and reproducibility of the measurement results as well as fast cycle times as short as 1 second. Sniffing mode

"Busch offers an exchange set for the Seco SV, Seco SD and Seco DC series so that conventional vanes can be exchanged for the new high performance Aerodur 274 zircon vanes. Vacuum pump or compressor operators can quickly and easily exchange the vanes themselves."

The Pfeiffer Vacuum ASI 35 Modular Leak Detector

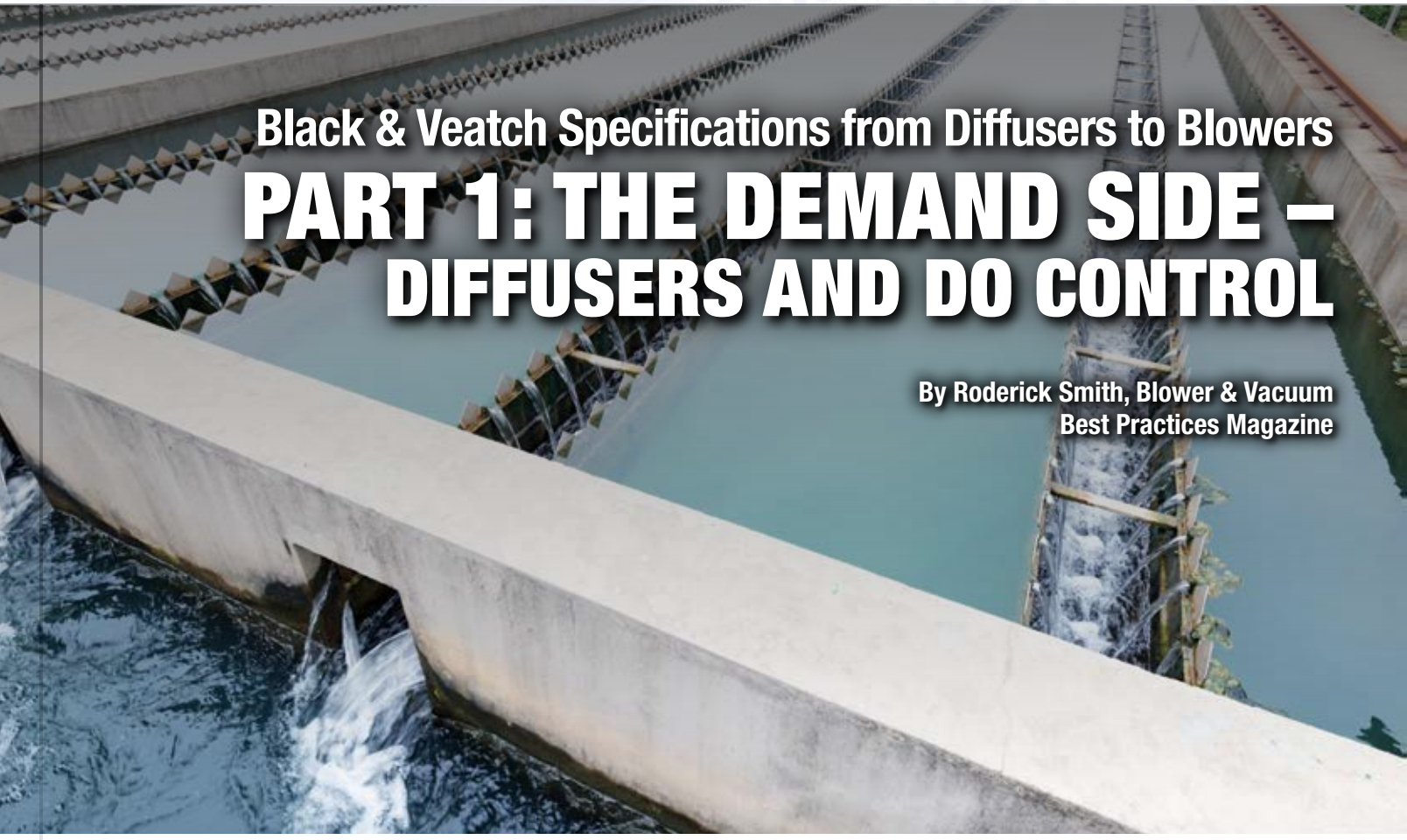
performance makes the ASI 35 the perfect leak detector when multipoint sniffing is needed.

The electronics module is suitable for universal voltage, making the ASI 35 easy to integrate into systems designated for worldwide operation. The leak detector is designed for working conditions in ambient temperatures up to 45°C. Simple mechanical integration is complemented by a wide range of interfaces, allowing data acquisition and complete external control of the system. A customized I/O configuration permits a basic version of the ASI 35 leak detector to be operated without a PC or PLC.

Pfeiffer Vacuum – North America

Pfeiffer Vacuum North American operations offer marketing, sales, field services, repair, customer training, and applications and support. Sales and support functions are located throughout the U.S. with major customer support centers in Milpitas, California, Austin, Texas, Hingham, Massachusetts, and Nashu, New Hampshire.

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



Black & Veatch Specifications from Diffusers to Blowers

PART 1: THE DEMAND SIDE – DIFFUSERS AND DO CONTROL

By Roderick Smith, Blower & Vacuum Best Practices Magazine

Blower & Vacuum Best Practices Magazine interviewed Julia Gass, P.E. and Patrick Dunlap, P.E. at the Black & Veatch offices in Kansas City during the summer of 2016. Ms. Gass is responsible for aeration blower specifications while Mr. Dunlap is a wastewater process engineer. We held a general discussion covering technologies impacting aeration blowers in wastewater treatment plants, which we have tried to summarize in a two-part article. Part 1 covers DO control strategies and system components like diffusers and valves. Part 2 will be published in the Jan/Feb 2017 Issue and covers aeration blower technologies and the new ASME PTC 13 Standard under development.

Good afternoon. Thank you for taking the time to discuss the demand-side of a wastewater treatment plant - as it relates to aeration blower requirements.

Good afternoon. We are pleased to discuss wastewater treatment plants (WWTP) and the technology evolutions we examine to provide our clients with the best possible specifications. Wastewater treatment plants are very significant energy consumers and obviously provide an important service to every community. When new technologies are introduced, there's always a learning curve for everyone involved; the manufacturer, the engineering firms, the contractors and the wastewater treatment plants themselves.

We do the best we can to stay on top of the new technologies and really cross-examine the claims being made. We research prior installations to learn about product performance and durability, we inquire as to what kind of service capabilities exist, and we evaluate performance claims. With new technologies, it's the performance claims which can be the most difficult to ascertain – until the units are shop performance tested.

Can you provide some observations on diffuser technology and in particular on diffuser fouling and aging?

Sure. Diffusers are largely evaluated for their oxygen transfer efficiency (OTE), the pressure drop across the diffuser and their vulnerability to fouling and aging. Fouling and aging are a facts of life with diffusers and they result in a loss of OTE and an increase in pressure drop over time. To give you an idea of its significance, we use fouling factors which are generally in the range of 0.5 to 0.7 representing efficiency loss over time when specifying diffusers. As part of an aeration design project, process engineers specify the number and type of diffusers in each zone, based upon fouling factors, loading, and a number of other considerations. This design is a big part of what drives the airflow requirements we provide to Julie to specify blowers.

Backing up a bit, most wastewater plants changed in the 1980s and '90s to fine bubble diffusers. Most of the original systems had coarse bubble diffusers with larger bubbles of 6 to 10 mm in diameter. Coarse bubble diffusers are basically stainless steel tubes with perforations. They required more air flow due to a lower OTE but also require less pressure.

Oxygen transfer efficiency improves with decreasing bubble size, which led to the adoption of fine bubble diffusers (producing bubbles less than 5 mm in diameter)starting in the 1980s. The first fine bubble diffusers were made of a porous ceramic material. The big drawback with ceramics is they have a narrower range of air flow per diffuser and, if they are not cleaned and maintained properly, fouling can be irreversible. Irreversible fouling is more likely if they are required to run at air flows below their low limit. It's also more difficult and expensive to clean them compared to membranes.

The membrane fine bubble diffuser technology came into more common use around the year 2000. Most plants have adopted EPDM rubber membrane diffusers in disc or tube shapes while very few use membranes in other geometries or made of other materials. With membranes excess air can be sent to them to dislodge biofilm (called bumping the membranes) periodically such as once a month to try and clean them. When membranes foul or age, the fine bubbles become coarser and we lose oxygen transfer efficiency. Aging is a unique problem for membranes and refers to the membrane losing its elasticity. At the end of the day, we have to plan for the worst fouling/aging condition during design to protect the system against fouling and events.

What's going on with panel diffusers?

EPDM rubber discs are sort of the standard but there is a potential to reach higher efficiencies, whether with diffusers that can get to higher floor coverages or materials which foul & age less severely. One example is panel diffusers which are promoted as the latest-greatest thing due to their ability to achieve lower air flux rates across the membranes resulting in a higher OTE. However they also operate at a higher pressure. Disc diffusers are mounted one foot off the basin floor, while panel diffusers are on the floor and also have a greater pressure drop through the diffuser itself; so you need to consider diffuser type & material in design. An advantage of disc diffuser vendors is their experience and long installation lists with historical performance data from many projects. There just aren't that many panel diffuser installations and, therefore, there is less historical data available on pressure losses in all working conditions.

There's just a lot going on with diffusers-there are also "mini-panel" and strip diffusers which can also offer greater transfer efficiency through higher floor coverage. Panels have been around for years but the mini-panels are very new and the term is defined differently from one vendor to another. In contrast disc diffusers have lower maximum floor coverages but are less expensive, are durable and people know how they will work.

On a large recent project, we performed a life cycle cost evaluation and silicone tube membrane diffusers were determined to have the lowest life cycle cost. They claim less fouling/aging and are able to install more diffuser area leading to a higher transfer efficiency and a to lower projected operating costs over a twenty-year life cycle. We have made some creative contractual attempts to hold them to these claims.

What are some trends with Dissolved Oxygen (DO) and Most Open Valve Control (MOVC)?

The EPA Fine Pore Aeration Systems Design Manual, published in 1989, first described these controls. At that time, the most common approach was to control aeration blowers by a header pressure set-point. If blower air pressure doesn't meet the set-point, blowers ramp up or an additional unit is turned on. Meanwhile in the basins we have a Dissolved Oxygen (DO) Probe, modulating valve and sometimes a flow meter per zone. It used to be we'd have a complete mix activated sludge system with the intent being to evenly distribute air throughout the whole basin.

On the control side there is room to save energy as well. Depending upon what your permit requirements are, you might be able to turn the air off or reduce the DO requirements, in certain zones or during certain time periods at the WWTP. In the past, the DO probes would foul and weren't reliable. The technology has improved and some of our plants are reporting very reliable operation with certain technologies such as the luminescent DO probe.

Some older plants have DO control but not MOVC. When it's added, you can lower discharge pressure and save, on average, five percent of power consumption. The idea of Most Open Valve-Control (MOVC) is we don't want to build pressure at the blower just to waste it at the basin valves by throttling them excessively. The intent is to keep the valve completely open, for the zone needing the most air, and throttle the others just enough to get the right air flow split.

A bigger issue was the MOVC's were integrated by low bid integrators that may never have worked on a wastewater aeration system before. While the larger wastewater engineering firms (Black & Veatch and others) are proficient at writing control descriptions, they key to making these system function smoothly is in tuning, time delays, and deadbands.

BLACK & VEATCH SPECIFICATIONS FROM DIFFUSERS TO BLOWERS

Setting these parameters requires an integrator with DO control experience. Without that experience, problems such as valve-hunting frequently occurred. This can happen when a dynamic system changes too rapidly. This results in valves turning on/off constantly and valve actuator motors may even burn out causing reliability and maintenance problems. We are aware of wastewater plants that simply disabled the MOVC because of the problems .

Aeration blower vendors now supply DO controls, don't they?

Yes and we'd like to think we helped start that trend! Due to the issues the inexperienced integrators had, we began building DO control integration into the aeration blower specification. Many blower vendors now provide a complete scope including basin control. Some do it in-house or they work with an experienced integrator so they can provide single-source responsibility. If we know a blower vendor does not have this experience, we will require them to hire one of a short list of integrators as a sub. We know the integrators we name have the necessary experience. Specifying integrators with experience has resulted in properly operating MOVC systems which save energy and significantly reduce maintenance issues.

I'm hearing more about flow-based controls, how's that going?

A more recent innovation is to control the aeration blowers off of total air flow instead of header pressure. In order to know how much air is going to the basins, we have to sum all the basin flow meters. Blowers are almost never installed with dedicated flow meters for each. Blowers are programmed to respond to flow requirements as needed and within their performance curves.

The advantages of systems which use total air flow control for the blowers is they are, as a rule of thumb, two percent more energy efficient and provide faster recoveries from a process upset - such as sudden change in plant load. Header pressures vary more with flow-based systems. With flow-based controls, we have to be very careful with who the integrator is. Do they have experience with total air flow-based control systems or do they only understand pressure based control? Do their references indicate their flow-based systems operate reliably? Advancements made by the blower manufacturers in blower surge controls,

including continuous monitoring by PLCS, are also making flow-control more possible without the risk of forcing a blower to surge.

What impact are Biological Nutrient Removal processes having?

Before Biological Nutrient Removal (BNR) processes were common, aeration basins tended to be more like completely mixed basins and over-aeration wasn't a process detriment. In these basins a single point of aeration control was considered adequate if energy was not a big driver; for example when power was cheap. This strategy isn't good enough for BNR processes where over-aeration is not only costly but also detrimental to the process itself. If we are doing a BNR process, we have a recycle from the end of the aerated part of the basin back to the unaerated part where the nitrogen is removed and having oxygen carrying over into anaerobic or anoxic basin zones results in diminished performance. You have to get rid of oxygen to do this and independent control of DO levels throughout the basin becomes important. We have to taper the air flow for the series of zones we now have in each basin and get more air at the upstream oxic or aerated zones because it is a plug flow process.

Now that we aren't distributing air equally to each basin, we do need a modulating valve and flow meter per zone. The purpose of the flow meter is to provide feedback to the system to which indicates whether the DO/air flow set point is being met. We have two control loops- one per zone in the basins plus the blower control loop based on either header pressure or total air flow. You want these two control loops to interact. If the zone with the most-open valve is getting too much air, in a pressure-based control system, the header pressure needs to adjust downwards slightly (like 1/10th of a psi), so blowers deliver less air. You want the two control systems to interact, and they interact at the blower header set-point.

How do you set the DO specification for BNR?

The process must provide adequate oxygen to fully nitrify (fully convert ammonia to nitrate). When flows and ammonia loads increase, the process must convert more ammonia to nitrate in a shorter retention time. This will require more air but can also be ensured by reaching the DO concentration adequate to ensure the maximum biological rate.

However, there are advantages to cost and performance to operating at lower DO set points. If you want to realize the benefits of lower DO operation but need to nitrify consistently, then you need to have dynamic controls to respond to changes in ammonia loadings. This might mean the plant can decrease the DO set-point from the standard of 2 mg/L to 1 mg/L or even below, for example. A rule of thumb on energy savings we use is this; a 1 mg per liter drop can translate to a 12% reduction in power consumption. So if you reduce the DO setpoint to 1 mg/L, you can reduce energy consumption by 12%.

Do most plants have a fixed DO level?

In the early years, most plants had a varying DO because it simply wasn't controlled! Now we are varying DO levels from zone to zone. If there's a wet weather or loading event, an ammonia reading can drive a higher DO set-point. Zone 1 will normally have a higher DO requirements, while in the later zones we might be able to run lower DO levels and save some energy. For example, the DO Level might be 2 in Zone 1 while it's 1 in Zone 2.

Other factors impacting DO level requirements to fully nitrify are inhibitory constituents in the wastewater and the regulatory permits driving local effluent requirements. Most of the things we are talking about aren't going to reduce blower sizes and maximum air flow requirements as we still have to account for diffuser fouling/aging and maximum loading conditions/events. What they do impact, however, are average DO level and aeration blower power consumption.

This sounds like ammonia-based control.

Exactly; and there are some new ammonia based control systems/concepts coming out. The idea is to analyze ammonia somewhere in the process and utilize the ammonia information to adjust DO. You can then program the controls and respond to changing conditions using either a feed-forward or feed-back loop on ammonia. Some companies specializing in wastewater process controls, as well as the larger blower vendors and their controls subs are developing software to do this. The reference list, however, is short. As with all new technologies, evaluation is important to determine if it is right for you. Maintaining ammonia analyzers is a time-consuming task which must be done frequently. In some cases, the plants do not have the maintenance staff with time to handle this. However, as energy costs continue to increase and plant discharge permits become more restrictive, a life cycle cost analysis may be warranted to determine whether the additional maintenance is cost effective. BP

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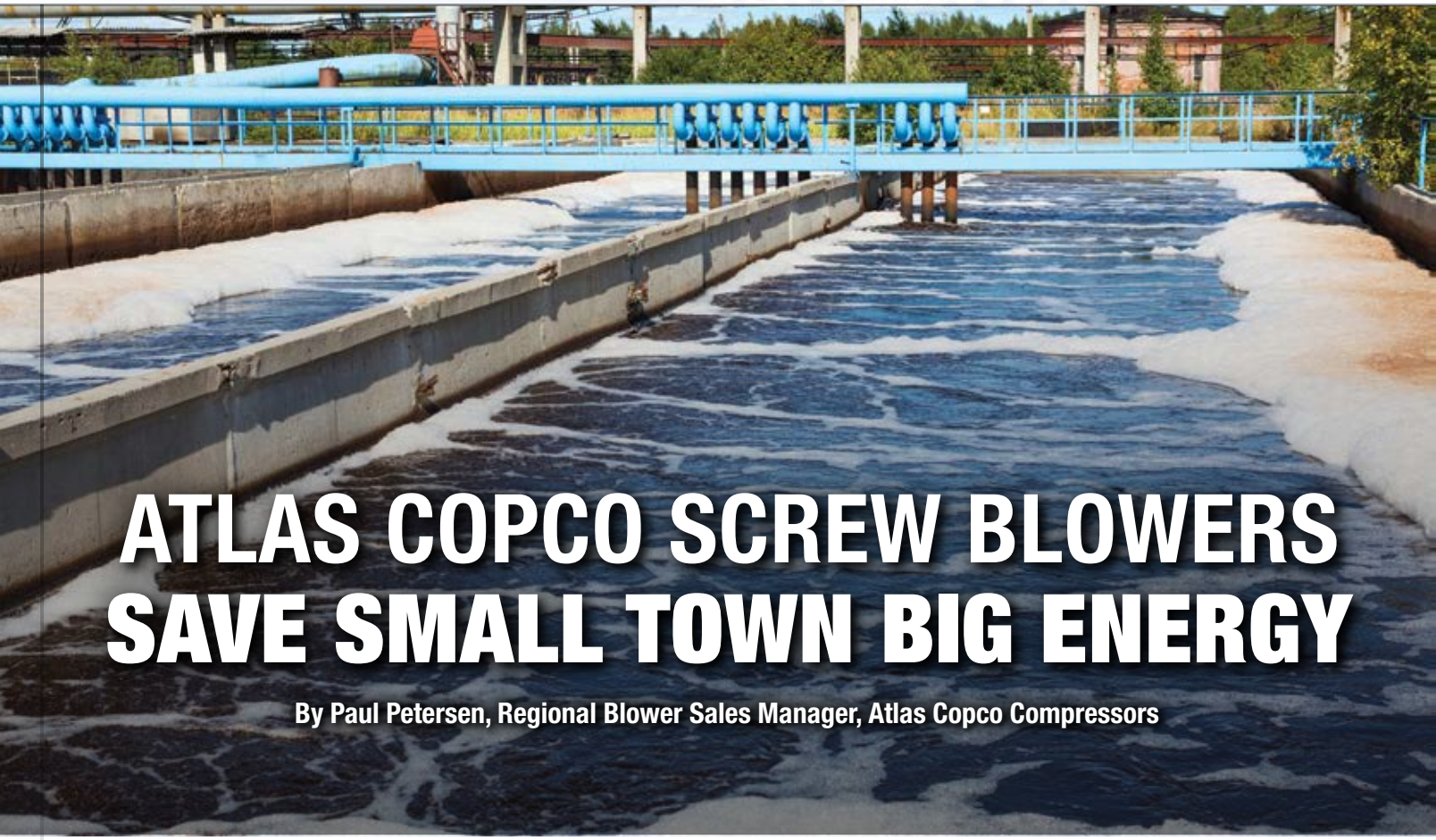

ATLAS COPCO SCREW BLOWERS SAVE SMALL TOWN BIG ENERGY

By Paul Petersen, Regional Blower Sales Manager, Atlas Copco Compressors

The wastewater treatment plant in the Town of Hurlock, Maryland provides service to approximately 2,100 residences. However, the majority of the water treated comes from a nearby poultry processing plant, giving the plant influent a high organic content. That is why the Town of Hurlock replaced its two million-gallon-per-day (MGD) lagoon plant with a 1.65 MGD four-stage activated sludge facility ten years ago. After construction was completed, operating costs of the new plant were significantly higher than before. This meant the town had to get creative in order to keep costs down for their ratepayers.

Why Upgrade?

The activated sludge process was developed in the United Kingdom in the early 1900s and is currently utilized in medium- to large-scale wastewater treatment plants. The activated sludge process separates the flocculants (suspended solids) from the wastewater through sedimentation. Effluent enters the aeration tank or lane, and low pressure air is introduced through a grid of diffusers. Water usually passes through the process in a few hours, while the sludge retention rates vary from a few days in warmer climates, to a few weeks in colder weather.

Although similar to the activated sludge process, lagoon aeration is typically used in rural areas with small- to large-sized plants. A series of shallow earthen basins (lagoons) act as the aeration basins and holding tanks. Although

> "In an effort to reduce energy consumption in 2015, the plant turned to the largest energy consumer in their plant. Blowers, for aeration and mixing, typically account for 40 to 75 percent of the total energy consumption in a wastewater treatment plant."
>
> — Paul Petersen, Regional Blower Sales Manager, Atlas Copco Compressors

lagoons are often equipped with surface aerators, there are several diffuser systems available specifically for these applications.

City of Hurlock Wastewater Plant Superintendent, Eric Barnhart, said the lagoon system was cost effective, but did not provide the desired quality of effluent they were looking for. The activated sludge treatment facility in Hurlock has won several awards. The plant was first named the Maryland Rural Water Association Wastewater Treatment Plant of the Year in 2008, before winning an award from the EPA in 2009 for operations and maintenance excellence. The problem, however, was that the new activated sludge plant used nearly 7 times as much energy as the old lagoon system (now averaging $18,000 per month in electricity).

Energy Savings

In an effort to reduce energy consumption in 2015, the plant turned to the largest energy consumer in their plant. Blowers, for aeration and mixing, typically account for 40 to 75 percent of the total energy consumption in a wastewater treatment plant. For the Town of Hurlock, the aeration blowers accounted for $7,000 per month of their total monthly $18,000 electrical cost. When the activated sludge plant was built, positive displacement lobe blowers (PD blowers) were installed to provide air to the aeration basins. Although only ten years old, the 75 HP lobe blowers were very inefficient. To understand why, one first needs to understand more about the technology.

Lobe-Style Blowers

The lobe-style blower invented in the 1800s remains very much unchanged today. The primary advancement in lobe technology over the past 150 years has not been improved efficiency, but reduced noise. Bi-lobe blowers produce very high amplitude pulsations

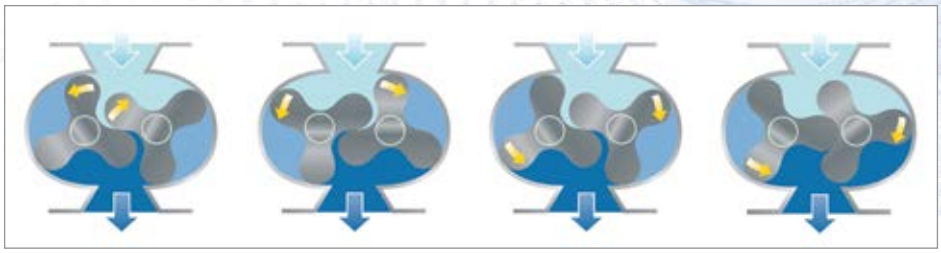

Figure 1: Lobe blower compression cycle

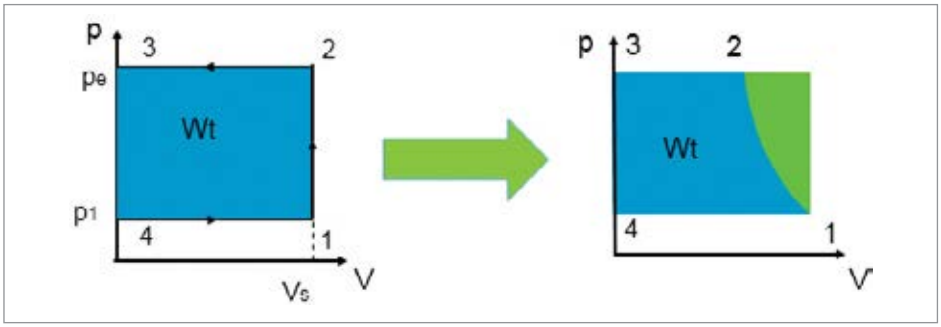

Figure 2: Compression cycle of a lobe blower (left) compared to the compression cycle of a screw blower (right)

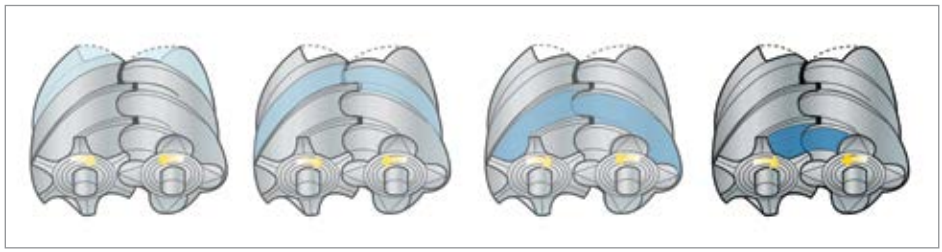

Figure 3: Screw blower compression cycle

at a low frequency. In order to reduce the amplitude and increase the frequency of the pulsations, a third lobe was added. While this innovation decreased efficiency slightly, it reduced noise levels to below 85 dBA as mandated by OSHA. Figure 1 shows the four stages of compression of a tri-lobe blower.

While lobe blowers are reliable and work well in many applications, their inefficiency is a big drawback. One of the reasons PD blowers are inefficient is due to rotor slip. Slip occurs when hot (compressed) air moves back to the inlet of the blower past the small gap between the rotors, and the rotor and casing. This means the hot air must be compressed again before being discharged to the system, reducing capacity and efficiency. In general, slip increases as pressure increases.

Another reason PD blowers are inefficient is due to external compression. As air passes through a PD blower, the actual compression of the air occurs at the discharge flange due to blowback of the receiver. A pressure versus volume graph (p-v diagram) of the lobe blower's four stage compression cycle is shown below in figure 2. The laws of thermodynamics dictate that the area under the curve is proportional to the amount of power consumed. Therefore, by

ATLAS COPCO SCREW BLOWERS SAVE SMALL TOWN BIG ENERGY

Figure 4: Existing 10-year old lobe blowers installed at the wastewater treatment plant of Hurlock, Maryland.

Figure 5: New Atlas Copco ZS55 blowers installed at the Town of Hurlock, Maryland wastewater treatment plant

reducing the volume of air during the compression cycle, the area under the curve can be reduced (AKA: reduced power). This reduction is accomplished by a rotary screw blower.

Rotary Screw Blower

In an effort to increase the efficiency of positive displacement blower technology, the rotary screw blower was introduced to the market in 2009. The rotary screw blower uses a helical screw profile, instead of lobes, to create internal compression of the inlet air. The screw rotor profile serves three purposes. First, the internal compression of air reduces energy consumption by 30 percent compared to traditional lobe blowers. Second, the helix of the rotor profile helps to reduce slip by creating a tighter gap between each of the rotors and the blower casing. Third, the helical rotor profile also eliminates the pulses caused by a lobe-style rotor. This means that screw blower noise levels are typically below 75 dBA, which is three to five times

"Now that the new screw blowers have been in operation for a few months, the difference between the two technologies has become apparent. The plant electrical cost has gone from approximately $18,000 per month to $16,800 per month, resulting in over $14,000 in energy savings each year."

— Paul Petersen, Regional Blower Sales Manager, Atlas Copco Compressors

quieter than conventional tri-lobe blowers. Figure 3 illustrates the compression stages of a rotary screw blower.

After learning the advantages of screw blower technology, the Town of Hurlock elected to replace two of their 75 HP lobe blowers with 75 HP Atlas Copco ZS rotary screw blowers. Both new ZS blowers were installed before the end of 2015, and have been running ever since. "We really like our Atlas Copco blowers," says Barnhart, "We are able to get more air out of them and use less energy than we did with our old lobe blowers." Figure 4, below, shows the old lobe blowers installed at the plant.

Now that the new screw blowers have been in operation for a few months, the difference between the two technologies has become apparent. The lobe blowers typically operate at 28 Hz on a VFD, and draw approximately 74.3 Amps. The Atlas Copco ZS75VSD rotary screw blowers consume only 67.5 Amps when operating at the same frequency. The plant electrical cost has gone from approximately $18,000 per month to $16,800 per month, resulting in over $14,000 in energy savings each year. According to Eric Barnhart, "We are saving about 30% in energy with the new Atlas Copco blowers."

Conclusion

The Town of Hurlock seems to be fully committed to sustainability. They have 5 acres of land housing 3,420 solar panels on 114 fixed-array tables. "We buy electricity from VW Energy, and it saves 10 to 12 percent on our electric bill," says Barnhart. "After 20 years, we'll save about $500,000 and the system will belong to us." The wastewater treatment plant will soon switch to all LED lighting, something that has already been done at the water treatment plant and town office building. With all of these plans in place, the town wants to handle the upgrades economically, says Barnhart. "Over the next three years, we'll phase out the other three blowers and replace them with the Atlas Copco models." BP

For more information please contact Paul Petersen, Atlas Copco, at tel: 803-817-7000, email: paul.petersen@us.atlascopco.us or visit www.atlascopco.us

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HOWDEN ROOTS DO CONTROL SYSTEM OPTIMIZES BIRD ISLAND WWTP

By Tim Hilgart, Sales Manager, Howden Roots

➤ A 180 MGD Challenge

Bird Island Wastewater Treatment Plant (WWTP) in Buffalo, N.Y., had an inefficient aeration control system that, ironically, had been installed in 1998 as an efficiency upgrade. The operating principle was that air flow to all 32 of the plant's aeration basins, or zones, would be properly controlled by an average of several Dissolved Oxygen (DO) level measurements taken by DO probes in a few of the basins. However, changes in tank loadings and physical dynamics, along with differences in oxygen transfer rates between diffuser grids, prevented a uniform air flow in the aeration zones. The plant also struggled to accurately adjust the air flow from the blowers because the 60-second open/close travel time of the valve actuators was too short.

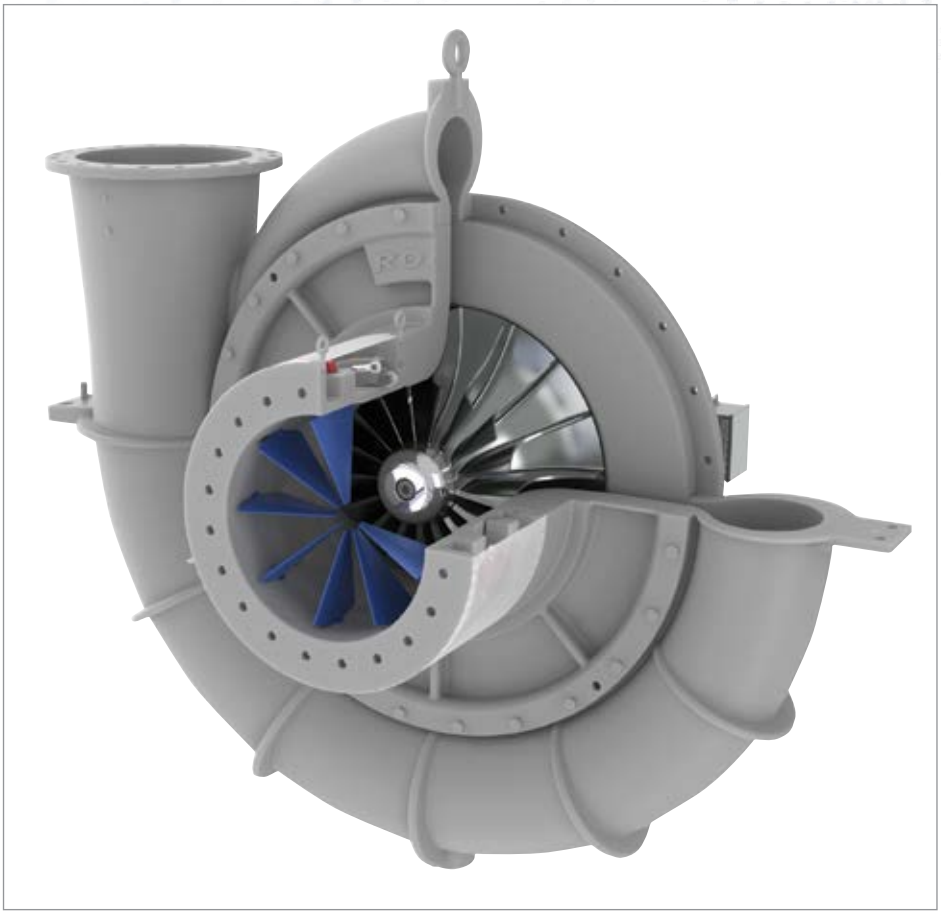
By 2008, the Buffalo Sewer Authority (BSA) decided it had to cut the energy consumption of the blowers, which used more energy than any other part of the plant. To make that happen, the plant would have to get a new system that independently controlled each aeration basin. Bird Island, the second largest wastewater treatment facility in New York State, with a dry weather design flow of 180 million gallons per day (MGD), had obtained four 5,000 HP Roots single-stage compressors back in 1980, two of which had been rerated to 3,000HP in 1995, and after looking at product options for two years, BSA turned to Howden Roots for another solution to Bird Island's aeration control problems.

Tim Hilgart, Sales Manager, Howden Roots

"DO-to-Flow" Concept Eases Header Pressure

Howden Roots worked with BSA to change the aeration control plan for Bird Island and also recommended the replacement of the old valve actuators with RCS actuators that had a 180-second open/close travel time. In the fall of 2011, Howden Roots began operating the largest-ever installation of its Roots IntelliView Controls system at Bird Island's aeration basins. The system, comprised of RCS actuators and a Roots Aeration Master Control Panel with a remote access VPN portal, has been successfully deployed at more than 300 wastewater treatment plants in the U.S.

Key to its operation is a flow-based configuration where individual DO probes calculate the air flow required for each basin. The accumulated data determines the total flow demand for all basins, and the necessary adjustment in air distribution is communicated to the blower panel. Part of this "DO-to-Flow" concept is the use of



Howden Roots Single-Stage OIB Centrifugal Compressor

"true" Most-Open-Valve logic, where at least one valve always remains in the fully open position. This sets a positive domino effect in motion that eases system header pressure, lessens the load on the blowers, and finally reduces the amount of energy needed to move the required volume of air.

BSA applied to the New York State Energy Research and Development Authority (NYSERDA) for partial funding to defray the estimated $800,000 project cost. BSA documented an expected annual savings of 3.8 million kWh equaling $345,000. This would be accomplished by lowering average DO levels from 3.1 milligrams per liter (mg/L) to 1.5 mg/L. NYSERDA was willing to pay for up to 50 percent of the project, and conducted a measurement and verification review to test those assumptions.

Control System Reduces DO Levels and Limit Fluctuations

Roots IntelliView controls significantly improved the stability of the plant's aeration process, and because the system also handles fluctuations in loading, the plant has been able to operate some of its aeration basins at a DO set point well below the norm – 0.75 mg/L in the first pass of each basin – and keep DO levels within a very narrow range. This has provided additional energy savings. "The system offers a logical approach that makes decisions like a plant operator would when controlling DO levels in the activated sludge basin," says James Keller, former BSA treatment plant superintendent at Bird Island.

NYSERDA's completed review showed that annual energy savings would be even greater than expected because of the aeration control system's success in holding DO levels down and limiting their fluctuations. The findings led NYSERDA to furnish half the total project cost. That generous incentive payment gave BSA a very quick full return on its investment.

Lessons Applied

Having a reliable DO Control system allows plant operators the flexibility and comfort to make process modifications without having to worry about the control systems ability to handle system upsets (i.e. Dump loading, Rain events, etc.). Howden Roots has since applied our DO Control Systems to many advanced Biological Nutrient Removal systems. Having reliable DO Control allows operators to "dial-in" DO targets in control zones for optimum Nitrification and De-Nitrification operations in the system. Designed around current plant capacity and configuration, we can design a control system that will make sense from both a process and an economical basis.

About Howden Roots

Howden Roots Intelliview Controls for DO Control Systems have been supplied to numerous facilities worldwide regardless of the equipment manufacturer. Howden Roots Intelliview controls are fast becoming the Industry standard for superior process control coupled with industry leading results in energy efficiency. BP

For more information contact Tim Hilgart, Howden Roots, tel: 414-702-7425, email: Timothy.Hilgart@howden.com, www.howdenroots.com

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AERATION BLOWER REQUIREMENTS

By Tom Jenkins, JenTech Inc.

Aeration blowers receive a lot of attention from design engineers, suppliers, and end users. That is understandable since blowers account for more than 50 percent of the energy used in a typical wastewater treatment plant (WWTP). They represent "low hanging fruit" for energy conservation measures in wastewater treatment!

In some industries blower applications are specified with a single operating point consisting of the design flow and discharge pressure. Municipal wastewater treatment applications, however, usually require blower systems that provide a spectrum of flows and discharge pressures. Although this can be frustrating for suppliers, it reflects variability in the treatment process. Understanding the variable process demands on the system is critical to optimizing the performance of the blowers.

Basic Wastewater Treatment Process

Sewage isn't inherently poisonous. The destruction of aquatic life that results from wastewater discharge is caused by oxygen depletion. Microbial metabolism depletes water's dissolved oxygen below the level needed to support aquatic organisms. Municipal wastewater processes are designed to concentrate and accelerate the metabolism of pollutants in the WWTP, minimizing the impact on the receiving water.

Figure 1 shows one of many process arrangements in municipal WWTPs.

Primary treatment removes solids from the wastewater. Primary treatment may include screens, grit removal tanks, and primary clarifiers. Clarifiers are essentially large basins where low turbulence allows solids to settle to the bottom for removal to additional treatment. The wastewater then goes to secondary treatment. Secondary aeration is the principal WWTP application for blowers.

In the aeration basin microorganisms (sludge), a food source (pollutants in the wastewater flow), and oxygen are brought together. This results in controlled metabolism of the pollutants. The oxygen is typically supplied by blowers and the air is bubbled into the bottom of the basin.

From the aeration basin the wastewater flows into another set of clarifiers. Treated wastewater passes out for additional treatment and/or disinfection. Most of the settled microorganisms are returned to the aeration basins to continue metabolizing pollutants. They are referred to as Return Activated Sludge (RAS). Reproduction of microorganisms in the aeration process produces an excess population, which is removed as Waste Activated Sludge (WAS).

Blower Functions

The air supplied by the blowers to the aeration basin has several functions. The first is to supply oxygen needed for metabolizing organic compounds in the wastewater. The organic compounds are referred to as "BOD_5" (biochemical oxygen demand), named after the 5-day test used to measure the concentration of these compounds. The

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AERATION BLOWER REQUIREMENTS

oxygen must be dissolved in the wastewater in order to be used by the microorganisms. The diffusers use tiny bubbles of air to efficiently dissolve oxygen into the wastewater.

Additional oxygen is required when microorganisms convert ammonia (NH_3) into nitrate (NO_3), a process known as nitrification. Nitrification often represents half of the total process oxygen demand.

The combination of sludge and wastewater in the aeration basin is called mixed liquor. The air supplied by the blowers creates turbulence in the mixed liquor to maintain the sludge in suspension. Mixing also keeps the contents of the aeration basin homogeneous. In many plants mixing limitations, rather than oxygen demand, dictate the minimum air flow rate. A typical value for mixing air flow is 0.12 SCFM per square foot of aeration basin plan area.

Most diffusers have an upper limit on air flow rate to prevent physical damage. The maximum flow varies with diffuser design.

Basics of Determining Air Flow Rate

The first problem for many blower suppliers is understanding the units of air flow. The process demand is based on the mass flow rate of oxygen needed to treat the wastewater, so designers generally specify the required mass flow rate of air. However, this mass flow rate is expressed as Standard Cubic Feet per Minute (SCFM). This is confusing because it looks like a volumetric flow rate. The key factor is that "standard" defines the air to be at 68°F, 14.7 psia, and 36% Relative Humidity. This in turn establishes the density as 0.075 lb/ft^3. The effect of humidity can usually be ignored, making conversions to volumetric flow straightforward:

$$ACFM = SCFM \cdot (460+T)/528 \cdot 14.7/p$$

ACFM	=	volumetric flow rate
SCFM	=	mass flow rate
T	=	temperature, °F
p	=	absolute pressure, psia

The process demand for air can be estimated if the flow rate of wastewater and the concentration of pollutants are known:

$$SCFM = (0.335 \cdot mgd)/OTE \cdot (ppm\ BOD \cdot 1.1 + ppm\ NH_3 \cdot 4.6)$$

SCFM	=	required mass air flow rate
mgd	=	wastewater flow rate, million gallons per day
OTE	=	oxygen transfer efficiency, decimal
ppm BOD	=	concentration of organic pollutants, parts per million
ppm NH_3	=	concentration of ammonia, parts per million

One of the difficulties of specifying aeration blower flow is that the process rarely operates at steady state. Rain events or snow melt can dramatically change both hydraulic loading (wastewater flow) and organic loading (combined BOD and NH_3). Wastewater temperature varies seasonally - affecting microorganism metabolism and OTE. Slug loads from industrial discharges or internal plant side streams will increase organic loads.

Treatment plants are designed to meet the peak load projected twenty years into the future. The process equipment must be sized to meet the worst case loading at that future date. The result is that WWTPs usually operate at loads well below their capacity. Most facilities are operating at approximately one third of design loads.

The most important loading variation for most plants is the diurnal (daily) fluctuation in load associated with normal human activity.

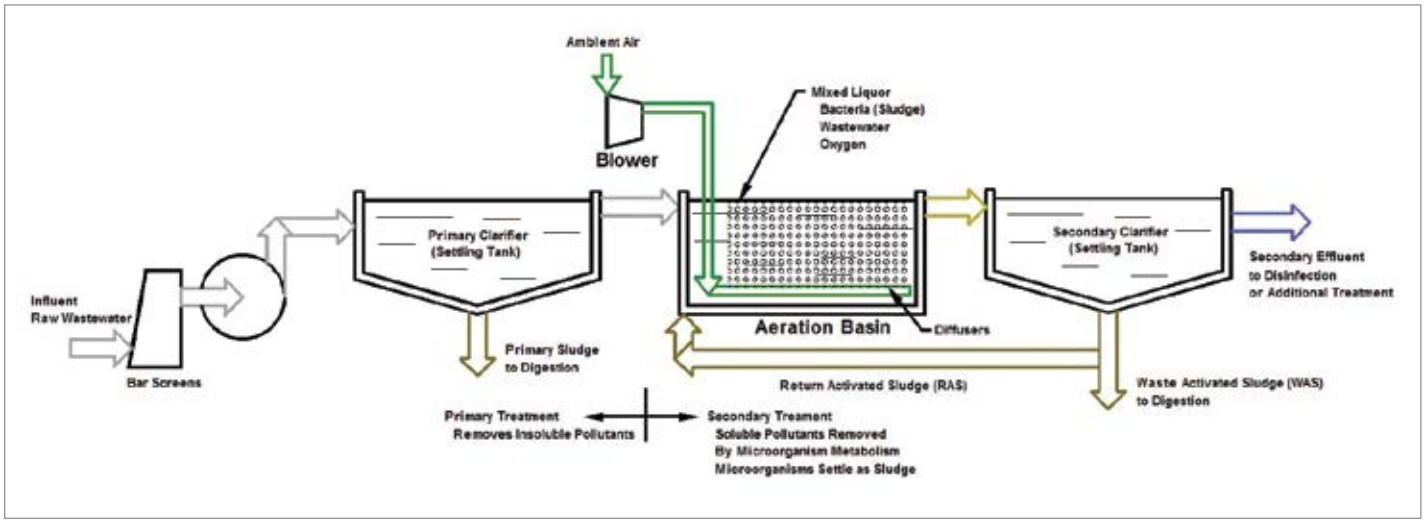

Figure 1: Typical WWTP Process


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As Figure 2 illustrates, the process load shows a 2:1 range between nighttime low and daytime peak.

A final complicating factor in establishing air flow is the impact of ambient conditions on air density. Blowers are essentially volumetric machines. Because the air density is lower in summer than in winter, the volumetric flow rate in summer must be higher than in winter for identical mass flow rates.

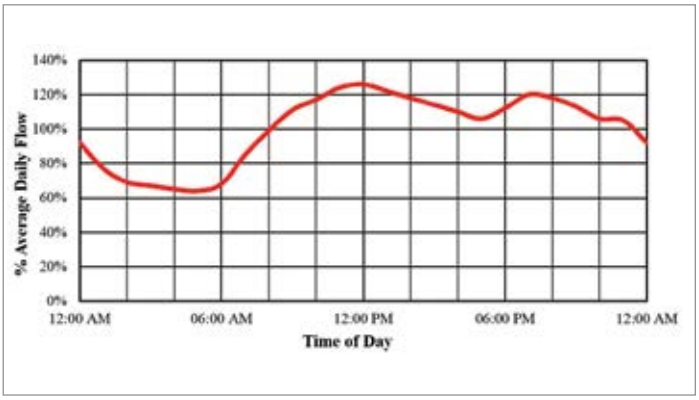

Figure 2: Typical Diurnal Loading Pattern

The consequence of all these variations is that the blower system rarely operates at one specified design point. Another result is that turndown is a critical parameter in optimizing process performance and providing satisfactory blower system operation. Most individual blowers only provide 50% turndown. A minimum system turndown of 80% is needed in most WWTPs to satisfy process requirements:

Turndown = $(q_{max}-q_{min})/q_{max} \cdot 100$
Turndown = ability to reduce blower flow rate, %
q_{max}, q_{min} = maximum and minimum blower or system flow rates

Turndown is more critical to optimizing blower energy consumption than efficiency. Supplying excess air wastes more energy than the savings available by using a more efficient blower. An oversized blower with the highest best efficiency point (BEP) may not provide the lowest energy consumption for actual operating conditions.

Regulatory agencies require standby blower capacity: the system must be able to provide design air flow with the largest blower out of service. Many designers provide two blowers at 100% of design capacity in order to minimize equipment cost. This arrangement will result in 50% system turndown – much lower than needed. Another common arrangement is

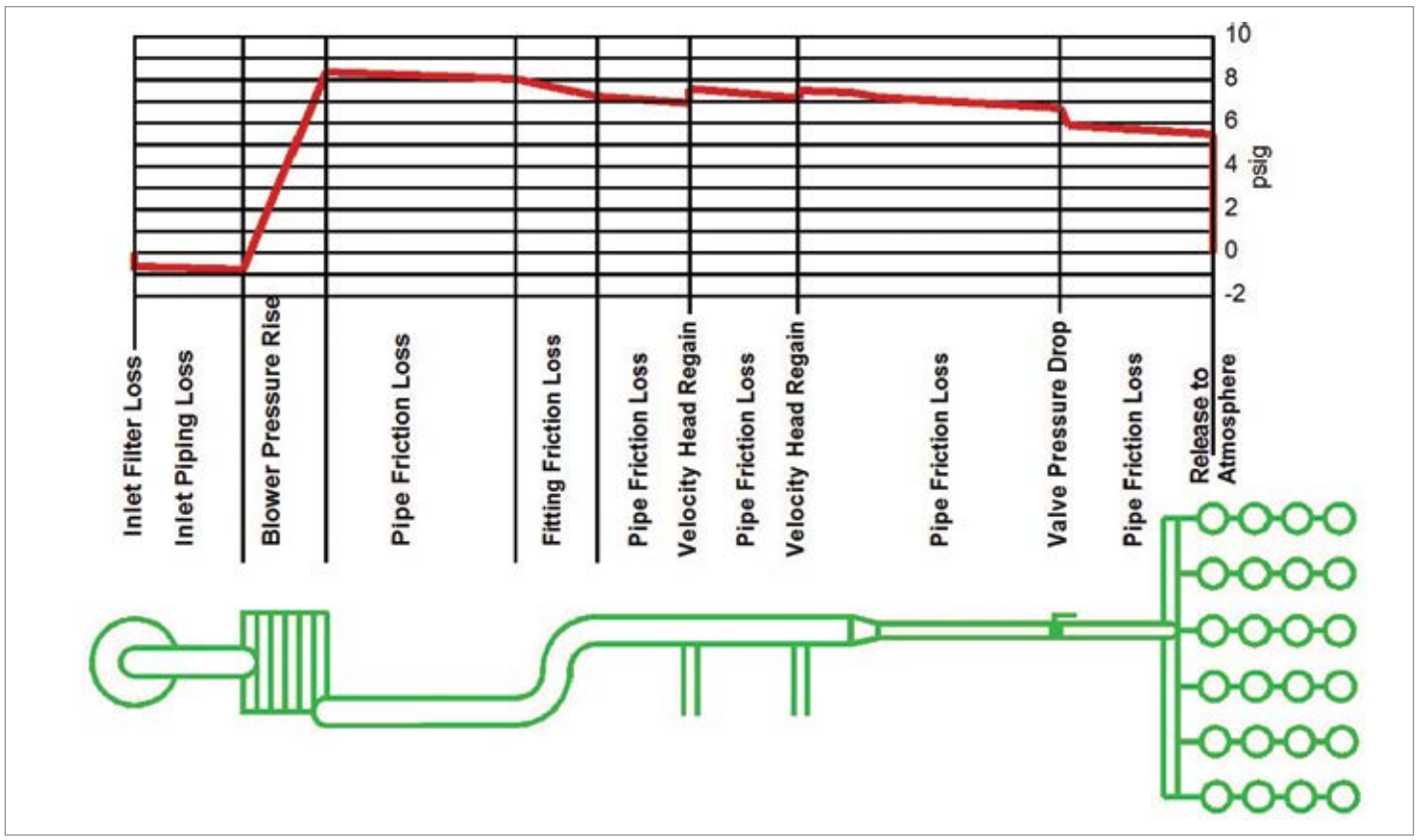

Figure 3: System Pressure Grade Line

three blowers - each with a capacity of 50% of design flow; this provides about 75% turndown.

A better arrangement is four blowers. Each may be sized to provide 33% design capacity; the resulting turndown is 83%. Alternatively, two may be sized at 50% design flow and two at 25% design flow; then 88% turndown can be achieved.

Basics of Determining Discharge Pressure

Once the air flow rates for the system are established, it is possible to define the discharge pressure – the second parameter needed to make a blower selection. As with air flow, the discharge pressure in most WWTPs is not a single value but rather a range of values.

It should be noted that blowers produce air flow, not pressure. The process resistance to air flow creates pressure. The blower must be capable of overcoming that pressure at a given air flow. If this seems counterintuitive, consider a blower operating without discharge piping. The result would be zero pressure, but lots of flow!

The most substantial portion of the system resistance to flow is due to the submergence of the diffusers. The resulting static pressure is essentially constant:

p_{static} = d/2.31
p_{static} = static pressure, psig
d = depth of submergence at top of diffuser, feet

Air distribution piping, fittings, and valves create friction. The resistance to flow is proportional to the square of the air flow rate:

$\Delta p_{friction} = k \cdot q^2$
$\Delta p_{friction}$ = pressure drop from friction, psig
k = empirical constant for a given piping system
q = air flow rate, CFM

When air is drawn off a common header at multiple points, the velocity changes. This results in an increase in pressure from the change in velocity head. In some systems this change is negligible, but in others it may affect air distribution between basins:

$p_{velocity} = (\rho \cdot V^2)/(3.335 \cdot 10^7)$
$P_{velocity}$ = velocity head (pressure), psi
ρ = air density, lb_m/ft^3
V = air velocity, feet/minute

The gradient in air pressure throughout the distribution system is a function of air flow, static pressure, friction, and velocity head. This is illustrated in Figure 3.

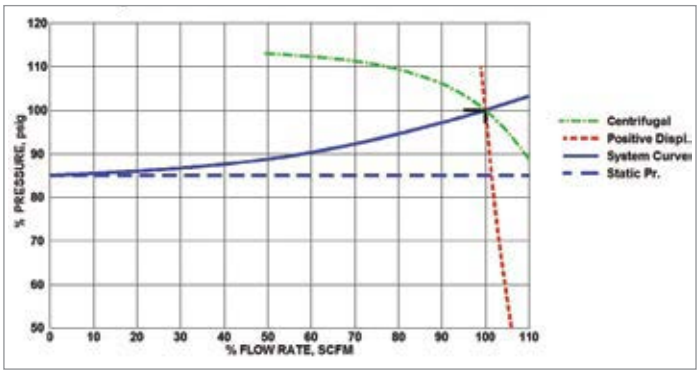

Figure 4: System Curves and Blower Performance

Further complicating blower selection is the potential impact of air density on a blower's pressure capability. The pressure rise through a centrifugal blower is reduced at lower air density. Centrifugal blower discharge pressure should be specified at the highest anticipated ambient temperature and lowest barometric pressure. Positive displacement (PD) blowers can create any pressure needed in overcoming the resistance to flow – up to the point a relief valve opens or system damage occurs – regardless of density variations.

The system curve and the blower characteristic curve must be plotted together to determine the operating point of the blower system. An example is shown in Figure 4. The intersection of the two curves establishes the flow rate. Note that the curve for the centrifugal blower is only applicable at one set of inlet conditions.

Summary

Blowers for wastewater aeration are part of a complex treatment system. The process demand for air is constantly changing. Supplying one blower operating at a single flow rate and discharge pressure is unlikely to meet the system requirements.

A good design will include considerations of variable process demand, current and future loadings, and the impact of ambient conditions on performance. The resulting specification should identify the range of operation the blower system must cover. BP

For more information contact Tom Jenkins, President, JenTech Inc., email: info@jentechinc.com, www.jentechinc.com

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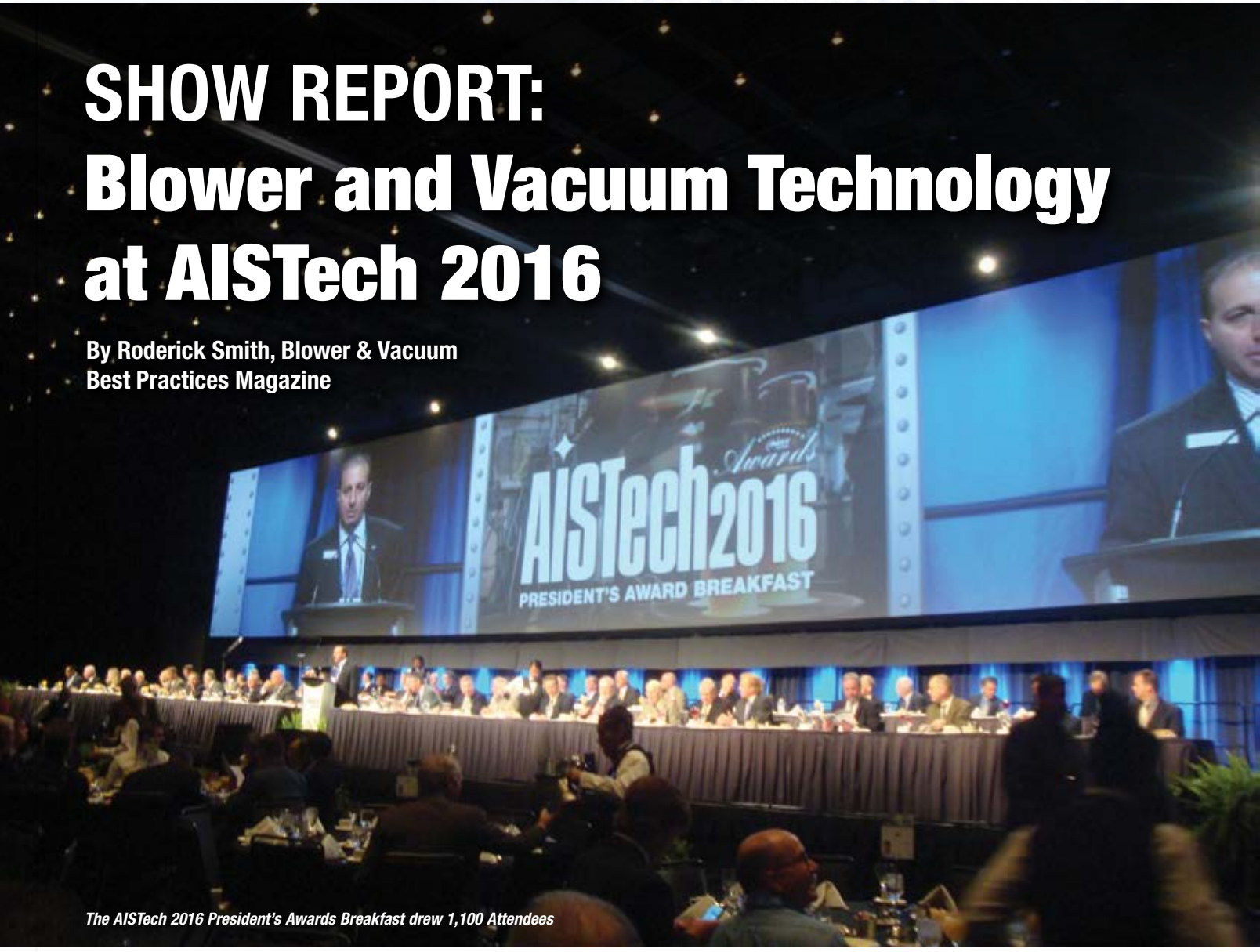


The AISTech 2016 President's Awards Breakfast drew 1,100 Attendees

AISTech 2016, steel's premier annual technology event, returned to Pittsburgh May 16-19 at the David L. Lawrence Convention Center. For the first time ever the exposition spanned two levels of the convention center making it the largest yet with a total of 542 exhibiting companies. The total attendance of 7,764 was the third highest in AISTech history.

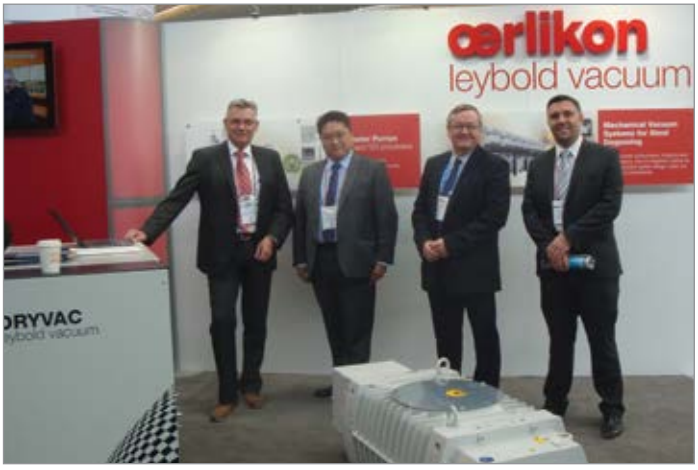
Air Separation

The Aerzen booth was excited about recent growth in operations and product lines. Tim Manthey, the Manager of the Process Gas Division said, "Aerzen USA has been on a growth path over the past several years. We have opened a new office in Houston, Texas and in July celebrated a groundbreaking event to further expand manufacturing, warehouse and office space at our headquarters in Coatesville, PA." Lead Application Engineer Tim Grady said, "Aerzen has a brand new line of air separation blowers. They are very large rotary lobe blowers designed for the air separation industry. Designed to be very efficient and very reliable, you can direct-drive them. This new line will likely eventually replace all of our large blowers."

Optimizing Steel Degassing

Dr. Derek Corcoran, at the Oerlikon Leybold booth, was kind enough to discuss the trend towards Mechanical Vacuum Pumps in steel degassing applications. "The steel degassing systems in mills are moving away from steam ejector systems to mechanical vacuum pump (MVP) systems due to very significant environmental, quality, maintenance and cost benefits. Oerlikon Leybod MVP systems are designed with smaller

Tim Grady, David Szabo, and Tim Manthey at the Aerzen USA booth (left to right).



Hans-Jürgen Blum, Ricardo Toshiro, Nick Jones, and Dr. Derek Corcoran from Oerlikon Leybold Vacuum (left to right).

modular systems using frequency drives to provide flexibility, efficiency and redundancy."

Dr. Corcoran showed us that the top row of a steel degasser would consist of 7 or 8 blowers on top, using their largest roots-type blower, the WH 7000, which is equipped with a frequency drive. "Typically you'll have 4 or 5 of these skids providing 200,000 to 1 million cubic meters per hour in total pumping speed. The advantage of these small roots blowers is the built-in redundancy allowing one to be changed if necessary. The roots blowers are the big air gulpers delivering air to the dry screws for final compression."

Two blowers are always located on the interstage and are followed by dry screw DV pumps. "The final compression stage is done by the DV1200 which is made up of two DV650 pumps. These are twin dry running screws (oil only in the gearbox) using a single motor. We

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Theron Everett, Matt Murray, and Mike Charnak presented a new model of the GXS Dry Screw Vacuum Pump line at the Edwards Vacuum booth (left to right).

Dan VanderPyl is the President of Sonic Air Systems

Juliet Molina and Keith Timmons at the Silvent InTech booth (left to right).

believe this is one of the best dry screws on the market due to it's strong resistance to and stability in dusty environments- plus a long bearing life."

Oerlikon Leybold is headquartered down the road in Export, PA where all these systems are configured, engineered and assembled. Corcoran continued, "Each system is custom-built and varies in configuration. There are several different steel degassing techniques. All require very fine control of pumping speeds, from half a mbar all the way to atmosphere. We have frequency drives on the blowers controlling the low pressure end of the range. For the high pressure range, where customers are using oxygen to blow in, we use a special valve at the top to provide fine control. Pumping speed control enables the customer to control the system to provide higher quality steel."

Secondary Metallurgy Vacuum-based Steel Degassing

Edwards claims to have the largest installed base of dry vacuum pumps in the global steel industry. Marketing Specialist Matt Murray said, "Edwards also has the world's largest mechanical vacuum pumping system installed in China. Used for degassing 230-ton batches of liquid steel, the system has a pumping capacity of more than 1 million meters cubed per hour at 0.67 mbar!" Murray described why secondary metallurgical processing is switching from steam ejectors to dry mechanical vacuum systems. "Lower running costs and improved productivity are just two of the reasons. Dry pumps have been proven to reduce energy costs by as much as 97% compared to steam ejectors."

Murray pointed us to their Steel Degassing brochure where we learned a bit about the secondary metallurgy vacuum-based treatments listed below. Edwards modular vacuum system designs enables degassing and decarburizing melt sizes up to 200 tonnes in electric steelmaking facilities.

- VD: Vacuum Degassing for alloy steels
- VOD: Vacuum Oxygen Decarburising for stainless steels
- VDOB: Vacuum Degassing Oxygen Blowing
- VDC: Vacuum Carbon Decarburising for low and ultra-low carbon steels

The big-dog (that's my own technical term), large, integrated steel making facilities use Ruhrstahl Heraeus (RH) secondary metallurgical systems. Edwards has developed "super degasser" modules to address these high volume flow rates reaching up to 1 million cubic meters per hour.

Blow-off Air Engineering

Dan VanderPyl is the President of Orange County, California-based, Sonic Air Systems and someone who is invited, by utility incentive rebate managers, to do seminars on blow-off air optimization. At AISTech 2016, they were showing the newest Sonic 350 blower model used in steel industry applications. The new unit no longer uses a belt-drive, rather a VFD motor requiring no maintenance. VanderPyl commented, "We've been selling a belt-driven 350 to the steel industry for 16 years. The reductions in steel industry maintenance staffs have created demand for VFD motors which obviously do not require belt-maintenance."

The company sells blowers and air knives based upon quality and energy efficiency. The opportunity is particularly ripe when the client has been using compressed air. VanderPyl said, "In a typical rolling mill, using one of our blowers almost always provides 75% reduction in energy consumption (vs. an air compressor). A typical application can be two 50 hp blowers for us - replacing 400 hp in air compressors. ROI's can often be one year or less for projects like this." He emphasized that air compressor should be used for "high pressure applications", not for open-blowing. "We are a blower manufacturer which focuses on engineering customized air systems (including air knives, blower, piping) able to reduce energy costs and improve quality." We are a blower manufacturer that can do air engineering using air knives.

We also spoke with Keith Timmons, the Managing Director of Silvent in North America. "Today we are presenting the Silvent InTech Division which is focused on steel works. One problem steel works have is with the quality of steel. Emulsions are placed on the steel and need to be removed effectively to avoid staining." Timmons went on to say that Silvent Intech has designed an air header specifically for this application called the "Air Plow. "We customize each Air Plow according to the mills' speeds and are able to reduce compressed air use while maximizing emulsion-removal effectiveness."

Cooling Systems

At the Hydrothrift booth, Bruce Williams and Ron Lair were discussing industrial cooling systems for the steel industry. In particular, they were focusing on Hydrothrift's ability to repair, rebuild and remanufacture heat exchangers. They service a long list of heat exchanger technologies; shell and tube, plate and frame, plate coil, "u" nest, coil, integral fin, wound and plate fin, serpentine and surface enhanced.

We met Dave Yolton and Mark Carrothers at the Cooling Tower Depot booth. We were impressed by how excited they were about their

Bruce Williams and Ron Lair at the Hydrothrift booth (left to right).

Dave Yolton and Mark Carrothers at the Cooling Tower Depot booth (left to right).

Eizo Kitamura, Robert Winsand, and Dieter Geisensetter from Ross Controls

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company. Special Projects Manager Yolton said, "We believe we have the highest quality products on the market and they are Made in the USA, designed in-house and fabricated in Texas and Colorado." They told me they have offices in 13 cities around the country and gushed about an online tower designing app. National Sales Manager Carrothers commented, "We have a free web-based program, free to users, which will provide them with a tool to input specifications and optimize a cooling tower design on their own. It even provides pricing!"

Conclusion

Last but not least, Ross Controls has been around since 1921 and their legacy products are found in countless process industries. The company presented me with a "global leader in fluid power safety" brochure. Speaking with Global Industry Manager-Metals Group, Robert Winsand, at their booth, the safety focus was evident. "We focus on four main safety areas: energy isolation, critical control of hazardous cylinders, hose whip protection and hearing protection." Within the energy isolation topics, Winsand focused on manual lockout tagout (LOTO) and electro-pneumatic LOTO. "In all process industries, electro-pneumatic safety controls is something we focus on. We bring Safety Teams to the site and conduct onsite training on current safety standards and best practices. We are proud of our knowledge on how to integrate safety and electro-pneumatics to comply with OSHA Standards." BP

AISTech 2017 will be held May 8-11, 2017 in Nashville, Tennessee. For more information please visit www.aist.org

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"In all process industries, electro-pneumatic safety controls is something we focus on. We bring Safety Teams to the site and conduct onsite training on current safety standards and best practices."

— Robert Winsand, Global Industry Manager-Metals Group, Ross Controls

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Advertising & Editorial: Rod Smith
rod@airbestpractices.com
Tel: 412-980-9901

Subscriptions & Administration: Patricia Smith
patricia@airbestpractices.com
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