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COLUMNS

FROM THE EDITOR

Industrial Blower & Vacuum Systems

We are very grateful to David Aguirre, from Tuthill Vacuum & Blower Systems, for supplying an excellent article on applying vacuum pumps to chemical distillation processes. This is truly one of those articles to keep in the drawer for future reference.

Pneumatic conveying systems cannot compromise process quality, safety and compliance with Good Manufacturing Practice (GMP) challenges. Doan Pendleton, from VACU-U-MAX, has generously provided our readers with a glimpse of how their client, A&C, works with them to meet these challenges. A&C is a custom manufacturer and supplier of excipients, process solutions, buffers and Active Pharmaceutical Ingredients.

Aeration Blower Systems

We were fortunate to interview Joseph Cantwell, from Leidos Engineering, about their work with Wisconsin's Focus on Energy. He says their combined efforts have helped wastewater treatment plants in the dairy state save more than 726 million kWh and more than 52 million therms of natural gas since 2014!

In the second of his two-part series on aeration control valves, Tom Jenkins of JenTech Inc., now writes on interactions between valves and discusses new flow control technologies.

Please consider registering to attend the 2019 Best Practices Expo & Conference, taking place October 13-16, 2019 at the Music City Convention Center in Nashville, TN.

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

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BLOWER & VACUUM TECHNOLOGY PICKS

Atlas Copco Launches DHS VSD+ Range of Dry Vacuum Screw Pumps

Built for rapid cycling and applications requiring continuous operation, the DHS VSD+ is a truly clean, zero-contamination range of four dry vacuum pumps that require no water or oil cooling. By eliminating the need for the water dry screw technology typically requires, air cooling provides convenience and saves money on water and sewage costs. Plus, there's zero chance of water contaminating the final product.

Equipped with and controlled by the MKV Elektronikon®, the pump is a pioneer in variable speed drive screw technology. Featuring a built-in variable frequency drive soft start, which improves efficiency and extends the lifetime of the motor, this range of pumps eliminates the need for costly control panels – the user simply needs to provide it with power. The pump easily integrates with plant-management systems, and users get the latest status updates on runtime, stopped hours, warnings, and fault and shutdown indications. Combined with Atlas Copco's SMARTLINK, the pump also offers unrivaled remote-monitoring capabilities.

Thanks to the completely dry operation of the range, no oil can migrate into the pump environment – ensuring a cleaner and safer working environment. This is a great advantage, especially in applications such as vacuum drying and cleaning, paper converting, sensitive and regulations-driven electronics manufacturing, and food packaging. Offering clear environmental benefits at the point of use, the range is housed in a noise-reducing canopy that ensures a noticeably quiet, vibration-free operation with a low pitch sound level.

The DHS VSD+ is a truly clean, zero-contamination range of four dry vacuum pumps requiring no water or oil cooling.

"The new screw profile of the DHS 065-200 VSD+ offers best-in-class performance in its category," said Walter See, Atlas Copco's product marketing manager for vacuum pumps in the United States. "We set out to build a pump that would create a safer, cleaner and smarter industrial environment. The robust design, clean operations, and remote monitoring and control capabilities make it the perfect pump for industrial applications."

Reduced maintenance is an integral feature of the DHS VSD+ series. The grease-lubricated bearings and the belt are the only parts that require replacement. The belt itself can be changed without external service support within 30 minutes – less than a third of the time it would typically take. Plus, the pump comprises only 50 parts – 50 percent less than most on the market. The robust canopy retains the integrity of the internal parts and can be removed easily. This greatly reduces installation complexity and associated costs, contributing to a truly clean, clever and compact vacuum pump.

Certified as oil-free in the category "Class Zero" according to ISO standard 8573-1, the pump is free of oil emissions, including aerosol oil content in the outlet air stream. The reduced number of parts within the pump combined with the variable pitch screw design help increase efficiency and reduce maintenance.

To learn more about the DHS VSD+ series and other Atlas Copco products, please visit www.atlascopco.com/en-us or contact us directly.

Atlas Copco Group & Atlas Copco Compressor Technique

Great ideas accelerate innovation. At Atlas Copco, we have been turning industrial ideas into business-critical benefits since 1873. Our passionate people, expertise and service bring sustainable value to industries everywhere. Atlas Copco is based in Stockholm, Sweden with customers in more than 180 countries and about 37,000 employees. In 2018, revenues were BSEK 95, approximately 10 BUSD.

Atlas Copco Compressor Technique partners with customers to turn industrial ideas into smart, connected air and gas solutions and leading edge compressed air technology. By listening to our customers and knowing their needs, we deliver value and innovate with the future in mind.

Atlas Copco Compressors

Atlas Copco Compressors LLC is part of the Compressor Technique Business Area, headquartered in Rock Hill, South Carolina. Atlas Copco

Compressors provides innovative solutions including world-class compressors, vacuum pumps, air blowers, quality air products and gas generation systems, all backed with full service, remote monitoring and auditing services. With a nationwide service and distribution network, Atlas Copco Compressors is your local, national and global partner for all your compressed air needs. Learn more at www.atlascopco.com/air-usa.

Sensaphone 1800™ Monitoring System for Water and Wastewater Facilities

For many water and wastewater operations, having personnel on premises 24 hours a day to keep an eye on the facility is not an option. The Sensaphone 1800™ system allows users to remotely monitor for changes in environmental conditions that can indicate a malfunction of critical equipment. It remotely monitors conditions like pump status, tank level, pump alarm outputs, power failure and security at water and wastewater facilities to help keep operations running smoothly.

The system also detects problems such as temperature changes, humidity fluctuations, water leaks, power failure, carbon monoxide

The Sensaphone 1800™ System for monitoring water and wastewater facilities.

BLOWER & VACUUM TECHNOLOGY PICKS

and carbon dioxide levels, and smoke. When the system detects that a sensor reading has moved out of the preset range, it immediately alerts up to eight people with custom phone calls, allowing personnel to quickly address the situation.

The Sensaphone 1800 system is a cost-effective monitoring solution that is easy to install and operate. One Sensaphone 1800 unit monitors status conditions 24/7 for up to eight locations. The internal rechargeable battery backup provides 24 hours of continuous monitoring and alerts in the event of a power outage.

Each monitoring unit is sealed in an enclosure to protect it from moisture, dirt and chemicals. Operators can obtain the status of each monitored condition at the installation site or via telephone.

Visit www.sensaphone.com/products/sensaphone-1400-and-1800-monitoring-systems.php to learn more about the Sensaphone 1800 monitoring system.

About Sensaphone

Sensaphone offers a comprehensive line of remote monitoring products that safeguard valuable assets by tracking critical environmental data such as temperature, humidity and power failures. Sensaphone products provide alerts and proactive monitoring data to homeowners and facility managers in many areas including telecommunications, oil and gas, water and wastewater, HVACR, agriculture, healthcare, data centers and greenhouses. More than 400,000 Sensaphone systems are in use today around the world, and they continue to be manufactured in the USA. For more information, call 877-373-2700, email contact@sensaphone.com, or visit www.sensaphone.com.

Leybold Presents the 100% Oil-Free Screw Type Vacuum Pump NOVADRY

Leybold launched the new NOVADRY vacuum pump series. The completely newly developed, oil-free screw vacuum pump ensures significantly greater safety and efficiency in food and packaging processes.

The demands placed by manufacturers and consumers on the quality, shelf life and resource efficiency of food and packaging processes are constantly increasing. This applies even more to such perishable products as for example meat or fish. Vacuum is considered as an enabling technology, contributing significantly to optimizing these processes. Therefore, Leybold developed the innovative NOVADRY, a new 100% oil free, air-cooled pump.

"Many users in meat processing and packaging cannot actually tolerate vacuum pumps emitting oil," stresses product manager Niels Gorrebeeck. NOVADRY prevents such contaminations. That is why Leybold designed a 100% dry pump following hygienic criteria. This increases safety in applications such as tumbling, filling, vacuum packaging and thermoforming. An additional advantage of oil-free vacuum pumps is the lower cost of ownership, as less maintenance and spare part changes are required. In addition to the oil-free screw principle, Leybold has transferred proven components and principles from other vacuum pump series, including the bearing structure and the belt drive, which synchronizes the rotors.

Leybold NOVADRY 100% oil-free screw type vacuum pump.

Normally, dry pumps are water-cooled, but this pump is air-cooled. This reduces operating costs by simplifying the installation and commissioning. "The total life cycle operational costs of the NOVADRY are lower than for

BLOWER & VACUUM TECHNOLOGY PICKS

oil-sealed vacuum pumps, this was a key driver during the pump development," said Uwe Zöllig, Head of Business Development at Leybold.

The pump also stands out due to its long uptime and robustness. Some competitor products lose their end-pressure or reduce pumping-speed due to wear of the inner coating, for example. It achieves its performance over the entire pressure range and life cycle. This makes it ideal for simple applications, which emit low amounts of humidity, such as packaging of cold products. Moreover, the pump is also perfectly suited for more demanding processes with large amounts of water vapor, for example when hot meals with temperatures of up to 95 °C have to be quickly cooled down by evaporative cooling. "In addition to the air/steam mixture coming from the process, the NOVADRY screw vacuum pump can also handle the anticipated contamination inside the gas flow very well. These are for example organic acids, spices, vinegar or other residues," said Pierre Lantheaume, Business Development Manager Food & Packaging at Leybold.

NOVADRY has successfully passed many qualifying field endurance tests in a wide range of food applications – tumbling, tray sealing and thermoforming. In all applications, it shows very good performance, the users reached fastest cycle times and low final pressure.

Leybold have succeeded in developing a forward-looking product which has the potential to set a new standard for the food processing and packaging markets. This is due not only to the absence of oil, but also to the NOVADRY's noise behavior, the robust design and the low life-time costs.

For further information on the benefits of oil-free vacuum technologies for food applications visit https://lp.leybold.com/en/food-and-packaging/.

About Leybold

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

About Atlas Copco

Great ideas accelerate innovation. At Atlas Copco, we have been turning industrial ideas into business-critical benefits since 1873. By listening to our customers and knowing their needs, we deliver value and innovate with the future in mind. Atlas Copco is based in Stockholm, Sweden with customers in more than 180 countries and about 37,000 employees. Revenues of BSEK 95/ 9 BEUR in 2018. For more information: www.atlascopcogroup.com.

DEKKER Vacuum Unveils VmaxPLUS® Oil-Sealed Liquid Ring Vacuum Pump

DEKKER Vacuum unveiled the first model of a new series of liquid ring vacuum pump systems with the VmaxPLUS®. This new pump is a 10 horsepower (hp) oil-sealed liquid ring vacuum pump system designed for the toughest applications in the industrial, building supplies, aerospace, plastics, packaging, medical and other key industries. Advantages include lower maintenance costs, zero downtime, smaller footprint, reduced noise levels and a full three-year warranty.

The new Vmax^{PLUS} design is based on DEKKER's flagship product, the Vmax®. The DEKKER name

has been recognized as an innovator in oil-sealed liquid ring technology since the 1970s. The company has continued to build on that reputation with the release of this new product. Liquid ring technology is known throughout the industry for minimal maintenance requirements. Combine this with the extremely low operating noise levels and compact design of the pump and you have a desirable vacuum system for today's workplace.

To further enhance energy savings opportunities, the Vmax^{PLUS} is available with a Variable Frequency Drive (VFD) option to control power consumption, maintain constant pressure and to eliminate part slippage. The pump is available in multiplex configurations and can be stacked upright to save space in your facility.

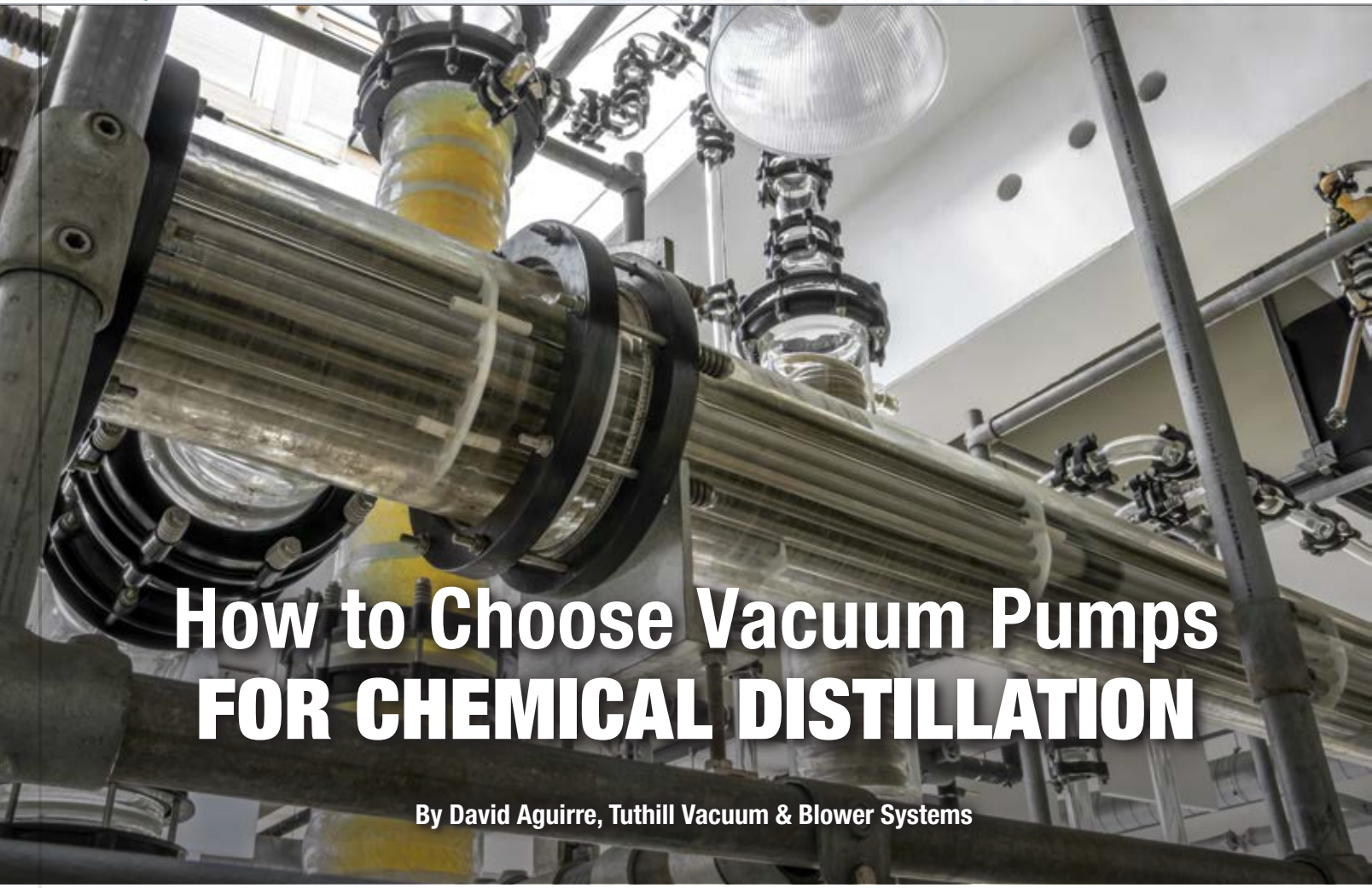
DEKKER's Vmax oil-sealed liquid ring vacuum pump systems achieve deep vacuum level and a high capacity. The performance of the VmaxPLUS at 24"Hg reaches 145 cfm. Exclusive to woodworking operations, DEKKER offers an inlet filter and vacuum relief valve as standard, to protect the pump from ambient contaminants and to extend the life of the system.

Liquid ring vacuum pumps are widely employed in tough industries because of their high tolerance of liquid and solid carryover without compromising the pumps' mechanical integrity or efficiency. Unlike other types of vacuum pumps, liquid ring machines don't need to be rebuilt or replaced on a regular basis. The pump has only one moving part, and there is no metal-to-metal contact between the impeller and the casing. Liquid ring technology can handle the severest challenges year in and year out.

About DEKKER Vacuum

DEKKER provides vacuum solutions for a wide range of wood and plastic applications, including CNC routing, drilling, engraving, laminating, milling, thermoforming and veneering. Because woodworking is one of the most abusive work environments for vacuum pumps, all DEKKER pumps and systems are engineered with superior efficiency and reliability to deliver maximum productivity under the harshest conditions. For more information, visit www.dekkervacuum.com or call (888) 925-5444.

The new Vmax^{PLUS} liquid ring vacuum pump system delivers superior hold-down force.



How to Choose Vacuum Pumps FOR CHEMICAL DISTILLATION

By David Aguirre, Tuthill Vacuum & Blower Systems

To determine which type of vacuum pump will be most suitable for an application, it is important to understand the distillation process, the factors that make distillation work, and the features of the different pump types.

How Does Distillation Work?

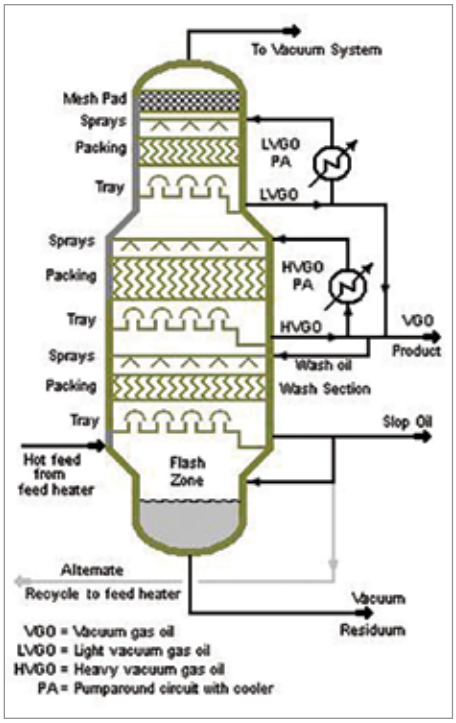
Distillation, degassing, drying, filtration, membrane separation, adsorption, and crystallization are all among the separation processes that rely on the differences in the physical properties of substances in a mixture. Distillation relies on the differences in boiling point or in vapor pressure versus temperature characteristics. Heating, evaporation, and condensing are the tools used in distillation that separate the liquid constituents in a liquid mixture.

For separating liquid constituents with differences in boiling points of less than 30 °C, a fractionating column with plates or packing is normally recommended. This provides repeated condensing and re-evaporation of the reflux liquid as it progresses up the column for better separation of the constituents.

More volatile liquids have lower boiling points or higher vapor pressure versus temperature curves and more readily evaporate. The vapor phase mixture is richer in the more volatile compounds and can then be condensed, contained, and returned for further separation and purification, if necessary. The greater the difference in the volatility of a component from the mixture, the more easily it is separated.

Understanding Volatility

Volatility is the concentration of a substance in a solution (or its mole fraction) in the vapor phase compared to the concentration of the same substance in its liquid phase. Volatility is



Depicted is an example of distillation column set-up for separation processing.

also a substance's pure component pressure compared to its total pressure. The relative volatility of two substances is the ratio of their pure component vapor pressures.

Volatility of substance "i" is defined as:
Ki = yi/xi.

Where:

Ki is the volatility of the i component.

yi is the mole fraction of the i component in the vapor phase.

xi is the mole fraction of the i component in the liquid phase.

(Mole fraction is the ratio of the number of moles of a substance to the total number of moles in a solution.)

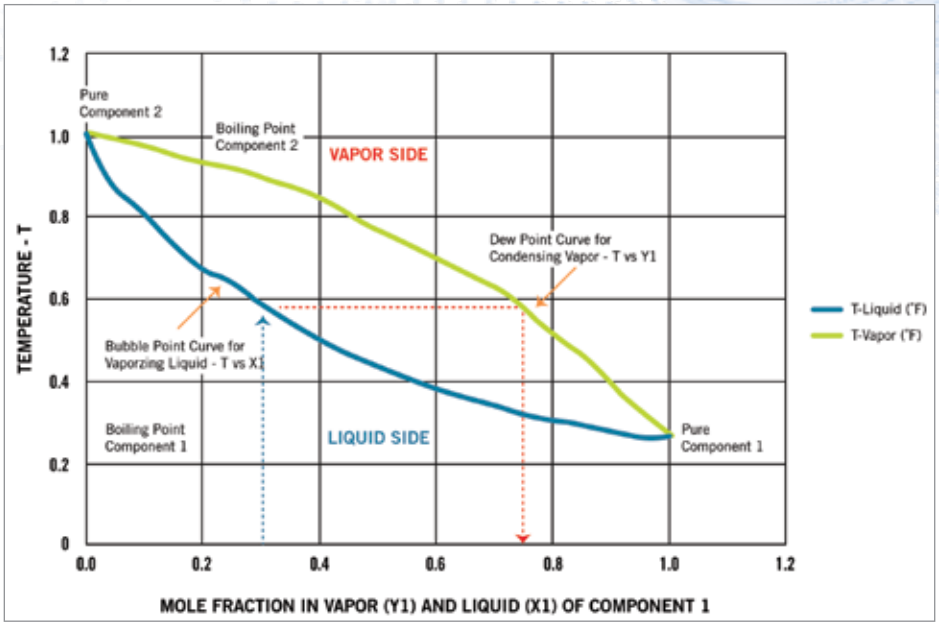


Figure 1.

HOW TO CHOOSE VACUUM PUMPS FOR CHEMICAL DISTILLATION

Shown is a KLRC 300 Tuthill Kinney liquid ring vacuum pump.

Shown is a Tuthill SDV 800 screw-type dry vacuum pump.

The ratio is the same between a substance's pure component pressure and its total pressure:

Since yiP = xiPvi, where P is the total pressure and Pvi is the pure component vapor pressure: then yi/xi = Pvi/P.

The relative volatility "α" of two substances is:

$$\alpha = K1/K2 = (y1/x1)/(y2/x2) = Pv1/Pv2$$

For a simplified binary mixture that behaves as an ideal liquid, a phase diagram at constant pressure can be drawn with the mole fraction of the more volatile component on the horizontal axis and the temperature on the vertical axis.

The lower curve is normally referred to as the "bubble point" where, for a given mole fraction of liquid mixture, the liquid begins to boil at a given temperature. The higher curve is normally referred to as the "dewpoint," which indicates the different temperatures where the different mole fractions of the vapor would start to condense.

As an example, Figure 1 represents a phase diagram at constant pressure for a well-behaved binary mixture. It shows the mixture will boil at 0.59 Temperature (T) when the more volatile Component 1 represents 0.3 mole fraction of the liquid mixture and will have a saturated vapor "y1" that represents almost 0.75 mole fraction of the entire vapor. This large difference between the vapor and liquid contribution of Component 1 makes it easier to distill off.

"Heating, evaporation, and condensing are the tools used in distillation that separate the liquid constituents in a liquid mixture."

— David Aguirre, Tuthill Vacuum & Blower Systems

The Vacuum Distillation Process

For a simplified binary mixture that behaves as an ideal liquid, vacuum distillation provides a convenient and efficient format for the separation at lower temperatures without harmful reactions with other gases such as oxygen.

In some cases, a mixture of two or more liquids at a given mole fraction of constituents will behave as a pure liquid, where the vapor that boils off at a constant temperature has the same mole fraction in the vapor phase as in the liquid phase and no further separation of the constituents occurs. This is known as an "azeotrope." For example, a mixture of ethanol and water will separate through simple distillation until the mole fraction of ethanol reaches 0.895 and no further change in concentration will occur.

Some azeotropes can be separated by changing the pressure at which distillation occurs. Vacuum distillation can help in some of these cases by providing a pressure variation for shifting the azeotrope to allow for further separation. The ethanol/water azeotrope disappears at distillation pressures below 70 millimeters (mm) HgA. As in all processes, the cost of further separation dictates its feasibility.

The Molecular Distillation Process

Molecular distillation is a similar process but occurs at much lower pressures (normally from 0.1 to 0.0005 mm HgA) so that collision of the distillate molecules with the condenser predominate compared to intermolecular collisions.

A thin film distillation process using Wiped Film Stills (WFS) and Evaporators (WFE) provides a convenient method for separating out compounds for the chemical, food, or pharmaceutical sectors that have high boiling points, or high viscosity, or are sensitive to thermal degradation but are readily evaporated at modest temperatures at low pressures.

Preferred Vacuum Pumps

Condensers are used for knocking out most of the condensable vapors. However, for removing the permanent gases, including air leakage and the saturated vapors at the exhaust temperature of the vent condenser, the most common and

HOW TO CHOOSE VACUUM PUMPS FOR CHEMICAL DISTILLATION

preferred pumps for simple or fractional vacuum distillation are the liquid ring and dry vacuum pumps. For lower pressure operation, a Rotary Lobe Booster can be connected in series with either of these to provide higher pumping capacity at a lower pressure.

The liquid ring does not require internal lubrication and can run on most liquids such as water, low viscosity oil, or many solvents that are compatible with its materials and its process in terms of vapor pressure and viscosity. It can handle liquid slugs from process upsets or a continuous flow of liquid condensate from a pre-condenser.

In some cases a liquid ring can perform as both a vacuum pump for non-condensables and a direct contact condenser for vapors, increasing its overall pumping capacity. It is one of the most reliable and durable mechanical pumps because of its simplistic design with one rotating shaft assemblage. It is also available in 316 stainless steel for greater corrosion resistance to process effluents.

The rotary screw dry pump also does not require internal lubrication and can handle some liquid carryover, but as the name implies, it is better to keep the pump dry for optimum performance.

Knockout pots would normally be recommended to trap out liquid slugs. Since the dry pump contains no liquid within its pumping chamber, it is not limited by the vapor pressure of the liquid and can achieve lower pressures without producing process-contaminated waste products. The dry pump handles condensable vapors by keeping them in the vapor phase at an elevated temperature while traveling from suction to discharge, so they can be condensed out in an after-condenser. The rotary screw dry pump and

HERE ARE ADVANTAGES AND DISADVANTAGES OF LIQUID RING AND DRY PUMPS:

DRY PUMP ADVANTAGES	DRY PUMP DISADVANTAGES
Lower ultimate pressure and higher capacity at low-pressure end for single-stage pump.	Higher purchase price.
Lower power consumption.	Higher complexity affects reliability.
Lower cooling water usage.	More difficult to disassemble and reassemble on site by end user.
More compact footprint.	Solvent handling limited by auto-ignition temperature of solvent.
Can pump high vapor pressure solvents.	Limited liquid ingestion.
Environmentally friendly with less pollution.	
LIQUID RING PUMP ADVANTAGES	**LIQUID RING PUMP DISADVANTAGES**
Can perform as both vacuum pump and direct contact condenser.	Normally higher operating cost than dry.
Lower purchase price.	Higher power and cooling water consumption.
Simplicity of rotating parts improves reliability.	Larger footprint.
Low maintenance.	Pump performance is limited by vapor pressure of sealant.
Because of pump simplicity, can be readily disassembled and reassembled on site by end user.	Requires a supply of liquid sealant for makeup or change-out.
Lower operating temperature for thermal sensitive or polymerizable process material.	Operation normally results in larger amount of hazardous waste.
Liquid sealant allows for handling higher temperature inlet gases/vapors.	
Can ingest liquid from process or condensater from upstream condenser.	
Less sensitive to process particulate due to larger clearances.	
Liquid within pump may act as quench to reduce chance of ignition from sparking.	

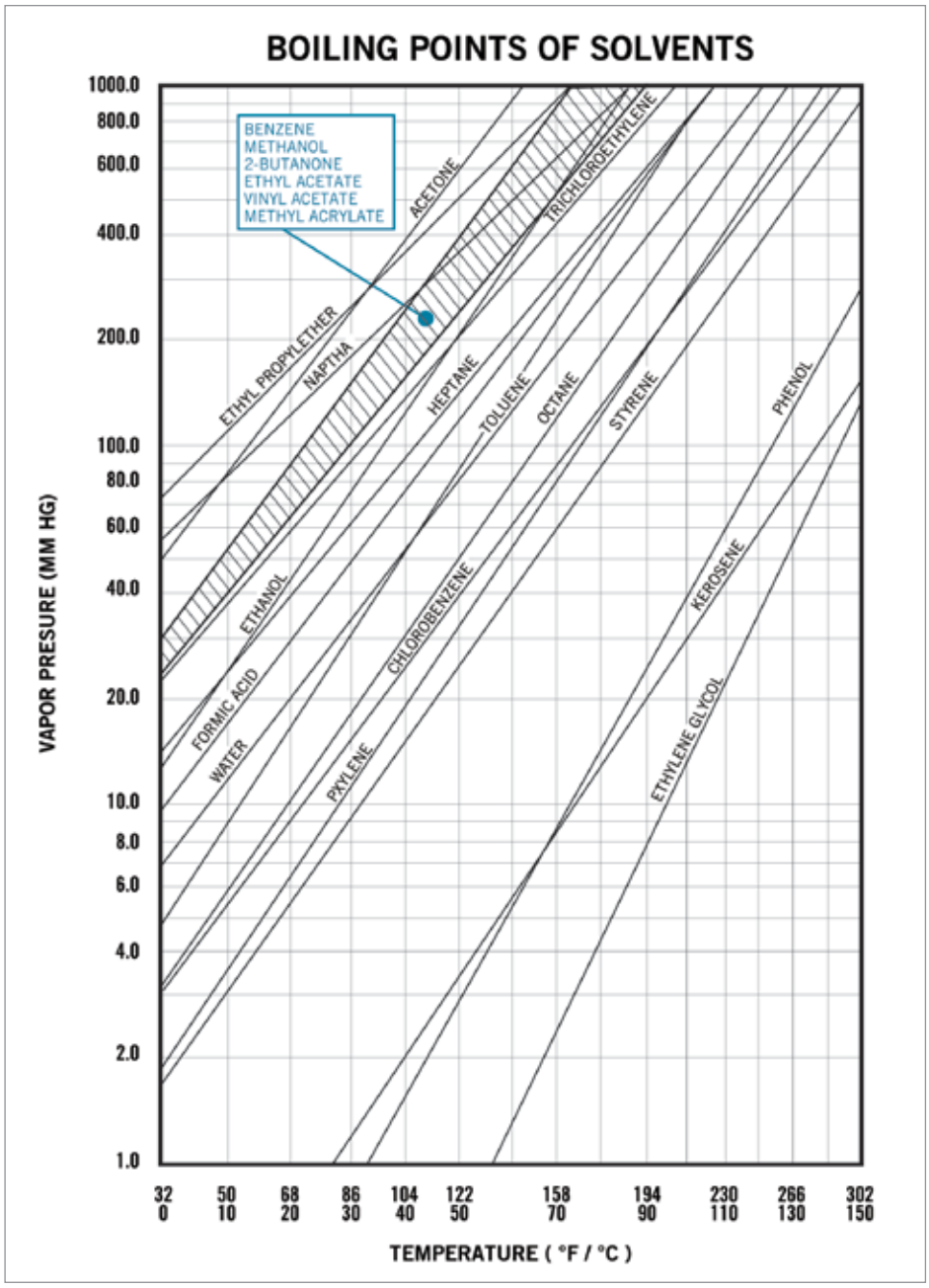
rotary lobe boosters are also available with optional protective coatings.

Because of the low-pressure requirements for molecular distillation and reduced carryover, multi-stage booster packages utilizing liquid ring, dry rotary screw, or oil sealed rotary piston vacuum pumps as the atmospheric stage are available.

Liquid Ring Versus Dry Vacuum Pumps

In choosing the best pump for the application, many factors need to be considered concerning the substances that need to be distilled, substances that need to remain in the liquid solution, the pump types themselves, and other aspects of the process:

- Boiling points of substances.
- Vapor pressure versus temperature curves of substances.
- Viscosity and sensitivity to thermal degradation of substances.
- Liquid carryover the pump will need to withstand.
- Pump's ability to handle liquid slugs from process upsets.
- Need for providing higher pumping capacity at a lower pressure.
- Pump's level of corrosion resistance.
- Footprint of the pump and complexity of maintenance.
- Pump's purchase price versus power consumption prices.
- Process cooling water usage and hazardous waste production. BP



About the Author

David Aguirre is Vacuum Product Manager for Tuthill Vacuum & Blower Systems.

About Tuthill Vacuum & Blower Systems

Tuthill Vacuum & Blower Systems was formed in 2002 after a series of acquisitions and corporate restructuring. Currently, the company is the sole manufacturer of Kinney® vacuum pumps, along with M-D Pneumatics™ rotary blowers, vacuum boosters and vacuum pumps. Several recent additions to the Tuthill team have helped to broaden the company's engineering capabilities. The process began with the hiring of Roger Palmer, the new Director of Engineering. Under Roger's direction, Tuthill's team is looking at all existing products to identify opportunities for enhancement in performance and improvements in the manufacturing process, daring to make better every day. For more information, email vacuum@tuthill.com, or visit www.tuthill.com.

All photos courtesy of Tuthill Vacuum & Blower Systems.

To read similar articles on ***Industrial Vacuum Technology,*** please visit www.blowervacuumbestpractices.com/technology.

Helping Wisconsin Wastewater TREATMENT FACILITIES SAVE ENERGY

By Blower & Vacuum Best Practices Magazine

Leidos Engineering works with Focus on Energy to help water/wastewater facilities throughout Wisconsin identify and implement methods for reducing energy use.

➤ Leidos Engineering, LLC (Leidos Engineering) is responsible for implementing the Wisconsin Focus on Energy® Large Energy Users (LEU) Program in Wisconsin. Blower & Vacuum Best Practices interviewed Leidos Engineering's Joseph Cantwell, P.E., Senior Energy Management Professional, Focus on Energy – LEU Program, to learn how the firm works with Focus on Energy to help wastewater treatment facilities in the dairy state reduce energy consumption and save costs.

Good afternoon! Tell us about Leidos Engineering and Focus on Energy.

Leidos is a Fortune 500® firm based in Reston, Virginia, with 32,000 employees around the world. We offer information technology, engineering and science solutions with the mission to make the world safer, healthier and more efficient. Since 2014, the work our Leidos Engineering division has done with the LEU customers of Focus on Energy has saved more than 726 million kWh and more than 52 million therms of natural gas. That's enough savings to power about 25,000 homes or heat over 5,200 homes for a year.

Leidos Engineering is proud to be working with Focus on Energy (https://focusonenergy.com/), which is the statewide utilities' energy efficiency and renewable program funded by Wisconsin's investor-owned energy utilities and participating municipal and electric cooperative utilities. The goal is to help Wisconsin residents and businesses install

> "Since 2014, the work our Leidos Engineering division has done with the LEU customers of Focus on Energy has saved more than 726 million kWh and more than 52 million therms of natural gas."
>
> — Joseph Cantwell, P.E., Senior Energy Management Professional, Leidos Engineering, LLC

cost-effective energy efficiency and renewable energy projects. In fact, the Focus on Energy program was recently recognized in a study conducted by the Lawrence Berkeley National Lab as the most cost effective energy efficiency program in the United States.

What is your professional background and your role with Focus on Energy?

My work with municipalities and wastewater treatment facilities goes back to my days as an undergraduate student at Marquette University in Milwaukee, Wisconsin, when I worked for a municipality as part of the university's co-op program.

I also worked for municipalities in various jobs for a few years after earning my bachelor's degree in civil engineering. I then began to focus on wastewater treatment facility design and water systems. Toward that end, I earned my master's degree in sanitary engineering and then joined an engineering consulting firm in their wastewater treatment facility design group. After that, I worked for a couple of consulting firms and focused on wastewater treatment and water systems, but basically focused on the wastewater side.

In 2000, I joined Leidos Engineering. Since then, I've become extensively involved in the Focus on Energy LEU Program. I was the lead author of *Focus on Energy's Water & Wastewater Industry Energy Best Practices Guidebook,* which is a 179-page resource designed to assist water/wastewater systems to identify and implement methods for reducing energy use. I'm currently an energy advisor for

Joseph Cantwell, P.E., Senior Energy Management Professional, Focus on Energy Large Energy User Program, Leidos Engineering, LLC.

HELPING WISCONSIN WASTEWATER TREATMENT FACILITIES SAVE ENERGY

the program and my job is to help large water and wastewater systems identify energy-saving opportunities and take advantage of incentives offered by Focus on Energy.

How do you help treatment facilities get involved with Focus on Energy?

Energy advisors like myself visit customers throughout the state to review their operations and processes to identify where they have opportunities to save energy. Once we've identified potential opportunities, we conduct baseline energy assessments to determine how much energy a given opportunity can save based on the initiatives involved.

Our discussions include the types of incentives we can offer through Focus on Energy and the potential savings, as well as the payback on the investment. The treatment facilities we work with must have energy utility bills that are consistently over $60,000 per month to qualify for LEU Program incentives.

What kinds of incentives does Focus on Energy offer Large Energy Users?

The first type of incentive is "prescriptive," which means a set dollar amount is awarded for replacing equipment with more energy-efficient equipment.

The second is a "custom incentive." This type of incentive involves more unique projects, such as when equipment is being added or even eliminated. The incentive varies based on the estimated annual energy savings. The incentive amounts are calculated based on estimated first-year savings.

Focus on Energy also helps fund project assessment studies including an incentive to assess applicability of anaerobic treatment.

What are some examples of prescriptive and custom incentives?

A good example of a prescriptive incentive is the installation of a Variable Frequency Drive (VFD) on a constant-speed device. In this case, the plant would receive a predetermined number of dollars per horsepower as long as the equipment operates a minimum of 2,000 hours per year.

I'll use an aeration project to describe how a custom incentive works. Let's say the treatment facility replaces its coarse bubble diffusers with fine-bubble diffusers. This means the facility would save energy on an ongoing basis throughout the year. This could result in hundreds of thousands of kilowatt hours (kWhs) saved per year. The estimated annual savings in kWh and kW is multiplied by the per kWh and per kW incentive the program pays in order to determine the total custom incentive.

Since projects involving custom incentives are more sophisticated and require approval before implementation, energy advisors help gather energy savings calculations on the front end. We'll also submit an application for the incentive on behalf of the customer.

How does a treatment facility verify whether energy conservation measures worked?

On certain projects, a separate team will review the energy consumption of a facility a few months after project implementation and compare it to the energy baseline taken before the energy-savings project started. At times, the team will work with the facility to assess the overall project impact to confirm the project achieved the claimed savings.

At the end of the day, municipalities are most interested in whether the treatment facilities fully understand their electric bills and learn how to keep energy costs in control based on the initiatives implemented. If energy consumption and costs don't go down, the municipality and facility superintendent will revisit the project to assess what conditions changed.

Where can wastewater treatment facilities realize the most energy savings?

It's important to note there is no typical wastewater treatment facility. They might have similar processes, but each one functions and operates differently.

That said, the most intensive energy use takes place in the primary and secondary

Shown is a rotary screw blower at a Wisconsin wastewater treatment facility.

stages of a conventional wastewater treatment process. It's known that pumping in the primary stage and aeration in the secondary stage of processing together account for about two-thirds or more of a facility's energy consumption. It's normally either aeration systems or raw sewage pumping we focus on.

With aeration, the main areas for energy savings opportunities include the use of aeration blowers, diffusers, and control systems. As far as equipment itself, an aeration blower is typically the largest consumer of facility energy.

What can treatment facilities do with blowers to realize energy savings?

The most significant opportunity has to do with machine sizing and selection. The reason is because facility design codes require treatment facilities to select blowers with the intention of meeting peak-flow conditions for a 20-year period. Facilities must also have a redundant unit as a backup safety factor for unforeseen equipment failures, peaks or emergencies.

It started from the EPA in the 1970s and continues now; you look at your treatment facility for 20-year peak conditions and size blowers for that. There are a lot of facilities that have one large blower and then a second one because they need to have redundancy. But low loading conditions were not looked at, which may have been a lot less. Therefore, the blower should have been, or could have been, sized a quarter or a third of its size in order to efficiently meet the low loading conditions. This is where the potential opportunity for energy savings comes in.

What should facilities do differently with blower sizing and selection?

Put in three or four blowers, each one a third of what you need, or a quarter of what you need to meet that low-flow condition efficiently. Then you can turn the second or a third unit on as loads increase. Or throughout the day, they go up or they go down with diurnal flow, and you can efficiently meet the changing conditions.

Let me give you an example. Say a treatment facility picked a 100-horsepower (hp) blower based on its need to meet peak conditions. Let's also say the plant installed a second 100-hp blower for redundancy. On the first day of operation the facility probably only needed 22 to 25 hp. The primary 100-hp blower, however, doesn't have sufficient turndown to efficiently

HELPING WISCONSIN WASTEWATER TREATMENT FACILITIES SAVE ENERGY

A number of Wisconsin wastewater treatment facilities leverage a host of technologies, such as this biogas-fueled generator set, to offset their energy consumption.

match the airflow rate for this minimum process need.

So instead of two 100-hp blowers, why not install three 50-hp blowers and use one of them at 50% of capacity to efficiently meet the low-flow conditions? You can then turn on the second, or third blower as loadings increase. This also provides redundancy.

That's just one example of multiple ways blower sizing and selection can reduce energy use. When the Focus on Energy program started, we reviewed approximately 50 sites. From that, we learned most facilities operate at only 30-35% of their designed condition.

What impact are advances in blower technology having on energy savings?

I think blower sizing and selection is the biggest challenge for wastewater treatment facilities while blower technology is a secondary consideration.

There's no question advances in blower technology have gained traction in the wastewater world and have helped facilities reduce energy consumption. But different blower technologies are better at meeting different ranges of airflow. I try to get people to focus on the right size selection of the blower and then select the right technology for that airflow rate.

How would you assess a treatment facility's interest in adoption of energy-conservation measures?

Facility operators openly embrace energy efficiency and seek ways to better manage their energy use. They know more restrictive discharge requirements are coming, but facility operators typically do not just say, "Oh, well. This is something we have to do." Instead, they ask, "How can we operate our facilities more efficiently when requirements change?"

Operators are environmental stewards. Not only are they cleaning the inflow and discharging good, clean water but they're also doing it with the least amount of energy consumption. They're managing the use and costs.

Are there water resource recovery facilities that have gone net-zero energy?

We have a couple in Wisconsin that have that capability. We have others that are using renewable energy resources, primarily biogas, to offset a fair amount of their energy.

What impact do programs like Focus on Energy have on a facility's decision to implement energy conservation measures?

The vast majority of feedback we've received is very positive and I think part of it is because Focus on Energy offers an independent, third-party review of and recommendations for energy-saving opportunities.

What we're saying is, "This is how you can get the same amount of work done at your facility, but not work as hard to produce the same or better effluent results, all while saving energy and money."

It makes sense when you consider utility costs are usually a treatment facility's second highest cost, coming in behind labor costs.

Thank you for these insights. BP

For more information about Focus on Energy's Large Energy User Program, contact Joseph Cantwell, email: joseph.c.cantwell@leidos.com, tel: 262-786-8221. To obtain a copy of the Focus on Energy's Water & Wastewater Industry Energy Best Practices Guidebook, visit: https://focusonenergy.com/sites/default/files/WW-Best-Practices_web_1.pdf.

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Pneumatic Conveying Helps Pharmaceutical Ingredients and Excipients Manufacturer SAFELY AND EFFICIENTLY MEET DEMAND

By Doan Pendleton, VAC-U-MAX

With global focus on health, the aging population, and overall worldwide population increases, the pharmaceutical industry focuses not only on results but also on production utilizing the most advanced process technologies. Over the past century the industry has realized unprecedented advances in human health, yet the industry is struggling to keep up with demands. Increased demand results in the need for increased production, which poses a complete set of new challenges for companies in the supply chain.

Such production challenges were realized by A&C, which is a service-driven organization finding unique solutions to its customer's Good Manufacturing Practice (GMP) challenges. It overcomes the challenges through many methods, including the use of advanced technology.

Focusing on Process, Quality, Safety & Compliance

A&C (www.acggp.com) is a custom manufacturer and supplier of excipients, process solutions, buffers and Active Pharmaceutical Ingredients (APIs). The company is audited by both the Federal Drug Administration in the United States and Health Canada, affirming their constant and stringent efforts to meet regulatory requirements for

"The bulk density of a material is one of the first indicators of design in terms of sizing various system components such as vacuum receivers and air sources."

— Doan Pendleton, VAC-U-MAX

pharmaceutical and biopharmaceutical raw material suppliers.

With two GMP facilities located in Montreal, Canada, A&C manufactures, packs and distributes bioprocessing liquid and bulk materials under GMPs with full compliance to all international regulatory requirements. GMP ensures products are consistently produced and controlled according to quality standards. It is designed to minimize the risks involved in any pharmaceutical production that cannot be eliminated through testing the final product.[1]

As product demand increased, A&C realized the need for significant investment in bulk material handling capabilities to support expanding business and increased production, while focusing on minimal downtime. As part of this initiative, A&C continually focused not only on process, but also on end-product quality, safety and compliance.

"A major challenge our customers face is the way bulk materials are supplied to the market. We needed a material handling system that would keep up with our demand, ensure worker safety and limit manual manipulation of material. The VAC-U-MAX team designed and manufactured a material handling system capable of conveying over four and half million pounds of powders per year that now allows us to continually meet our growing business," said Damien O'Rourke, Vice President & Chief Operating Officer at A&C.

Driving Transparency in the Supply Chain

A&C promotes a leadership position in providing full transparency in the supply chain, as demonstrated through EXCiPACT, GMP and Good Distribution Practices (GDP) certifications. EXCiPACT is a non-profit organization that owns and manages oversight of an independent, high quality, third party certification available to pharmaceutical excipient manufacturers and distributors worldwide.[2]

"A&C's quality management system is based on providing the highest quality product to companies worldwide while safeguarding public health," said O'Rourke. "We place strong focus on plant and personnel safety, product lead times, minimizing product contact and manual manipulation of product in support of GMP initiatives."

Among A&C's service offerings, the powders it processes are supplied in custom packaging meeting customer specific requirements. Product must be conveyed from different containers to the discharge point at a rate of 2,200 pounds per hour.

Manual handling of product poses its own set of challenges including slip and fall hazards, fugitive combustible dusts and other sanitary issues that may result in decreased production and lengthy downtime.

Employing vacuum conveying technology for dust containment, labor savings, cleanliness, or safety and environmental reasons lies in the ability of vacuum conveying experts to understand powder characteristics and how those characteristics interact with equipment design. A&C also wanted its solutions to incorporate the best ergonomics for employees.

A bag dump station with integrated dust collection and load-lifter allows the operator to remove heavy bags from a pallet and easily place them on the bag station grate.

PNEUMATIC CONVEYING HELPS PHARMACEUTICAL INGREDIENTS AND EXCIPIENTS MANUFACTURER SAFELY AND EFFICIENTLY MEET DEMAND

Material Properties and Conveying Behavior

As most pharmaceutical and nutraceutical processes start with a powder or granular material, material characteristics must first be defined with focus on the materials attrition and segregation, vacuum conveying behavior, flow properties, and particle properties like shape, size, cohesiveness, and bulk density.

The bulk density of a material is one of the first indicators of design in terms of sizing various system components such as vacuum receivers and air sources. Bulk density helps determine how many cubic feet per minute (cfm) of air is needed to move the material through the convey line. In A&C's case, the bulk densities were on the heavy side at 95 and 133 pounds per cubic foot.

Attention is given to the prospect of segregation especially during manual transfer of materials in drums or other containers to the next process vessel in the production process. Vibration caused by moving containers promotes segregation. While each application requires a unique resolution based on distinctive environments and equipment, systems are generally built using standard components and customized according to the application requirements. A&C's process requires the conveyance and discharge of multiple materials from diverse types of packaging, such as bags, bulk bags and drums. The process is also in a cleanroom environment, which is subject to wash-down sanitation.

The Activator system features lubrication-free pneumatic lifters that consume 50% less compressed air than air-cylinders.

Introducing Materials to the Process

Equally important is the introduction of material to the process (i.e., the pickup point). Product can be introduced via simple suction wand (from a drum), or a sanitary bag dump station with integral dust hood or via bulk bag (a.k.a. super sac) unloading systems.

A&C introduces product to the process via VAC-U-MAX's sanitary 316 stainless steel bag dump station. The process uses a VAC-U-MAX LoadLifter to assist with the repetitive action of lifting heavy bags and placing them in the bag dump station.

The bag dump station is also equipped with an integral dust collector that automatically turns on when the dump station door is opened to keep dust from the bag opening away from the operator. Dust collected on the static-conductive filters is pulsed automatically into the bottom of the dump station so no material is lost. The materials have high bulk densities, so the station has a screw discharger on the bottom to provide a metered feed of material into the convey line. It is also designed to prevent any dribbling of powder into the convey line which might affect the accuracy of the conveying process.

The process also uses an Activator™ Bulk Bag Unloading System with "chisel bottom" screw dischargers. The system features a dust-tight cover and cantilevered open flight 6-inch (150 millimeter) auger to provide a consistent,

controlled flow of powder into the convey line. Four pneumatically operated actuator petals massage the lower portion of the bag in an alternating-side pattern to promote optimal material flow toward the center of the bag.

The bulk bag unloading system assembly includes a NEMA 4X control panel and level control so the bag is only massaged when powder is needed. The bag access door is capped for dust collection during bulk bag discharge. It also uses lubrication-free pneumatic lifters that consume 50% less compressed air than air-cylinders, providing A&C with lower operating costs.

A&C can minimize material handling devices, such as forklifts, in the work area by leaving the bulk bag on a pallet, lifting and placing it into the bulk bag unloader with its integral I-Beam and 2 hp hoist. The operator controls the hoist from a remote pendant, taking them safely away from the lifting zone.

The unloader is equipped with a manual iris valve in the bag access housing which allows the operator to untie a full bulk bag discharge spout without any release of product. All product contact surfaces are designed using 316 stainless steel. The entire bulk bag unloader is constructed in stainless steel to meet A&C's Current GMP (cGMP) program.

Observing Materials Travel Distances

Another key factor in sizing and determining the type of system needed is the distance the material is traveling. In pneumatic conveying, the need for more tubing incorporated into the bulk material handling system, or the further the conveying distance, results in the need for larger vacuum pumps since it takes more airflow to pull (or push) the air through the tube.

Vacuum conveying systems move product vertically and are calculated the same as moving product horizontally – in linear feet. However, each 90-degree sweep in the system equals 20 linear feet; thus, moving material horizontally 110 feet (34 meters) and vertically 110 feet (34 meters) with four 90-degree sweeps results in an overall conveying distance of 300 feet (91 meters).

A&C selected vacuum conveying technology because any leaks in the system will be inward, which mitigates the risk of an appositive-pressure system that can develop a leak, resulting in a cloud, or pile, or powder in the work environment. This not only reduces exposure for the operators, but it also aids in reducing combustible dust, sanitation and product yield issues.

The bulk material handling system also factors in the number of equipment connections, headroom requirements for vacuum receiver mounts, and any containment or clean room requirements, as required by A&C. By reducing the number of overall process steps, processors reduce the potential for product segregation resulting in better quality control, smaller equipment, simplified 1:1 scale-up, and shorter production time – while reducing labor and maintenance costs.

Vacuum Conveyor: The Heart of the System

The heart of the process is the sanitary pharma-grade VAC-U-MAX Vacuum Conveyor, which is mounted on a rolling lift frame to allow A&C to remove the equipment from the production room for cleaning. It also allows the conveyor to be raised into operating position above the drum on a scale, and lowered to a travel position.

The process at A&C involves the use of a vacuum receiver mounted on mobile cart with attached pick-up adapter to convey powders.

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PNEUMATIC CONVEYING HELPS PHARMACEUTICAL INGREDIENTS AND EXCIPIENTS MANUFACTURER SAFELY AND EFFICIENTLY MEET DEMAND

The vacuum conveyor is integrated into a screw discharger to eliminate conical hoppers and discharge valves. All product contact parts are designed in 316L stainless steel per 3A Sanitary and USDA design standards. A pneumatic poppet valve on the end of the screw discharger prevents any chance of dribble feed from the receiver into the conveying line. A gas pulse is sent to the receiver's filter to release any entrained material that may have accumulated on the filter during conveying.

A good vacuum conveyor needs a good vacuum producer. The vacuum producer selected for A&C's system is a VAC-U-MAX continuous-duty 5 horsepower (hp) regenerative blower unit due to its good vacuum production and airflow, compact size, direct-driven impeller and low noise level.

The vacuum conveyor also features a C-UL-labeled main control panel in compliance with Canadian electrical standards. The control panel at A&C incorporates all electrical and pneumatic functions from the bulk bag unloader, bag dump station, vacuum conveyor, screw dischargers and a platform scale. The remote devices are plugged into the main control panel with quick disconnect plugs that can be disconnected and capped before wash-down.

The vacuum transfer principle is used as a continuous refill device for continuous operation. Pneumatic receivers use negative pressure to draw material required for refill into the vacuum receiver, which is filled to a pre-determined level with the receiver holding a charge of material until the process below requests a refill. Level sensors are used to determine the level of material in the vacuum receiver. When the process requires a refill, the discharge valve opens, discharging material to the process below – keeping material moving from source to process. The vacuum receivers are designed to be crevice-free and easily cleaned.

Maintaining Momentum

Now more than ever pharmaceutical and nutraceutical manufacturers are enhancing production capabilities by implementing vacuum technology to deliver drugs to consumers faster, safer and more economically. Vacuum technology can also provide safer transfer of bulk dry materials, delivering solutions to tight industry standards for sanitation and environmental safety. BP

About the Author

Doan Pendleton is Vice President, VAC-U-MAX.

About VAC-U-MAX

VAC-U-MAX is a worldwide leader in the design and manufacture of pneumatic conveying components and systems for conveying, weighing, and batching over 10,000 various powders and bulk materials in the food, pharmaceutical, chemical, and plastics industries. Since 1954, VAC-U-MAX has offered solid application and process automation expertise for bulk material handling with a product range including pneumatic, aeromechanical and flexible screw conveying. It developed the world's first industrial vacuum cleaner operating only on compressed air for use in the highly combustible textile mills industry of New Jersey. Its product range also includes industrial vacuum cleaners for high volume recovery of a wide range of materials including combustible dusts, fine powders, granular materials, and flammable liquid recovery. For more information visit www.vac-u-max.com, or email info@vac-u-max.com.

All photos courtesy of VAC-U-MAX.

1 ISPE. https://ispe.org/initiatives/regulatory-resources/gmp GMP Resources. International Society of Pharmaceutical Engineering.

2 EXCiPACT. https://www.excipact.org/ What is EXCiPACT? International Pharmaceutical Excipients Certification.

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THE BASICS OF AERATION CONTROL VALVES – PART 2

By Tom Jenkins, JenTech, Inc.

In the first of this two-part series on the basics of aeration control valves we examined valve fundamentals and basic equations for analysis. Here, we look at interactions between valves and discuss new flow control technologies.

Basic Control Valve Principles

Most aeration systems have multiple diffuser grids drawing air from a common blower discharge header. Control valves are used for isolation and modulating airflow to match process demand.

Let's use Figure 1 to illustrate the basic principles. It shows an aeration system with two parallel tanks, identical diffuser grids, and 8-inch drop legs. The blower output will be regulated to equal the total demand of the two tanks. The air is assumed to be at 8.5 psig p_d and 180 °F_{Td}, and V1 and V2 are butterfly valves (BFVs).

If pressure drops in piping and diffusers are ignored, the downstream pressure is identical for both tanks because submergence is equal. Differences in diffuser pressure loss are negligible. The common air header creates equal upstream pressure at both tanks. Therefore the **pressure drop across both valves is identical.**

In systems with several tanks the valve restriction and airflow will vary from tank

> "Most aeration systems have multiple diffuser grids drawing air from a common blower discharge header. Control valves are used for isolation and modulating airflow to match process demand."
>
> — Tom Jenkins, JenTech, Inc.

to tank, but the Δp will be approximately the same. This is true whether the distribution system contains two valves or twenty. It is true regardless of the type of control device being used for throttling flow.

The upstream pressure of the system is determined by the valve at the position creating the lowest pressure drop necessary to meet the required airflow. This is the "most open valve." In automatic control systems sophisticated programming is required to establish the most open valve. For this simplified example V1 is established as the most open valve. At 1,500 scfm to Tank 1 and V1 set at 70% open the pressure drop will be 0.06 psi.

To create an airflow rate of 750 scfm at a Δp of 0.06 psig V2 must create a C_v of ≈700. With a typical BFV this is achieved at 56% open. Any control valve, regardless of type, would have the same C_v and Δp at these conditions.

It is instructive to analyze the position response of V2 when V1 is in different positions as depicted in Figure 2, which depicts valve positions in the two-tank system. As V1 is closed the pressure differential at 1,500 scfm increases. This in turn requires V2 to move further closed to create the C_v needed to maintain the desired airflow. The data shows a wide range of flow rates can be accommodated so long as the position of V1 is within a reasonable range.

The example assumes the blower is controlled to deliver the airflow required to meet the total process demand. If that's not the case the system can go awry quickly. As the valves at the basins throttle back the system pressure rises. If pressure control or direct flow control isn't used to reduce blower airflow the system will eventually shut down – from high pressure with Positive Displacement (PD) blowers or surge for centrifugal blowers. Control coordination between aeration systems and blowers is mandatory.

The two-valve example demonstrates the importance of Most-Open-Valve (MOV) aeration control for process performance and energy optimization. It also demonstrates that a system with properly sized BFVs can successfully control aeration systems across a wide range of process demands.

Examining Newer Valve Technologies

Economics have made BFVs the dominant throttling device in aeration control systems. In recent years newer technologies have been commercialized to provide alternate ways to control airflow. They include the iris diaphragm valve, the knife gate valve, and proprietary "jet" valves. Some designs offer integrated systems with the flow measurement device built into the control device.

The BFV has a disc mounted to a rotating shaft transverse to the flow direction. As the disc rotates it presents a changing obstruction to airflow. When completely closed a bubble tight seal is created, making it suitable for shutoff service. A variety of materials for specific application needs are available.

Another established technology being applied for airflow control is the V-Port ball valve. Instead of a disc, a ball with a through-hole is used to create a variable restriction and permit shutoff. Instead of a circular hole in the ball one side has a "V" shape to provide improved response to position changes.

Although the knife gate valve is not new technology, it is only in recent years that specialized configurations have been introduced specifically for aeration control. In operation the gate slides across the flow cross section, reducing the flow area. By using specialized shapes in the gate and seat various throttling characteristics can be obtained. The "diamond port" is common and available from multiple suppliers. Other proprietary configurations, such as an elliptical port,

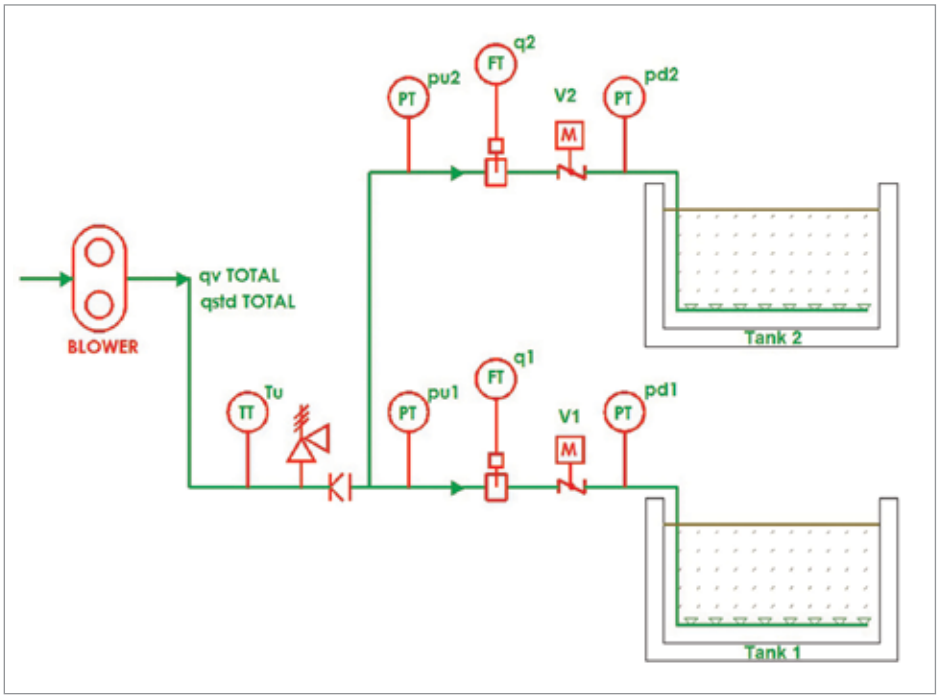

Figure 1.

THE BASICS OF AERATION CONTROL VALVES – PART 2

are available. Some knife gate valves provide a bubble tight shutoff, but many require a separate valve for shutoff.

The iris diaphragm valve gets its name from the similarity in appearance to the iris of a camera. A polygonal opening creates an orifice in the center of the pipe. By rotating the blades of the iris the area of the opening is varied, creating a variable restriction. Many iris diaphragm control valves do not provide bubble tight shutoff, and some have a limited pressure differential range.

The jet valve creates a variable annular orifice using the axial movement of a tapered control element. As the control element moves it changes the clearance between itself and the seat. This modifies the orifice area and restriction to flow. Jet valves provide bubble tight shutoff.

Evaluating Valve Design Performance

There are three advantages commonly claimed for alternate valve designs:

- Lower pressure drops.
- Improved control accuracy.
- Lower energy cost.

Claims of energy reduction must be tested against the Law of Conservation of Energy. The sum of the three pressures in Bernoulli's Law, static, velocity, and friction, must always be equal throughout the flow stream, although the relative proportions may change. This sum must equal the total or stagnation pressure at the blower discharge, which equals the static pressure plus the dynamic pressure. The Δp at the most open valve dictates the value of the discharge pressure.

Comparing different valve technologies can be difficult. Claimed energy savings must be put into the appropriate context. For example, high pressure in many systems is often the result of a control strategy based on maintaining constant blower discharge pressure. If the pressure setpoint is higher than needed at the diffuser drop leg the energy wasted will be the same, regardless of control device design. Claimed reductions in pressure are often the result of implementing MOV logic to reduce total system pressure and not the result of new valve technology.

Energy savings will result if system pressure is reduced. Reductions can be approximated using the blower pressure ratio, assuming inlet temperature and air properties are unchanged:

$$P_2 = P_1 \cdot \frac{\left[\left(\frac{p_{d2}}{p_i}\right)^{0.283} - 1\right]}{\left[\left(\frac{p_{d1}}{p_i}\right)^{0.283} - 1\right]}$$

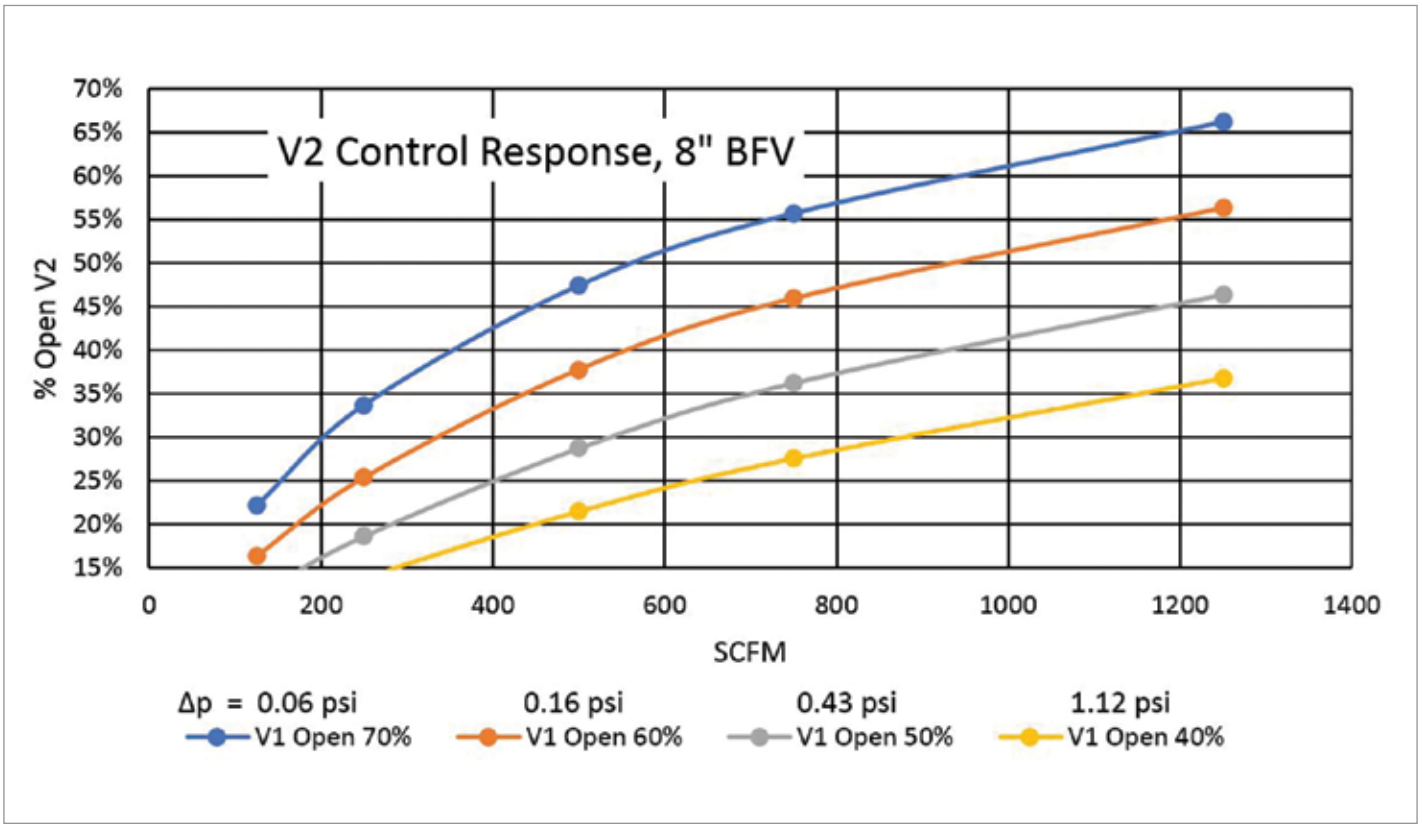

Figure 2.

Where:

$P_{1,2}$ = blower power at condition 1 and 2, kW or hp.

p_i = blower inlet pressure, psia.

$p_{d1, d2}$ = blower discharge pressure at condition 1 and 2, psia.

The claim that velocity head regain results in lower energy for some types is unconvincing. The dynamic pressure is negligible throughout the range of normal air velocities so potential savings are minimal. Furthermore, airflow rate is based on process demand and is independent of valve type. If size and airflow rate are identical then velocity and dynamic pressure are also identical.

Some control valves claim improved precision or greater usable travel, asserting a travel range from nearly 100 to nearly zero percent open. A comparison of C_v for various 8-inch control valves is illustrated in Figure 3 as an example. This shows that although there are variations in the C_v versus position relationship, none of the devices are entirely linear. (Note: The manufacturer of the jet valve does not publish C_v data, and therefore it is not included in this comparison.) Furthermore, in most applications the travel range is not significant; providing adequate flow control range is what is important to the process.

Control device linearity is not critical in most systems. A Proportional-Integral-Derivative (PID) loop does perform best with linear response, but a BFV will be stable if properly sized, equipped with state-of-the-art actuators, and controlled with well-tuned loops. Furthermore, advanced control algorithms used by some suppliers often provide better accuracy and stability than PID.

BFVs can control a wide range of flow. Figure 4 illustrates a 10:1 control range for V2 in the two-valve system, provided the pressure drop through V1 is reasonable. All four valve types operate within their normal range throughout the 10:1 flow variation. Any of the four options will provide good flow control in this system.

In Figure 4, which was developed by analyzing the two-valve system, the flow through V1 was set to 1,500 scfm at 8.5 psig downstream pressure and 180 °F, making air velocity equal to 3,000 ft/min. V1 is the most open valve, and the V1 BFV position was set at 70%. The resulting pressure drop is 0.06 psi. The C_v for the other control devices required to create a 0.6 psi Δp was calculated at various flows. The analysis was repeated with V1 positioned to create a 0.5 psig Δp. The position versus flow rate was plotted for each device. The conclusion is that despite

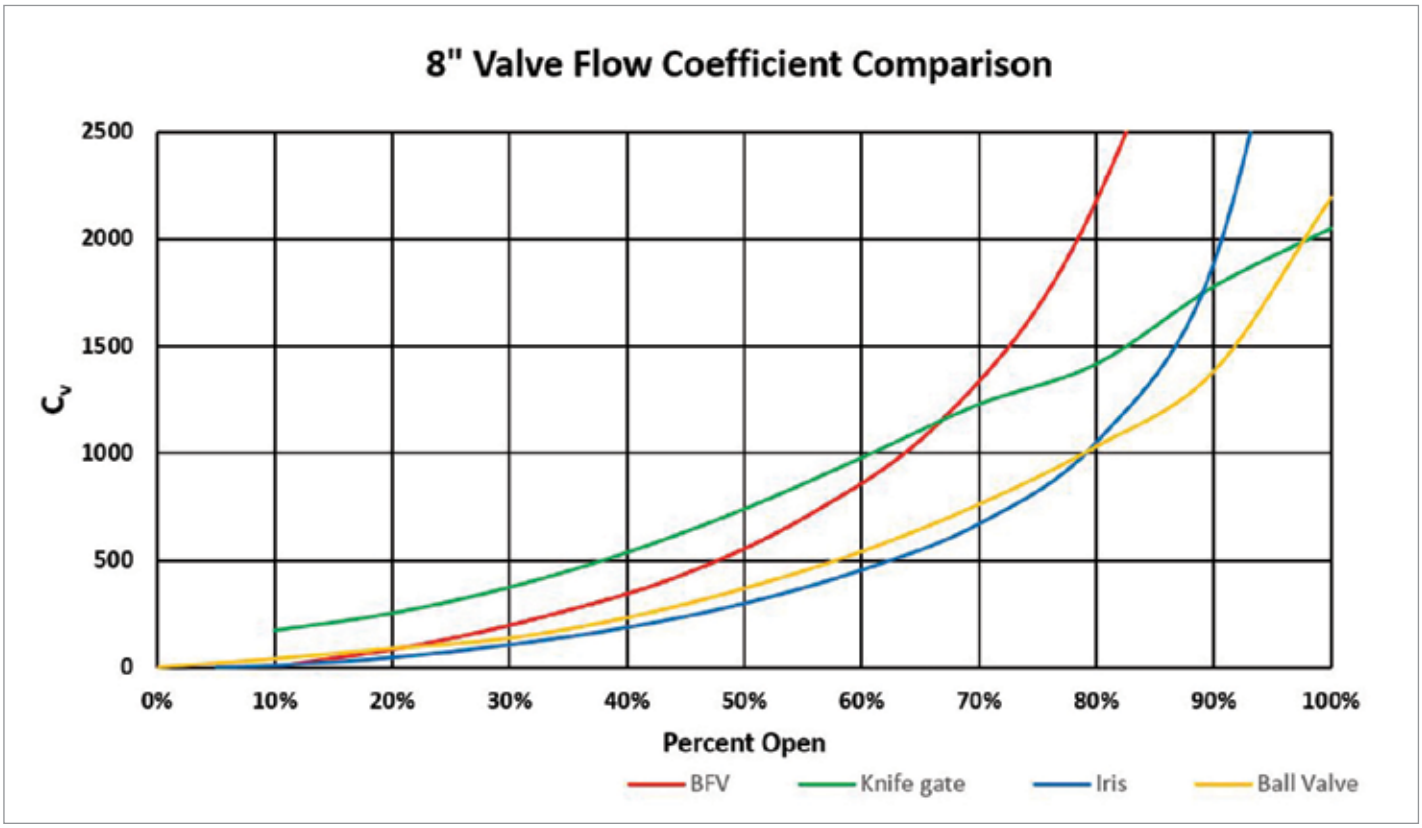

Figure 3.

THE BASICS OF AERATION CONTROL VALVES – PART 2

differences in percentage open all four types were able to provide control over a wide range of flow rates.

The claimed energy savings from increased control precision assume that errors in airflow control to an aeration zone will result in excess aeration. However, it is as likely the airflow error will cause under-aeration as often as over-aeration. Furthermore, experience has shown that with proper sizing and high-quality actuators airflow can be controlled within one or two percent with a BFV. This exceeds the requirements of most treatment processes.

There are many existing systems with poorly performing airflow control, and these failures are often blamed on the inadequacies of BFVs. In many cases, however, the failures were the result of poor sizing, unstable control algorithms, or inaccurate valve actuators.

Erratic control is often the result of poor actuator performance. Older actuators were often unable to provide position accuracy better than plus or minus 3%. Newer designs, with encoders, slow travel times, and digital communications can achieve better than plus or minus 1% accuracy.

Perhaps the most common problem in airflow control is improper sizing of the valve, regardless of type. Obviously, high air velocities through an undersized valve creates excess pressure drop, even at maximum open position. A more common problem, though, is oversizing the valve. This is usually done with the intent of minimizing frictional pressure drop. If this results in operating in the unstable (nearly closed) region small changes in position will result in large changes in C_v and pressure drop. This is true for any type of control device.

It is important to calculate control system performance across the normal operating

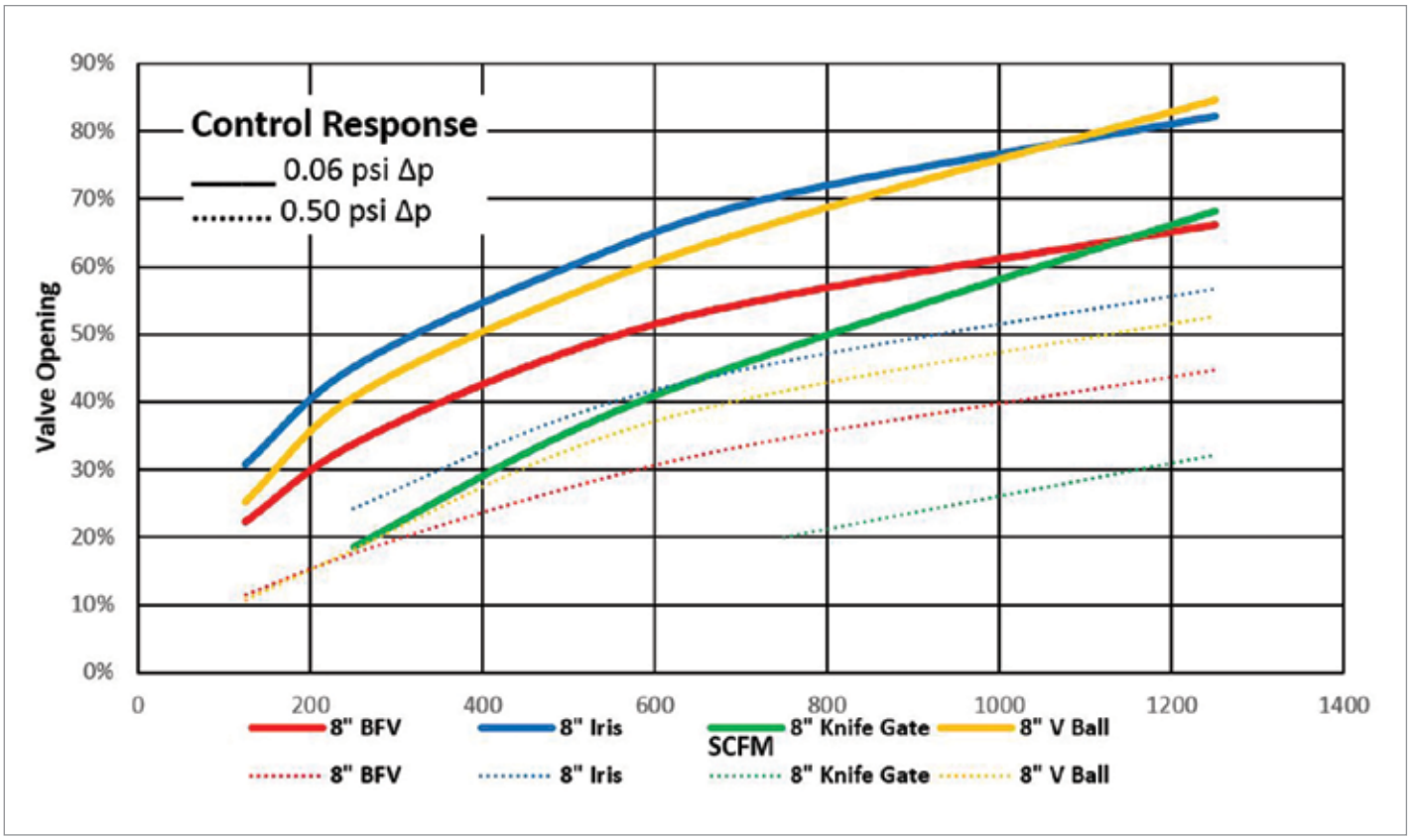

Figure 4.

range of the aeration system. Design specifications are usually based on worst-case conditions. Of course, the system must maintain process performance at design conditions. However, the worst case doesn't represent normal operation, and therefore should not generally be used in analysis for energy or control optimization. Experience has shown that a system with properly sized control valves and effective MOV control will typically operate at pressures 0.5 to 1.0 psig lower than worst-case design conditions.

The Importance of Rigorous Analyses

Valves function by creating pressure drops. Valves controlling airflow provide an adjustable restriction to create the available pressure differential at the required flow rate. Pressure drops across valves in aeration system drop legs are significantly lower than the static pressure downstream of the valve and total system pressure.

In any system the pressure drop will be approximately equal for all flow control valves. The magnitude of pressure drop is determined by the most open valve – typically the valve with the highest velocity. Minimizing pressure drop and optimizing control range requires automatic Most-Open-Valve logic.

There are many types of control valves available for aeration service. Many of these represent higher initial cost than the commonly used butterfly valve. In some applications the higher cost may be justified by lower energy consumption or better control precision. However, rigorous analysis of each application based on realistic conditions should be employed to verify the higher equipment cost is justified.

Any alternative valve selection must be capable of providing the necessary level of control accuracy. The alternative with the lowest lifecycle cost, i.e. the sum of energy cost and equipment cost, is the optimum selection. BP

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

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BLOWER & VACUUM SYSTEM INDUSTRY NEWS

VAC-U-MAX Celebrates 65-Year Anniversary

VAC-U-MAX has reached a proud milestone celebrating 65 years of business providing bulk material handling and industrial vacuum cleaning solutions to industries worldwide. The company has grown from the dreams of its founder Frank Pendleton, who designed the world's first industrial vacuum cleaner that operated only on compressed-air to service the highly combustible textile mills industry of New Jersey. In addition to servicing niches for combustible dust handling, in 1970 VAC-U-MAX designed and engineered compressed-air powered industrial vacuum cleaners for the evacuation of highly flammable jet fuel for Pan American Airways, recovering jet fuel from the wing tanks of the first Boeing 747 aircraft.

Since 1954 VAC-U-MAX designed, manufactured and marketed a full range of compressed-air driven industrial vacuum cleaners for combustible dusts, flammable liquids and reactive powders, with product range expanding to include explosion-proof electric-powered vacs used in agriculture, chemical and food industries, as well as portable, continuous-duty, and central vacuum cleaning systems. In 2018 VAC-U-MAX designed the first renewable energy lithium ion vacuum cleaning system for high volume recovery of post-consumer waste for municipal transit track cleaning applications.

A pioneer with many firsts, in 1965 VAC-U-MAX entered the pneumatic conveying business by designing the first venturi-powered vacuum generator with patented noise suppression for applications conveying black powder for a US ordnance manufacturer. In 1977 VAC-U-MAX introduced the vertical-wall Tube Hopper material receiver designed for difficult to convey materials. Today's manufacturing environment utilizes pneumatic conveying systems for moving a wide variety of powders and granular materials from sources like drums, totes and super sacks, to destinations like process equipment or packaging lines, with vacuum conveying technology the most commercially accepted. In 1989 VAC-U-MAX patented the Bulk Bag (Super Sac) Unloading Station which included massaging actuators that aid material flow from the super sac.

VAC-U-MAX's tradition, vertical integration, application expertise, and manufacturing in Belleville, New Jersey spans three generations, with Steve Pendleton the President of VAC-U-MAX. "It gives me great pride to follow our family tradition and entrepreneurial spirit," said Pendleton. "We are committed to building, expanding, and continuing our legacy by manufacturing high-quality solutions for industries worldwide. I am proud of what our company and employees have accomplished and will continue to accomplish, following the legacy of our founder, Frank Pendleton."

Since 1954, VAC-U-MAX has defined leadership in bulk material handling and industrial vacuum cleaning for a wide range of industries including food, pharmaceutical, nutraceutical, chemical, frac sand, precast

Frank Pendleton, Founder, VAC-U-MAX

Steve Pendleton, President, VAC-U-MAX

"We are committed to building, expanding, and continuing our legacy by manufacturing high-quality solutions for industries worldwide."

— Steve Pendleton, President, VAC-U-MAX

concrete, packaging, additive manufacturing, plastics, nonwovens, and more. A UL-listed designer and manufacturer of control systems for general purpose and hazardous locations, VAC-U-MAX furnishes integrated controls maximizing coordination of material movement with tie-in capabilities to existing control systems. With a customer-centric focus at every step of the process, VAC-U-MAX is committed to continual improvement with quality policies, strategies and quality systems communicated within the organization.

"The secret to the success of any business is being able to focus not on fighting to keep the old, but also on building and expanding the new," said Doan Pendleton, Vice President. "At VAC-U-MAX we focus on our customers and their applications and in doing so incorporate 65 years of process expertise," said Pendleton.

With over 6,000 square feet of available floor space in the Customer Test Facility, VAC-U-MAX offers the ability to create a multitude of equipment configurations. Over 10,000 difficult to convey materials have been tested in their 65 years, adding to VAC-U-MAX application expertise in bulk material handling and industrial vacuum cleaning. The test facility is equipped to meet customer demands for full-scale vacuum conveying, flexible screw and aero-mechanical conveying testing in addition to testing a wide range of industrial vacuum cleaners.

VAC-U-MAX product range includes vacuum conveying components and systems for general purpose and USDA Sanitary designs, multi-ingredient handling / batch weighing systems, bulk bag loading / unloading systems, bag dump stations with integrated dust collection and empty bag compaction, flexible and aero-mechanical screw conveyors, convey line diverter valves, direct charge blender loading, load lifters, mobile vacuum conveying systems, feeder refill systems, filter assemblies and media including HEPA filtration, UL-listed control panels, as well as a full line of portable, continuous-duty and central vacuum cleaning systems for high volume recovery of many materials including combustible dusts, flammable liquids, steel shot, reactive powders and more. For more information visit www.vac-u-max.com.

BeaconMedaes New Medical Vacuum Filter Assembly

BeaconMedaes, part of the Atlas Copco Group, introduced the MV Medical Vacuum Filter Assembly for medical gas pipeline systems. The new bacterial filter assemblies are designed to protect the vacuum system, the workers who maintain the equipment, and the surrounding environment.

The NFPA 99 standard, 2018 edition now requires the addition of bacteriologic filtration at the medical vacuum plant. To meet these new compliance requirements, BeaconMedaes has launched the MV Filter Assembly for medical vacuum, to be installed at the inlet of the vacuum system for removal of any liquids, solids or bacterial contaminations.

The new MV Filter Assemblies utilize a single point connection design featuring interconnecting piping, isolation valves, and a rugged frame that allows for seamless plug and play installation. The modular design allows for quick disassembly to accommodate any hospital or healthcare facility door entrances. With the complexity of installation reduced dramatically as the piping and valves are pre-fitted and assembled at the factory, overall installation costs are reduced. With flanged connections between the filters, valves, and piping, the single point connection design also means there is no risk of leakage. All MV Filter Assemblies are leak tested before leaving the factory.

BeaconMedaes MV Medical Vacuum Filter Assembly for medical gas pipeline systems.

The MV Filters incorporate filter elements of the highest quality. The elements are made from pleated glass fiber media which captures particulates, bacteria and liquid aerosols, removing contamination that could damage the vacuum pump and release harmful contaminants into the downstream air. The MV Filters are independent third party tested and fully compliant to HEPA filter efficiency rating.

In addition, these vacuum filter assemblies have endured stringent earthquake testing to receive the OSHPD seismic pre-certification, proving they are resistant to the most severe earthquake conditions. With the filter certification and the assembly rating, our MV Filter Assemblies provide you with peace of mind.

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

The MV Filter Assemblies range in system capacity from 45 scfm to 630 scfm. All filters in each assembly are capable of individual isolation, and all system capacities shown with one filter in reserve.

"At BeaconMedaes we understand the importance of the customer's lifetime value management. Our MV Medical Vacuum Filter Assemblies offer best-in-class performance, minimal service downtime, ease of installation and low maintenance costs," said Abhijeet Jain, Global Product Manager for Medical Vacuum. "When it relates to compliance and design specifications, we maintain strict standards and thus all our filter elements are third party tested and certified. Additionally, our filter assemblies are seismic certified too, we recognize the added value to offer all these certifications as part of our standard product features. Our MV Medical Vacuum Filter Assemblies are an ideal solution for hospitals and healthcare facilities of any size."

About BeaconMedaes

BeaconMedaes is a global leader providing complete medical gas solutions, including medical air, medical vacuum, gas distribution equipment and pipeline components. BeaconMedaes has several assembly facilities plus an extensive sales and service presence throughout the world. In July 2006, BeaconMedaes was acquired by Atlas Copco and has since become the global competence center for medical solutions within Atlas Copco. More information on BeaconMedaes can be found at www.beaconmedaes.com.

Carnegie Mellon University Professor Named ASCE Distinguished Member

David A. Dzombak, Ph.D., P.E., BCEE, D.WRE, F.ASCE, NAE, was named a Distinguished Member of the American Society of Civil Engineers (ASCE). This is the highest honor to which a civil engineer can aspire. Dzombak, a professor and head of the department of civil and environmental engineering at Carnegie Mellon University, is among the world's most prominent engineers in the area of water quality engineering, energy-environment matters, and water resources sustainability. He recently led a program at Carnegie Mellon on adapting infrastructure for climate change, serving as a template for other engineering schools. He has also led the development of a Ph.D. fellowship program in U.S. Environmental Sustainability.

"ASCE is proud to present the 2019 class of Distinguished Members. Distinguished Members are the most eminent members in ASCE. The nine professionals recognized in 2019 are well-deserving of this recognition for their contribution to the civil engineering profession," said Robin A. Kemper, P.E. "Each member has attained a level of excellence that sets the standard for their peers, paving the way for engineers of the future. These civil engineers will join the ranks of 220 other current ASCE members who have received this honor."

Dzombak is being honored for his outstanding education, leadership and research contributions to water quality engineering, sustainable water resources and energy-environment issues. Spanning a wide set of applications, his work has addressed topics in aquatic chemistry; fate and transport of chemicals in water, soil and sediment; water and wastewater treatment; in situ and ex situ soil and sediment treatment; industrial waste management; abandoned mine drainage remediation; climate change adaptation for infrastructure; interbasin water transfer; and sustainability in mining.

Dzombak has served on the U.S. Environmental Protection Agency Science Advisory Board, the National Academies Roundtable on Science and Technology for Sustainability, the National Academies Water Science and Technology Board, and has made significant professional service contributions with many other agencies and organizations.

Dzombak has coauthored several notable books on water and soil chemistry and treatment, including two books on surface complexation modeling which have been impactful in providing a consistent thermodynamic database for metal adsorption on hydrous metal oxides. He has published over 150 papers and book chapters and holds three patents.

In 2008, Dzombak was elected to the National Academy of Engineering for the development of models used in evaluating chemical behavior in water quality engineering and environmental remediation. Recent honors include the Gordon Maskew Fair Award from the American Academy of Environmental Engineers and Scientists (AAEES), the Civil Engineer of the Year Award from the ASCE Pittsburgh Section, the Distinguished Service Award from the Association of Environmental Engineering and Science Professors (AEESP), and the ASCE Simon W. Freese Environmental Engineering Award. Dzombak is a Fellow of ASCE, AEESP and the Water Environment Federation.

Dzombak is also a member of the American Academy of Water Resources Engineers, American Chemical Society, American Geophysical Union, American Society of Engineering Education, American Water Resources Association, American Water Works Association, National Civil Engineering Honor Society (Chi Epsilon), Engineers Society of Western Pennsylvania, Geochemical Society, National Ground Water Association, Pittsburgh Geological Society, Society of Environmental Toxicology and Chemistry, and Tau Beta Pi. Dzombak has a doctoral degree in civil engineering from Massachusetts Institute of Technology and earned his bachelor's and master's degree in civil engineering from Carnegie Mellon University, in addition to holding a bachelor's degree in Mathematics from Saint Vincent College.

About the American Society of Civil Engineers

Founded in 1852, the American Society of Civil Engineers represents more than 150,000 civil engineers worldwide and is America's oldest national engineering society. ASCE works to raise awareness of the need to maintain and modernize the nation's infrastructure using sustainable and resilient practices, advocates for increasing and optimizing investment in infrastructure, and improve engineering knowledge and competency. For more information, visit www.asce.org or www.infrastructurereportcard.org.

Piab Offers Three Models of piFLOW® Vacuum Conveyors

Regardless of whether they are used for baking goods, confectionery, instant food, food additives or nutraceuticals, piFLOW® vacuum conveyors meet the demands of the global food industry. Offering low noise and contained conveying, ATEX certification, compliance with FDA and EU 1935/2004 regulations, as well as fulfilling current Good Manufacturing Practice, the conveyors ensure a safe working environment and problem-free, highly productive operations.

Featuring a small footprint with flexible routing of pipelines, Piab's conveyors save space and are easy to move. A hygienic design makes them easy to clean and maintain, enabling quick changeover times and contributing to greater process uptime. Fitted with special features to mitigate segregation issues, they also guarantee safe and reliable production involving active ingredients.

Three models are available for the food industry; piFLOW®f serves the basic food industry, piFLOW®p targets premium applications, and piFLOW®t handles tablets and other fragile products. A comprehensive range of accessories complements the conveyors. This includes suction pipes that provide a lightweight and ergonomically correct solution for generally free flowing or granular materials, feed nozzles for more challenging materials that allow the air intake to be

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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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About Piab

Established in 1951, Piab designs innovative vacuum solutions that improve energy-efficiency, productivity, and working environments for vacuum users around the world. As a reliable partner to many of the world's largest manufacturers, Piab develops and manufactures a complete line of vacuum pumps, vacuum accessories, vacuum conveyors and suction cups for a variety of automated material handling and factory automation processes. Piab utilizes COAX®, a completely new dimension in vacuum technology, in many of its original products and solutions. COAX® cartridges are smaller, more energy efficient and more reliable than conventional ejectors, and can be integrated directly into machinery. This allows for the design of a flexible, modular vacuum system. In 2016, Piab completed two strategically important acquisitions, Kenos and Vaculex. Piab is a worldwide organization with subsidiaries and distributors in almost 70 countries. Its headquarters are in Sweden. For more information about Piab, visit www.piab.com.

piFLOW® vacuum conveyors feature a small footprint with flexible routing of pipelines.

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Advertising & Editorial: Rod Smith
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A Publication of: Smith Onandia Communications LLC
37 McMurray Rd. Suite 106
Pittsburgh, PA 15241

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

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