The Magazine for ENERGY EFFICIENCY in Blower and Vacuum Systems

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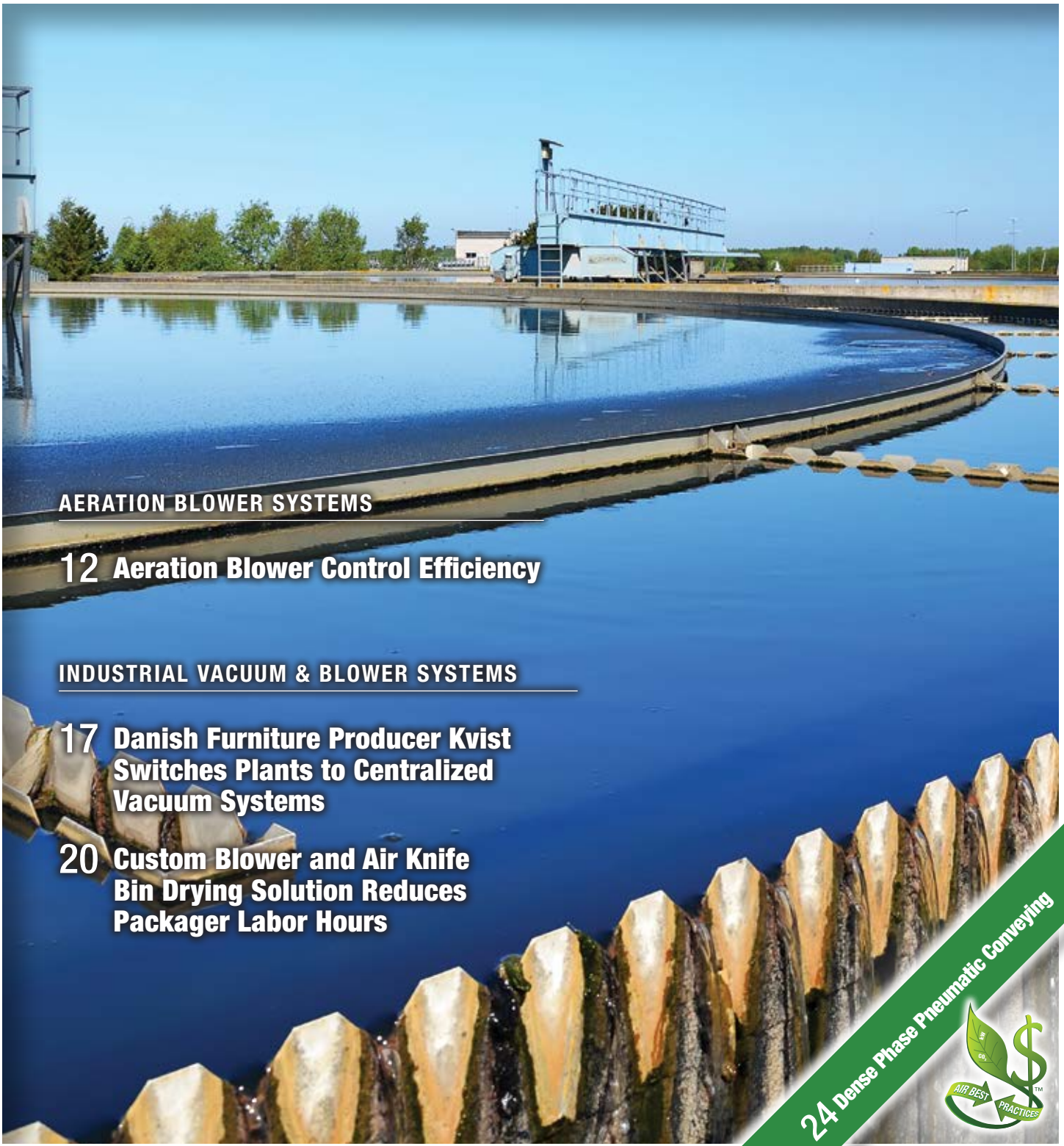

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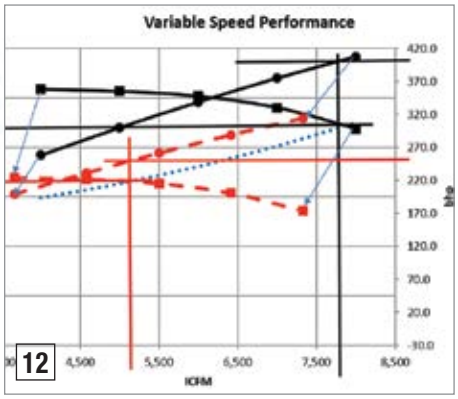

INDUSTRIAL VACUUM & BLOWER SYSTEMS

COLUMNS

FROM THE EDITOR

The aeration blower market has experienced dramatic changes over the past twenty years, driven by the average municipal Water Resource Recovery Facility (WRRF) realizing there were much better ways to aerate their plants. One significant change still occurring rapidly is in the field of aeration blower controls and control strategies. Industry expert, Tom Jenkins, kicks off this issue examining the control technologies on different types of aeration blowers and recommending topics system designers should analyze.

I personally believe the centralization of vacuum pumps, in industrial plants, is one of the next big system optimization opportunities. Danish furniture manufacturer, Kvist Industries, has centralized their vacuum systems in three plants. Uli Merkle reports Kvist, using Busch Mink Claw pumps to centralize, realized improved vacuum clamping response times, a safer and quieter work environment and vacuum system energy-savings of sixty-one percent (61%). This Energy Conservation Measure (ECM) should be on the radar screen of every Utility Incentive Program Manager looking to boost participation in their Industrial Custom Incentive Programs.

Air drying and blow-off applications are another ECM gaining momentum. JetAir Technologies is a leading solution provider with their centrifugal blowers and air knives. Kacie Goff provides us with an interesting article on a customized air drying application they engineered for a wine bladder production line. The solution allowed the company to automate their drying process and the labor hour savings allowed them to redeploy production workers into other areas.

Dense phase pneumatic material conveying carries a much different (higher!) energy cost than dilute phase systems. While most focus on system pressure, Hank van Ormer writes about a less understood dynamic in conveying systems, air velocity. In this case study, a transport system has inserted boosters into a dilute phase system, creating high energy costs and quality issues resulting from excessively high particle velocities.

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

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

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Three New Atlas Copco GHS 3800-5400 VSD+ Vacuum Pump Models

Atlas Copco is adding three new models to its highly efficient GHS VSD+ series of variable speed drive vacuum pumps. To date, the maximum flow rate has been 1065 cfm. Screw vacuum pumps are suitable for applications with high vacuum requirements, for example in the glass industry, on packaging lines, in can production or in drying processes. They are especially useful for upgrading from several decentralized pumps to a central vacuum supply system. With the GHS VSD+ users can significantly boost their productivity; Atlas Copco reports energy savings of up to 50% are possible, in comparison with conventional rotary vane vacuum pumps. "The payback period for a converted system is extremely short," says Christoph Angenendt, an Atlas Copco communications manager for industrial vacuum.

The three new variable speed drive GHS VSD+ vacuum pump models are available for intake flows from 3800 to 5400 m3/h.

"The new units deliver higher volume flows per hour and per kilowatt power input, than any other vacuum pump of comparable capacity," adds Angenendt. "And they are among the most efficient vacuum pumps on the market." The design of these units is based on the tried and tested plug-and-play principles of Atlas Copco's well-known compressors.

Vacuum Precisely Tailored to Meet Demand

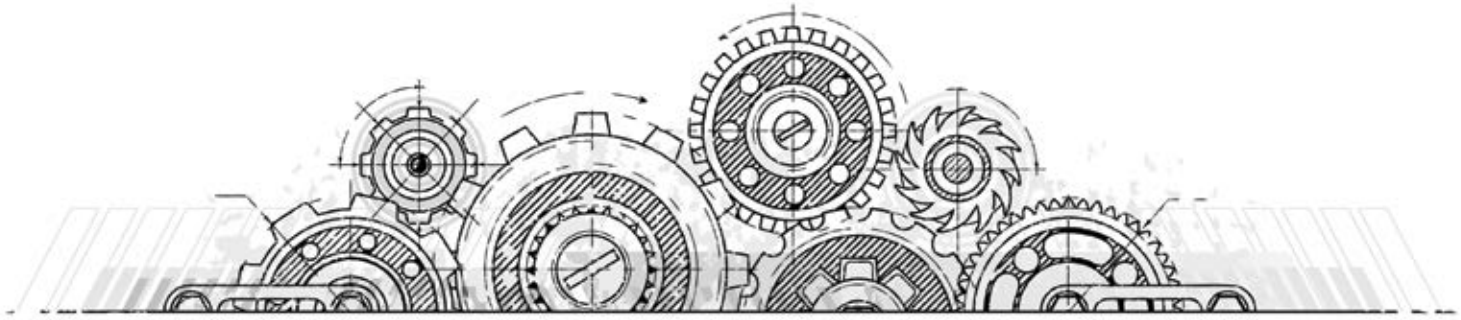
The GHS 3800–5400 VSD+ vacuum pumps are high-performance, environmentally compatible units. In a central vacuum system, the new pumps can precisely tailor vacuum production to meet customers' demand. The pumps, equipped with smart Elektronikon controllers and variable speed drive systems (VSD), are extremely economical in operation. The pressure set point control function also ensures the pumps deliver the lowest possible vacuum flow, maintaining the required vacuum. This means no energy is wasted and life cycle operating expenses are significantly reduced.

Low maintenance requirements also help keep life-cycle costs low. There are no rotary vanes needing to be replaced and the screw element does not require maintenance for many years. In addition, intake filters and oil separators can be replaced without dismantling any piping. Maintenance cycles in general are very long and operators can obtain information on all the maintenance work required using a network with Smartlink software.

Small Footprint, Easy Installation

Atlas Copco supplies the vacuum pump as a plug-and-play system in a single housing. Installation is very quick and simple, saving time and space. The units have a very small footprint. Even the largest variant of the GHS VSD+ series (3800-5400) is less than 6.5 ft. x 10 ft. These models are also considerably quieter than comparable pumps, and fit very well into environmental and energy management systems in accordance with ISO 50001 and 14001. Energy recovery components can be integrated into the system, allowing users to recover a large amount of the heat unavoidably generated by compression without sacrificing pump performance. Atlas Copco reports recoverable energy levels of about 75%.

The GHS-VSD+ pumps have been developed especially for the working pressures most commonly required in industrial vacuum applications. They offer significantly higher performance than other oil-sealed and dry



TECHNOLOGY PICKS

vane vacuum pumps. Energy recovery keeps heat release in the vicinity of the units to a minimum, meaning air conditioning systems are not needed for nearby work stations.

Electronically Monitored Cooling System

The cooling system is equipped with an electronic thermostatic valve accurately controlling the oil temperature. This means the oil retains its optimum consistency, as any entrainment of water to the oil cycle by condensation is avoided. The cooling system also operates with a speed-controlled fan to minimize energy requirements. The vacuum pumps in the GHS 3800–5400 VSD+ series are available with water or air cooling.

Due to the extremely high oil retention capacity of the GHS VSD+, environmental impact at all operating pressures is significantly lower than with other vacuum pumps. The range, recently extended upwards, now includes for the first time a new, patented oil separator limiting the residual oil level to a maximum of 3 ppm. "This means that the exhaust air is significantly more environmentally compatible than with other oil-injected pumps of this size available on the market," Angenendt reports. In addition, the Atlas Copco technology allows shorter cycle times because the pump reacts very quickly to changed process conditions in the pressure range relevant for the user.

The screw element has a sturdy design and a considerably longer service life than the elements typically used in screw compressors or rotary vane pumps. The special inlet control valve, operating in close liaison with the variable speed drive, allows energy consumption to be minimized.

All the pumps are equipped with Elektronikon controllers and the Smartlink remote monitoring system. The tried and tested Elektronikon controller is easy to understand and also ensures energy savings. It can be integrated into a process control system and can also control other manufacturer's vacuum pumps.

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and services focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden and has a global reach spanning more than 180 countries. In 2016, Atlas Copco had revenues of BSEK 101 (BEUR 11) and about 45,000 employees. For more information, please visit http://www.atlascopco.com/us/.

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TECHNOLOGY PICKS

Atlas Copco's Vacuum Technique business area provides vacuum products, exhaust management systems, valves and related products mainly under the Edwards, Leybold and Atlas Copco brands. The main markets served are semiconductor as well as a variety of industrial segments. The business area has a global service network and innovates for sustainable productivity in order to further improve its customers' productivity. Principal product development and manufacturing units are located in the United Kingdom, Czech Republic, Germany, South Korea, China and Japan.

Industrial Vacuum is a division within Atlas Copco's Vacuum Technique business area. It develops, manufactures and sells sophisticated vacuum products and solutions for customers in the industrial process and rough vacuum sectors, for example steel, CPI (chemical process industries), metallurgy, petrochemical, food packaging and paper handling. The division markets products under the Atlas Copco, Edwards, Quincy and Leybold brands. The division's focus is to improve customers' productivity. The divisional headquarter is in Cologne Germany, the main production locations are in Cologne, Qingdao and Tianjin China, Lutin Czech, Valence France and Antwerp Belgium.

ULVAC Introduces VS Single-Stage Rotary Vane Vacuum Pumps

ULVAC Technologies, Inc. has introduced the VS Series of single-stage rotary vane pumps for a wide range of industrial vacuum applications. The ULVAC VS650A and VS750A are robust, install-anywhere pumps, with speeds up to 750 m3/h. These small footprint, all-in-one pumping powerhouses are built for high reliability and ease-of-maintenance.

The ULVAC VS650A and VS750A are "install-anywhere" pumps with speeds up to 750 m3/h.

The VS Series models are available with air or water-cooling, offer low vibration and are affordably priced. Featuring a built-in oil-cooling fan, and simple to clean oil-mist trap, these compact units take up far less space than conventional single-stage rotary vane pumps. To increase pumping speeds even further, a mechanical booster pump can be added for speeds up to 3,100 m3/h. Typical applications include: evaporation, sputtering, ion plating, vacuum drying, gas exchange and leak testing.

About ULVAC Technologies, Inc.

ULVAC Technologies, Inc. is a leading supplier of production systems, instrumentation, vacuum pumps and components for the semiconductor, MEMS, solar, flat panel display, research automotive, medical, electrical, and refrigeration industries. ULVAC Technologies uses a class-10 process development laboratory and customer demonstration facility to meet the unique needs of their different markets. ULVAC Technologies is a subsidiary of ULVAC, Inc., made up of 39 companies engaged in most sectors of the vacuum industry. For more information, visit www.ulvac.com

Kice Industries Announces Release of New VJX Airlock

Kice Industries announced it has introduced the new Kice VJX Airlock to its Rotary Airlock line. The VJX Airlock offers better performance and reliability than other airlock valves on the market today.

"The patented bearing and seal cartridge allow us to eliminate the need for packing material around the shaft where it passes through the endplate," said Tim Kice, Kice Industries. "The bearing and seal cartridge not only outperform traditional packing material, it also eliminates several parts previously required. This reduction in parts reduces disassembly time greatly which will lead to more uptime, and reduced operating cost."

The VJX airlock is interchangeable with existing Kice Airlock models and is designed to comply with NFPA 69 requirements.

About Kice Airlocks

Kice rotary airlocks start with heavy-duty castings that are produced at Kice's own foundry. State-of-the-art equipment turns Kice's castings into precisely machined valves with consistently tight clearances. Kice airlocks are used in pneumatic conveying, dust control and flow control applications

TECHNOLOGY PICKS

The new Kice VJX Airlock

About Kice Industries

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

New Optimized Maxum Maxumizer® Part Drying Technology

Maxum, LLC has introduced a line of Maxumizer® blowers, nozzles, and air knives. The internal air flow design of all Maxumizer® Air Blower systems is specifically optimized to provide higher output with less energy in the best performance range for surface blow-off and drying applications. In most cases this design will use 30-50 percent less horsepower while running at much slower speeds.

RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Maxum's unique approach to air blow-off is illustrated in its innovative drive system. The Maxum Bearing Bridge™ drive system permits industrial parts drying and air blow-off systems to use less energy and effectively run on less horsepower at slower speeds, while lasting longer. This science-based drive system replaces the typical belt-driven system, and employs two separate bearing cases located on either side of the drive pulley. The unique design provides a properly distributed bearing load and dramatically reduces heat while greatly improving service life. Why? "Because this design provides properly positioned bearing load to reduce heat and dramatically extend service life," says Jim Freers, President and CEO. "In fact, this design provides 10-15 times the 'L10' bearing life of older cantilever drives that rapidly fail from the uneven overhung belt load."

Every Maxum Air Device includes standard output flow and pressure data, and every Maxum

Maxumizer® Air Blower systems provide higher output with less energy.

TECHNOLOGY PICKS

Blower provides CFM, pressure and horsepower required. As a result, users don't have to guess or "call the factory" to correctly select Maxum products. Maxum has also developed blower enclosures reducing the operating sound level below 75dB at a three-foot distance. These corrosion resistant polymer enclosures have a small footprint, standard gauges to monitor performance, oversize filters with pre-filters and an integrated skid mount.

Another prime example of Maxum's science-based approach is its new converging and laminar flow technology. With traditional blow-off devices, the focused air starts to expand as soon as it leaves the nozzle. With Maxum's converging and laminar flow technology, the air reaches the part in a stronger, faster, more concentrated form, improving efficiency while saving energy. All Maxumizer® Air Knives, Air Nozzles, & the Patented Nozzle Bar® System employ this converging and laminar flow technology.

Maxum's innovative air blow-off and drying equipment remove water, liquids, and debris, successfully preparing products for assembly, packaging, labelling, inkjet printing, inspection, powder coating, and more, using energy efficient blow-off equipment. Whether it is fruit, vegetables, bottles, cans, metal parts, circuit boards, extrusions, or any other air blow-off application, the Maxum mix of creativity and science ensures the success of your application.

For more information please visit www.maxumair.com.

Silvent Introduces New SILVENT MJ4-QS Air Nozzle Design

Silvent is introducing a new energy-efficient air nozzle designed for quick and easy installation. A growing number of companies are interested in compressed air optimization, and the new SILVENT MJ4-QS now makes it easy to equip small, open pipes.

SILVENT MJ4-QS is a micro nozzle made of 316 L stainless steel. The nozzle is designed with a central hole in combination with surrounding vents. SILVENT MJ4-QS is equipped with an adapter, easily installable on an existing open pipe. The adapter makes installation easy, smooth and quick, with no impact on the equipment. The small mounting dimensions for the nozzle can fit on most machine designs. SILVENT MJ4–QS is made for fixed-installations and fits 4 mm OD open pipes.

About Silvent

Silvent helps manufacturers with energy optimization and improved working environment. The headquarters are located in Borås, where all research and development takes place. The company has unique expertise in the area of compressed air dynamics. Silvent's products and customized solutions for blowing with compressed air are used by leading manufacturers and brands worldwide. Today, Silvent's products are available in 77 countries, and in 2016 the company's sales brought in SEK 125 million. Silvent is part of the Lifco Group, listed on Nasdaq Stockholm. For more information, please visit www.silvent.com

Aeration Blower Control Efficiency

By Tom Jenkins, JenTech Inc.

Blower manufacturers are the source for the most accurate information on aeration blower power consumption. This includes the impact of various control technologies on the many types of blowers used for aeration. However, system designers often need to analyze several alternatives, making reliance on input from suppliers inconvenient. An understanding of the principles of operation will also enhance the designer's ability to assess the data received from various sources.

Common Characteristics

Blowers are volumetric flow devices. ACFM (Actual Cubic Feet per Minute) at any conditions or, FAD (Free Air Delivery), at ambient conditions are terms commonly used to measure volumetric flow rates. Blower manufacturers prefer to work in ICFM (Inlet Cubic Feet per Minute), the volumetric flow at the blower inlet connection. It is important to always define the temperature and pressure of the volumetric flow rate under consideration to avoid errors.

The aeration process demand is a mass flow rate, often expressed as SCFM (Standard Cubic Feet per Minute) at 68° F, 14.7 psia, and 36% relative humidity. It is possible to convert between standard conditions and actual conditions:

$$ACFM = SCFM \cdot T_a / (p_a \cdot 35.92)$$

Where:

ACFM = Actual volumetric flow rate, ft^3/min
SCFM = Flow rate at standard conditions, f^3/min

Performance Table[a]						
Discharge Pressure p2 (psig)[b]		Delivered Air Flow - FAD (cfm)				
		MIN FAD[d]	FAD2[e]	FAD3[e]	FAD4[e]	100% FAD
14 psig	FAD[f]	322	450	634	675	841
	Spec. Power[g]	6.17	5.69	5.32	5.27	5.13
	Blower Speed (rpm)[h]	2500	3219	4225	4455	5375
12 psig	FAD[f]	324	511	777	870	1067
	Spec. Power[g]	5.66	5.11	4.81	4.78	4.74
	Blower Speed (rpm)[h]	2500	3556	5035	5575	6725
10 psig	FAD[f]	328	514	779	871	1068
	Spec. Power[g]	5.11	4.65	4.41	4.40	4.38
	Blower Speed (rpm)[h]	2500	3556	5035	5575	6725
8 psig	FAD[f]	334	554	863	984	1200
	Spec. Power[g]	4.18	3.83	3.72	3.75	3.79
	Blower Speed (rpm)[h]	2500	3759	5521	6245	7535

Figure 1: Sample PD Tabulated Data

Where:

T_a = Actual air temperature, °R
p_a = Actual air pressure, psia

This formula ignores relative humidity. For most process calculations, the resulting error is negligible. If relative humidity is significant, for example in evaluating power guarantee, the calculation becomes:

$$ACFM = SCFM \cdot 14.58 / (p_b - (RH \cdot p_{sat})) \cdot T_a / 528 \cdot p_b / p_a$$

Where:

p_b = barometric pressure, psia
RH = relative humidity, decimal
p_{sat} = saturation vapor pressure, psia (function of temperature)

Blower discharge pressure also has an impact on blower power. For most aeration processes, 80% to 90% of the discharge pressure is static pressure resulting from diffuser submergence. The second factor in system pressure, is the friction resulting from air moving through piping and diffusers. The total pressure can be calculated and plotted against the flow rate, creating the system curve:

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

Where:

p_{total} = Total discharge pressure, psig
d = Depth of water at top of diffuser, ft
k_f = Constant of proportionality for friction, $psi/SCFM^2$
Q = Air flow rate, SCFM

If an operating point of flow and pressure is known, either from calculation or measurement, the constant k_f can be calculated:

$$k_f = (p_{actual} - d \cdot 0.433) / Q_{actual}^2$$

Where:

P_{actual} = Discharge pressure, psig Q_{actual} = Air flow rate, SCFM

The system curve is necessary to evaluate blower performance. The intersection of the system curve with the blower performance curve identifies the operating flow rate, pressure, and power requirement. Regardless of the evaluation method used, it is important to identify the conditions of the air at the blower system inlet and discharge. The necessary parameters include:

- barometric pressure
- inlet pressure (barometric minus losses)
- inlet temperature
- relative humidity
- flow rate (SCFM preferred)
- discharge pressure

Wire-to-Air Evaluations

For any blower, the power can be calculated using:

$$P_{wa} = (Q_s \cdot T_i) / (\eta_{wa} \cdot 3131.6) \cdot X$$
$$X = (p_d / p_i)^{((k-1)/k)} - 1$$
$$(k - 1) / k \approx 0.283$$

Where:

P_{wa} = wire-to-air power, kW
Q_s = flow rate, SCFM
T_i = inlet air temperature, °R
η_{wa} = wire-to-air efficiency, decimal (includes blower, motor, and VFD)
X = adiabatic factor, dimensionless
p_d, p_i = discharge and inlet pressure, psia
k = ratio of heat capacity = Cp/Cv, dimensionless

In many evaluations, the cost of electricity is taken as a composite (average) rate. This is obtained by dividing the total cost for a month by the total power used in a month. The annual cost determination is straightforward:

$$\text{Annual Cost} = \$/\text{kWh} \cdot kW_{ave} \cdot 8760$$

The composite rate may not accurately reflect actual operating cost, typically composed of several components:

- On-Peak rate, typically 12 hours per weekday
- Off-Peak rate 12 hours per weekday and 24 hours for weekends (lower than on-peak)
- Peak demand charge for highest 15-minute average per month

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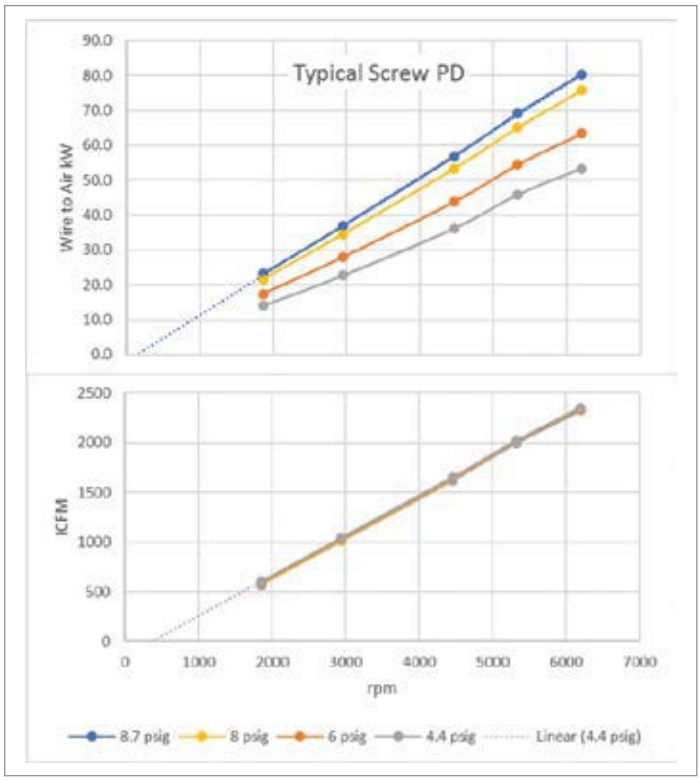

Figure 2: Sample PD Graphical Data

Each of these usually represents 1/3 of total power cost. The air-flow rates and power cost for each component can be estimated if the average daily air flow, Q_{ave}, is known:

$$Q_{OnPeak} = Q_{Ave} \cdot 1.15 \qquad Q_{OffPeak} = Q_{Ave} \cdot 0.85 \qquad Q_{Demand} = Q_{Ave} \cdot 1.20$$

The total annual electricity cost is the sum of On-Peak, Off-Peak, and Demand costs.

$$OnPeakCost = \$/kWh_{OnPeak} \cdot kW_{OnPeak} \cdot 60hr / week \cdot 52week / year$$
$$OffPeakCost = \$/kW_{OffPeak} \cdot kW_{OffPeak} \cdot 10hr / week \cdot 52week / year$$
$$DemandCost = \$/kW_{Demand} \cdot kW_{Demand} \cdot 12month / year$$

Blower performance is often referenced to efficiency, and design-point efficiency is sometimes used to compare blowers. However, the end user pays for energy and power, not efficiency. The total power across the expected operating range should be used for comparisons.

Positive Displacement (PD) Blowers

Positive Displacement (PD) blowers move a fixed volume of air from inlet to discharge for every revolution of the blower shaft. For positive displacement blowers at a given speed, the performance "curve" is quite linear. The total blower volumetric air-flow rate will not change substantially with discharge pressure, but power will increase with increasing pressure.

There are two types of PD blowers commonly used in wastewater treatment. The lobe type PD (often referred to as a "Roots" blower) has been available for 150 years. The newer type screw PD blowers provide excellent efficiency and broad operating ranges, albeit at a higher capital cost than lobe types.

Regardless of type, modulating the PD's air flow rate requires varying the blower speed. The most practical technique for doing this is the variable frequency drive (VFD).

PD blower performance may be provided in various formats. Manufacturer's formulas and characteristics may be available, although this information is often considered proprietary. It is more common to provide tabulated data indicating flow and power at various speeds and pressures. See Figure 1. Linear interpolation can be used to determine performance at operating points not included in the table. The "forecast" function in spreadsheet programs is a useful tool for interpolation.

Graphical representation of PD performance is also useful in estimating performance for variable speed PD blowers. See Figure 2. It should be noted neither flow, or pressure performance, has a zero intercept. This is a result of the blower's internal leakage and mechanical friction. Using speed ratio alone will produce significant inaccuracies. The conventional formulas for calculating lobe type PD blower performance illustrates the non-zero intercept:

$$ICFM = (N_{actual} - N_{slip}) \cdot CFR$$
$$bhp = [0.0044 \cdot N_{actual} \cdot CFR \cdot \Delta p] + FHP$$

Where:

- N = rotational speed, rpm (N_{slip} is the speed required to offset internal leakage)
- CFR = blower displacement, cubic feet per revolution
- bhp = blower shaft power, brake hp
- FHP = friction horsepower, bhp

Dynamic Blowers

Dynamic blowers, commonly called centrifugal blowers, have more complex performance characteristics than PD blowers. Centrifugal blowers convert the kinetic energy of the rotating impeller to kinetic energy in the air stream. In the diffuser section, and in the volute, some of this kinetic energy (i.e. velocity pressure) is converted to potential energy (i.e. static pressure). Unlike PD blowers, centrifugal blower flow-rate and discharge pressure are influenced by the density of inlet air, and by the process system's resistance to flow.

There are three types of centrifugal blowers used in wastewater treatment.

- Multistage blowers achieve required discharge pressure by successive compression in each stage.
- Geared single stage blowers achieve required discharge pressure by high impeller rotational speed. Standard motors are connected to the blower by speed increasing gear boxes.
- High speed gearless blowers, commonly called turbo blowers, achieve required discharge pressure by high rotational speed. The impellers are mounted directly on special motors, operating at several thousand rpm, and are powered through VFDs with output frequencies of several hundred Hz.

There are a variety of techniques used to modulate the flow rate of centrifugal blowers:

- Inlet throttling, typically with a butterfly valve, creates a pressure drop at the blower inlet. This method is inexpensive, but also has the lowest energy efficiency. Throttling can be used on any type of centrifugal blower, but it is common only on multistage blowers.
- Guide vanes, both on inlet and discharge, are generally found on geared single-stage blowers. Guide vanes modify the blower performance by changing the pressure vs. flow characteristics. Inlet guide-vanes pre-rotate the air, reducing the kinetic energy transferred. Variable discharge diffuser vanes modify the conversion of velocity pressure to static pressure. Both are more efficient than throttling, but introduce a loss in efficiency at low flows by creating a pressure drop.
- Variable speed, typically using VFDs, can be used with any centrifugal blower and is always used with turbo blowers. This is both the most efficient and most expensive control method. Varying blower-speed shifts the blower performance curve down and to the left.

Determining the performance of a centrifugal blower first requires calculating the impact on the performance curve of differences between the air density used to develop the manufacturer's curves, and the actual site density. Then, a family of curves is developed from the new curve, identifying the performance with several levels of modulation. Finally, the system curve is superimposed on these curves to identify the flow rate.

AERATION BLOWER CONTROL EFFICIENCY

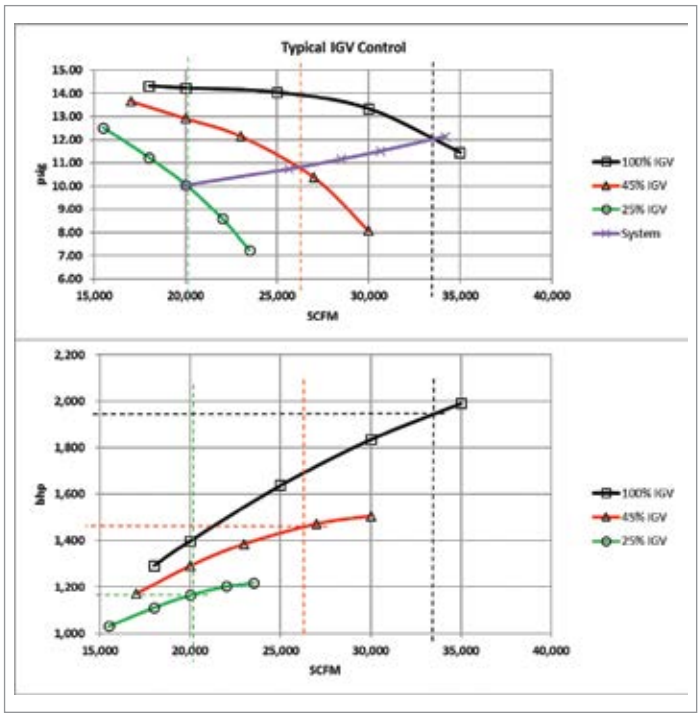

Figure 3: Example Inlet Guide Vane Control

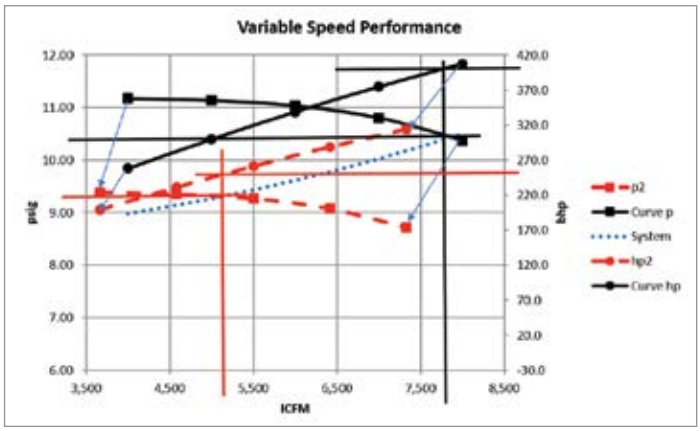

Figure 4: Variable Speed Centrifugal

For inlet throttling, creating a modulated curve requires calculating the pressure drop through the throttling valve at several flow rates. Next, calculate the discharge pressure using the new inlet pressure and the unthrottled pressure ratio. The pressure drop through the valve is determined from C_v, this in turn is a function of the valve design and position:

$$\Delta p_v = (Q_s / (22.66 \cdot C_v))^2 \cdot (SG \cdot T_u) / p_u$$

Where:

Δp_v = pressure drop across the valve, psi
Q_s = flow rate, SCFM
C_v = valve coefficient from manufacturer's data, dimensionless
SG = specific gravity, dimensionless, (1.0 for air)
T_u = upstream absolute air temperature, °R
p_u = upstream absolute air pressure, psia

Inlet guide vane operation is more complex, and the manufacturer usually supplies a set of curves showing performance at several vane positions. These curves need adjustment for changes in inlet density. The system curve can then be superimposed to determine performance. See Figure 3.

Centrifugal blowers controlled with VFDs don't follow simple linear relationships like PD blowers. Regardless of the type of centrifugal, the affinity laws must be used to create the modulated performance curves: See Figure 4.

$$Q_a = Q_c \cdot N_a / N_c \qquad P_a = P_c \cdot (N_a / N_c)^3$$
$$X_a = X_c \cdot (N_a / N_c)^2 \qquad p_d = p_i \cdot [(X_a + 1)^{(k/(k-1))}]$$

Where:

$Q_{a,c}$ = actual and curve volumetric flow rate, ICFM
$N_{a,c}$ = actual and curve rotational speed, rpm
$X_{a,c}$ = actual and curve adiabatic factors, dimensionless
$P_{a,c}$ = actual and curve blower power, hp
$p_{d,i}$ = inlet and discharge pressure, psia

Conclusion

Calculations for optimizing blower efficiency for aeration systems always involve the blower characteristics, the control system's effect on the blower performance, and the process system requirements. By using the proper calculation methodology, blower-system energy consumption for various blowers and control schemes can be estimated. This permits the designer to evaluate the life-cycle cost for several alternative designs. The result will be a system economically meeting the end user's objectives. BP

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

To read similar articles on ***Aeration Blowers,*** please visit http://blowervacuumbestpractices.com/technology/aeration-blowers.

Danish Furniture Producer Kvist Switches Plants to CENTRALIZED VACUUM SYSTEMS

By Uli Merkle, Head of Marketing Services, Busch Vacuum Pumps and Systems

Figure 1. High quality chairs and armchairs in all forms and versions are the main products of Kvist Industries A/S in Denmark.

High-quality seating furniture is the main product of Kvist Industries A/S. The Danish designer's furniture's wooden components are made from solid wood or molded wood. To meet their own high-quality requirements, and the exclusive demands of customers, manual processing performed by experienced personnel plays an important role. In particular, great attention is paid to the perfect finish of the surfaces, requiring expert craftsmanship. Automatic fabrication of the parts is performed on six different CNC processing machines. The individual parts are clamped with a vacuum generated by Mink claw vacuum pumps from Busch.

Founded 50 years ago, Kvist is a family business now being run by its third generation. Initially, Kvist dealt with manufacturing molded wood parts, mainly produced for various manufacturers of seating furniture. Today, their focus is on completely manufacturing their own seating furniture and tables, sold worldwide to end users via other furniture manufacturers.

Kvist's main markets are Germany and Scandinavia, but the significance of the Chinese market is growing as Chinese customers are increasingly interested in Kvist products. After 50 years, chairs and armchairs with designs from their initial years have become classics, now experiencing a renaissance in the product range. However, newly designed seating furniture is also part of Kvist's portfolio (Figure 1). Kvist Industries A/S's headquarters is located in the Danish town of Arre with two production plants. One of the plants produces seating furniture, while the other manufactures tables.

Kvist operates an additional production facility in Latvia, where 650 employees manufacture individual parts. Final assembly and quality assurance of this seating furniture is then mainly performed at the headquarters in Arre.

DANISH FURNITURE PRODUCER KVIST SWITCHES PLANTS TO CENTRALIZED VACUUM SYSTEMS

Centralized Vacuum Systems Using Three Mink Claw Vacuum Pumps

A centralized vacuum system with three Mink claw vacuum pumps is used in each of the two Danish plants to generate the vacuum required for clamping. Both central vacuum system units have been in operation since July 2015 when they replaced the previously used dry-running rotary vane and liquid ring vacuum pumps. The rotary vane vacuum pumps required a lot of maintenance due to wear on the vanes. In addition, this vacuum generator gave off waste-heat directly into the production room. Its loud operating noise was also extremely uncomfortable for the employees. The water level of the liquid ring vacuum pumps had to be monitored constantly, and refilled or exchanged if the water became polluted with wood dust.

Technical Director, Rune Kvist, was not satisfied with either type of vacuum generator, since the performance was not consistent. This sometimes lead to clamping problems because the vacuum did not achieve the required level or achieved it too slowly. Rune Kvist found the optimum vacuum supply with the two central vacuum system units from Busch: "We used to have a total of six vacuum pumps installed at three CNC processing centers with two processing tables for our seated furniture production. The associated waste heat and noise problems had a negative effect on the work stations. Today, we have three Mink claw vacuum pumps outside the building that go unnoticed except for the fact that we always have the vacuum we require for clamping," said Rune Kvist.

In addition, operational reliability was significantly increased. The required vacuum is immediately available at any time because the pipework between the vacuum pumps and the CNC machines serves as a vacuum buffer, where a constant vacuum of 200 millibars is maintained (Figure 2). The high level of operational reliability is also guaranteed by the demand-based control system. The only vacuum pumps in operation are the ones actually needed to maintain the vacuum level in the pipework system. In practice, a maximum of two of the three installed Mink vacuum pumps accomplish this. So, if one of

Figure 2. Solid wood and molded wood components are processed on several CNC machines.

them were to fail, this would have no effect on production.

In Addition to Enhanced Safety and Reliability – Significant Energy Savings

An additional essential benefit of the centralized vacuum system, huge energy savings, is made possible by the Mink claw vacuum pumps' demand-based control system and frequency-controlled drive (Figure 3). Firstly, a Mink claw vacuum pump requires less energy than comparable vacuum pumps of a similar size. This is made possible by contact-free and wear-free claw vacuum technology. Furthermore, the pumping speed and vacuum performance remain constant throughout the entire life-cycle. Whereas the pumping speed and achievable vacuum level of dry-running rotary vane vacuum pumps declines due to wear on the vanes. This is why one smaller Mink claw vacuum pump can often replace a larger dry-running rotary vane vacuum pump. In practice, this means less motor output is required for comparable pumping speed.

As a basic principle, fewer vacuum pumps are needed for centralization of a vacuum supply than for decentralized installation directly at the CNC processing centers. This is how the previously installed six rotary vane vacuum pumps were replaced by three new Mink vacuum pumps. Six rotary vane vacuum pumps used to operate during all working hours. In practice, the centralized vacuum system unit has demonstrated only one Mink vacuum pump operates at 50 hertz during working hours and a second is sometimes automatically turned on, but only briefly and usually at a lower frequency. This gives Kvist energy savings of 61% or 22,600 kilowatt hours per year for seated furniture production alone (Figure 4). The second centralized vacuum system, used for manufacturing tables, achieves similar values.

Rune Kvist is satisfied with the centralization of the vacuum supply. This is why he has also decided to use this technology at the new plant in Latvia, and has installed two identical centralized vacuum systems with Mink claw vacuum pumps.

Figure 3. Mink claw vacuum pumps generate the vacuum for clamping on the CNC processing machines in centralized vacuum systems at two Kvist plants in Denmark.

Comparision Energy consumtion	Rotary vane vacuum pumps installed directly at the CNC-routers	Centralised vacuum system with Mink claw vacuum pumps
Number of CNC-routers	3	3
Installed vacuum pumps	6	3
Total nominal motor rating	20,6 kW	18 kW
Really used motor rating	20,6 kW	approx. 8 kW
Operating time	8 hours x 5 days x 45 weeks	8 hours x 5 days x 45 weeks
Energy consumption	37.000 kWh/year	14.400 kWh/year
Energy saving	-	**22.600 kWh/year = 61 %**

Figure 4.

According to Rune Kvist, "maintenance of the Mink claw vacuum pumps amounts to practically nothing." They have a maintenance contract with Busch, including annual inspection of all Mink claw vacuum pumps and the changing of the gear oil. Due to wear-free operation of the claw vacuum technology, there is no need to exchange wear parts like the vanes of rotary vane vacuum pumps, nor for tasks related to operating fluids for liquid ring vacuum pumps.

About Busch

Busch Vacuum Pumps and Systems is a leading manufacturer and retailer of vacuum pumps, blowers, compressors and customized systems using vacuum technology. With over 50 years of experience and the largest selection of industrial vacuum pumps available today, Busch meets the demand for vacuum and pressure technologies in every industry across the world. BP

For more information, visit www.buschusa.com

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Custom Blower and Air Knife Bin Drying Solution REDUCES PACKAGER LABOR HOURS

By Kacie Goff, JetAir Technologies

Drying Station 1 at Scholle IPN.

➤ Putting wet product into secondary packaging can cause any number of issues. Damp cardboard deteriorates, rewetted labels go askew, water spots compromise consumer confidence. What happens though, when the secondary packaging itself is wet? This was the question Scholle IPN, a leader in bag-in-box and spouted pouch packaging, turned to JetAir Technologies and Valley Packline Solutions to answer.

Scholle provides boxed wine bladders. In order to conveniently ship these bladders to their customer, they designed reusable, collapsible bins. The customer could empty out the bin, then return it to Scholle to be refilled with a fresh batch of wine bladders.

Once the bins returned to Scholle, they were cleaned before refilling. Three Scholle employees re-erected and pressure washed these bins at a pace of 60 bins per hour.

The Problem

Although the collapsible bins were convenient for the customer, Scholle was dedicating 120 hours each week to prepare them for reuse. In order to streamline their process, they got in touch with the line engineers at Valley Packline Solutions. Valley Packline is the expert in designing, engineering, and manufacturing produce handling and processing equipment. They quickly found a way to optimize the bin cleaning by introducing a system pulling bins directly off the truck. This system then fed the bins straight into an erector/washer, eliminating the pressure washer.

After going through the erector/washer, the bins were then fed into the facility to be refilled with wine bladders. In short, Valley Packline had automated a system taking bins from the truck, and delivering them clean to Scholle.

The re-erecting and cleaning process could now connect directly with the refilling process. While great for optimizing facility flow, this did present a problem. Any time between the cleaning and refilling, previously allowing the bins to dry, was gone.

The bins couldn't be refilled while wet, and common air knives couldn't reach the bins' deep corners to thoroughly dry them by the time they were fed into the facility.

To the Testing Facility

As experts in drying, JetAir Technologies was there to help. JetAir knew this was a unique application, especially because of the large size of the bins, so they headed to their testing facility to try an array of solutions to find the ideal setup for Scholle. Using a sample bin at their testing facility, JetAir modeled a number of configurations of blowers and air knives to ensure the best results.

JetAir has a wide range of blower-based solutions. They routinely test centrifugal and regenerative blowers to find the best balance of flow and pressure for the specific application. Leveraging their in-house testing facility, they are able to replicate plant conditions.

Thorough testing of this unique bin-drying application allowed JetAir to arrive at its blower and custom air knife recommendation. "It was quite an extensive project to put in a drying system," said Adam Fehr, Valley Packline's sales manager. "Testing was very helpful in making a decision."

An Energy Saving Blower

By testing multiple air pressures and flows, JetAir arrived at a way to contribute to ongoing energy savings. Many air knife systems rely on compressed air as their air source. This creates a handful of challenges. First, compressors do not deliver a clean air stream (i.e. there is oil from the compressor in the air stream). Food-grade oil can be purchased to use with the compressor, but it is more expensive than standard compressor oil. This means an ongoing additional expenditure, leading to an additional issue with using compressed air, the cost of the air itself.

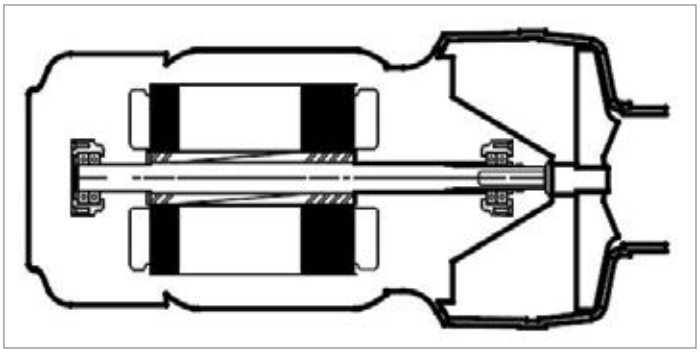
Compressors produce more pressure than needed for most applications, including the drying of these collapsible bins. Using compressed air would have led to large amounts of air simply being blown to the atmosphere. Not only does this mean wasted resources, it means wasted money. In short, compressed air is expensive.

Instead of relying on compressed air, Valley Packline and JetAir turned to a solution resulting in significantly less energy expenditure. They drove the drying system with a centrifugal blower connected to a variable frequency drive.

The centrifugal blower gives greater control of flow and pressure than an air compressor. The increased control results in a staggering 70% reduction in energy consumption over a compressed air system. By choosing a blower over compressed air, Valley Packline and JetAir Technologies built energy efficiency into the bin dryer.

The bin system designed by Valley Packline Solutions.

CUSTOM BLOWER AND AIR KNIFE BIN DRYING SOLUTION REDUCES PACKAGER LABOR HOURS



JetAir's Belt Free Blower Technology.

JetAir's JetBlast Nozzled Air Knife.

Belt-Free Blower Benefits

What's more, JetAir's centrifugal blowers differ from most others on the market because they are belt-free. While most centrifugal blowers rely on belts and tensioners, JetAir's blowers couple the impeller directly to the motor shaft. This means an 8% improvement in efficiency over belted blowers, plus the elimination of the hassle of changing and re-tensioning belts. A belt-free blower has no belt to break, so Scholle gained minimized maintenance concerns and no belt pinch safety hazards. Additionally, because the impeller and motor shaft are directly connected, this blower's footprint was less than half of a belted blower's.

To get even more efficiency from the blower, JetAir leveraged a variable frequency drive (VFD). With the VFD, facilities can connect directly to their PLC. This allows them to get non-spiking soft-starts, more precision in their airflow settings, and built-in motor protection.

Custom Air Knives

After testing, JetAir also discovered standard air knives would not be sufficient for the application. Instead, they designed, engineered, and manufactured custom square rings of JetBlasts (nozzled air knives) capable of moving up and down the bin interior and exterior for rapid and thorough drying.

JetAir chose nozzled air knives over traditional air knives for greater efficiency. By forcing air through engineered nozzles, these JetBlasts deliver superior air reach. The aerodynamic design of the JetBlast balances pressure evenly across all nozzles, projecting a clean, high-velocity air stream.

Valley Packline actuated the air knives to bathe the bins in high-flow, high-efficiency, blower-powered air. While one square ring of JetBlast air knives ran up and down the bin's exterior, another simultaneously ran up and down the interior.

After drying the interior and exterior walls, the bin moved to a secondary drying station. At this dryer, additional sets of JetBlast air knives removed water along the bin's base, drying both the interior and exterior bottom.

Saving Time, Saving Energy

At Scholle IPN, Valley Packline's engineering experience and JetAir's drying expertise came together to deliver an automated, energy efficient solution. Ultimately, the new system eliminated 120 man-hours each week dedicated entirely to erecting and washing. The new system can be manned by just one employee as it pulls bins directly off delivery trucks, re-erects, washes, and dries them, and feeds them into the facility for refilling. Throughput at Scholle was improved by the system, while energy costs were kept to a minimum.

On working with JetAir, Fehr said, "You guys did great. The timely testing helped us show that it worked. The equipment came out very nice."

To see a video of the installed bin washer and dryer including the actuated air knives, see the Youtube video Valley Packline Solutions Bin Washing and Drying.

JetAir is dedicated to delivering the most energy-efficient drying solution. Replacing compressed air can help slash energy consumption, but determining the right blower can pose a challenge for line engineers and plant managers. For unique applications, testing can be leveraged to determine optimal pressure and flow.

Finding the right blower-based solution is key for facilities wanting to save time, energy, and ultimately money. Once identified, the right air source will deliver the right flow and pressure along with savings in perpetuity. BP

For more information, contact Kacie Goff at JetAir Technologies via phone: (805) 654-7000, via email: kacie.goff@jetairtech.com, or visit www.jetairtech.com.

To read more articles on ***Drying and Blow-Off Applications,*** please visit http://blowervacuumbestpractices.com/technology/air-knives-nozzles.

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Beware Dense Phase Pneumatic Conveying RUNNING AS A DILUTE PHASE SYSTEM

By Hank van Ormer, Van Ormer Consulting

When a dense phase pneumatic material conveying system can't meet the required increase in production without adding an additional system, often the production is increased by just pushing more compressed air into the transfer pipe. But, at some point, the critical particle velocities get so high that the system is now close to a dilute phase. This action is not uncommon and causes many maintenance quality and production issues, and wasted energy.

This article reviews two common pneumatic conveying system types and the importance for each operating plant to know their design and operating parameters particularly conveying air flow velocity and particle velocity profile.

In many manufacturing operations, a significant compressed air use is pneumatic conveying of many types of materials such as cement, fly ash, starch, sugar, salt, sand, plastic pellets, etc. All of these conveying systems use compressed air, or in some cases vacuum, in some form to create pipe line conditions which will allow the product material to flow

"With proper data, plant personnel can evaluate the economics to convert to an improved dilute phase system - or add additional dense phase systems as required to reach the production levels."

— Hank van Ormer, Van Ormer Consulting

smoothly in the pipe line to the open end, avoiding production and quality issues.

These conveying systems are usually engineered by the conveyor system manufacture to meet the plants specific production requirements, planned transfer path, and most importantly, their analysis of the specific material. Once installed, tested, and operational, the system should run as designed unless changes are made such as, air flow; pipe line pressure; piping size and/or configuration; and "particle material characteristics".

Operating Energy Cost

The primary operating energy cost is the source of the compressed air, or vacuum, used to create and maintain the conveying air flow during the transfer time. The higher the required inlet pressure (psig) and inlet air volume (scfm), the higher the inlet compressed air energy cost per scfm/yr.

Figure 1 shows how pressure ranges dictate the appropriate compressed air source - 50 to 100 psig air compressors or 6 to 15 psig blower air for optimum efficiency (blowers can go as low as <3 psig).

Low Pressure Systems: Dilute Phase Systems under 15 psig

The two most distinct categories of compressed air driven pneumatic conveying are low pressure and high pressure systems.

Low pressure systems, also referred to as *dilute phase pneumatic conveying systems,* utilize entry air pressure under 15 psig to flow materials through the conveying line at relatively high velocities suspended in the air stream. They are described as low pressure/ high velocity systems and have a **high air-to-material ratio.**

A typical dilute phase, low pressure system will use a pick-up conveying air velocity of around 3,000 feet per minute at the beginning of the system, and about 6,000 feet per minute at the end. The conveying line pressure is 15 psig or lower at the beginning and near atmospheric pressure at the end.

- Particle velocity is very critical. Too low and the product falls from the air stream to the bottom of the pipe. Too high can cause particle-to-particle impact and particle-to-wall impact which will cause product degradation; fouling of the transport pipe walls; and plugging of the pipe. All which exacerbate any wear issues in the pipe and elbows.
- Certain material particles are more susceptible to dilute phase high velocity issues than others. These are:
  - **Friable Particles** - subject to breakage due to impact with each other or the walls can experience product degradation. Too high velocity impact can create heat at the impact points of the pipe line wall and leave coatings of product on the pipe. This can ultimately lead to fouling.
  - **Abrasive Particles** - high velocity may cause significant transport line and elbow wear, creating too high of downtime and maintenance issues (proper evaluation is much more complex than this).

When issues of this type are present, most plants will consider selecting a higher pressure, dense phase pneumatic conveying system.

Based on .05/kWh, 8760 hrs per year, .93 ME			
PRESSURE	**APPROXIMATE HORSEPOWER INPUT**	**ESTIMATED ELECTRICAL COST**	**$ SCFM/YR**
100 psig	220 hp	$77,295	$154.59
50 psig	133 hp	$46,735	$93.47
15 psig	92 hp	$32,355	$64.71
6 psig	33 hp	$11,555	$23.11

Figure 1. Relative electrical energy cost to produce 1,000 scfm of compressed air various pressures

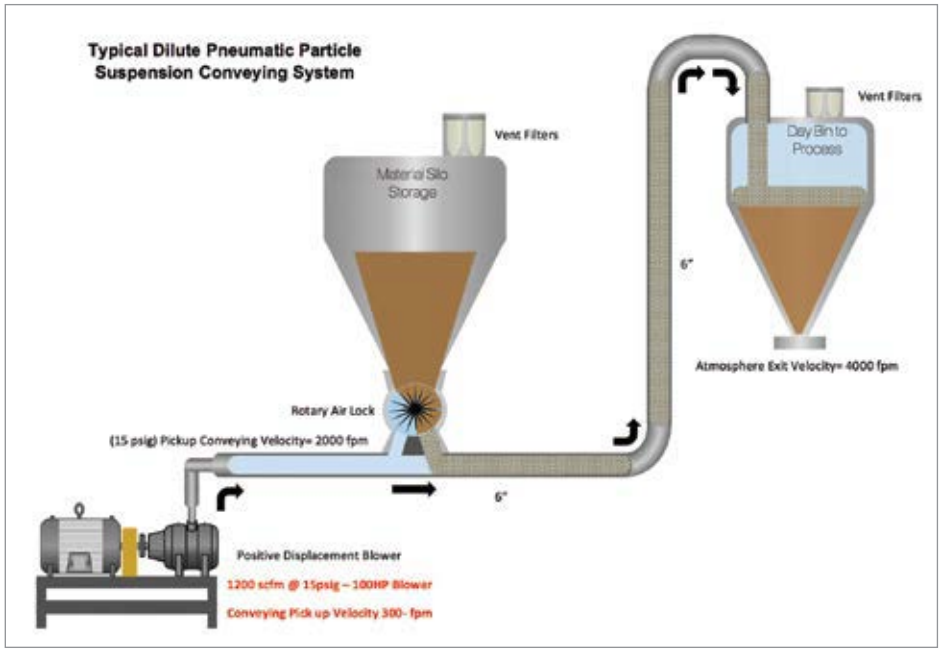

Figure 2. Dilute Phase Pneumatic Material Conveying -- image courtesy of VAC-U-MAX

BEWARE DENSE PHASE PNEUMATIC CONVEYING RUNNING AS A DILUTE PHASE SYSTEM

Dense Phase Systems from 15 to 50 psig

High pressure systems are known as dense phase pneumatic conveying systems. These systems utilize air pressure above 15 psig (up to 50 psig) at the entry and use positive pressure to push materials through the conveying line at relatively low velocities (from 100 fpm to a maximum of 1000 fpm), much like extruding. They are described as high pressure/low velocity systems and have a low air-to-material ratio.

Dense phase conveying uses smaller amounts of higher pressure air to move bulk solid material in slugs through the conveying line. Generally, the product being transported is often abrasive or sensitive to high velocity. The dense phase system is selected to eliminate or minimize transfer pipe wear and other issues associated with higher particle velocity. They maintain the designs moderate velocities and still deliver the appropriate pounds per hour of production. Generally, this type of system requires a compressed air supply of the appropriate size and pressures available (35 to 100 psig). The product and air flow volumes will always be lower than a similar dilute phase system.

Tips when Operating Air Booster/ Fluidizer

Many dense phase pneumatic conveying systems use "booster pulsers" also known as "air saver boosters" or "air fluidizers", to help move the product along the line and free it from the piping or hopper walls. These are usually supplied by higher pressure air (90+ psig). Operating properly, they input short small shots of compressed air, as required, to control the natural solidity of the product pipeline column and maintain appropriate compressed air pipeline velocity. The "air saver boosters" are usually carefully set and controlled to optimize the expensive high pressure air and not destroy the product column's solid integrity. Key tips to keep in mind when operating air fluidizers in the pneumatic conveying systems:

- More air will not improve performance. Measure, identify, and control the minimum volume of air to do the job correctly.
- Run the air only when the vessel is discharging. Running the fluidizers when the discharge is closed may create voids in the material, interfering with smooth flow.
- Run multiple fluidizers *sequentially, not simultaneously.* Use shortest pulse time with longest interval possible.
- Take the time to design the best possible timing of the pulsers with measured data in conveying air and particle velocity. Establish optimum timed pulse aeration for each product and adjust accordingly.

Case Study: When Dense Phase Becomes Dilute Phase

The following case study is a dense phase material transport system unable to meet the required production demands. Background: The pneumatic transport system fills five supply silos with the appropriate material to be mixed and sent on to production. There are two 6" production lines to the processes.

At the current production levels, the batch transporter system needs to constantly handle 30,000 pounds per hour of mixture. In order to establish a 2-hour cushion of supply in the day bins, the system must be capable of runs of 90,000 pounds per hour. In order to reach these required transport levels, the basic system was adjusted by raising the pressure and extending the cycles of the air boosters. The boosters are currently ***all running full open constantly with feed pressures from 30 psig to 90 psig as adjusted.***

Today, the measured average flow through the 6" transport system is 1,500 scfm

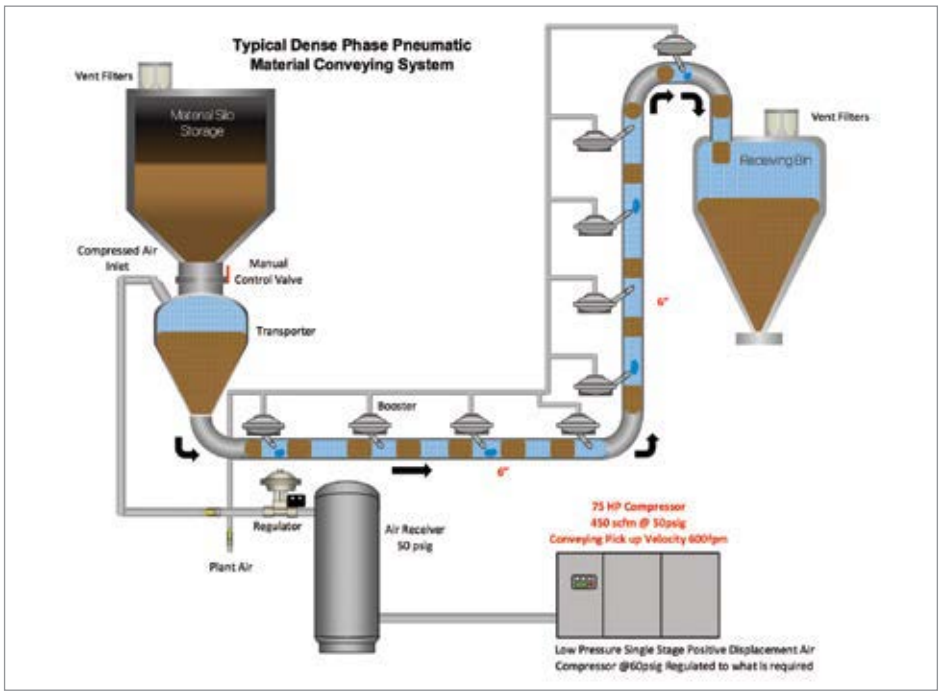

Figure 3. Dense Phase Pneumatic Material Conveying -- image courtesy of VAC-U-MAX

PRODUCTION RATE	INCREASED	DOES MEET PRODUCTION WHEN RUNNING
Original Energy Cost	1000 fpm (392 scfm @ 50 psig)	392 x $64.71 scfm/yr = $25,366 per year at 8760 hrs/yr
Current Energy Cost	2000 scfm average – 392= additional 1608 scfm @ 100 psig produced	= 1608 x $154.39 = $248,259/yr
Total Current Energy Cost	$248,259 + $25,366	8760 hrs/yr = $273,625/yr
Values are based on 8760 hrs/yr	The plant runs the system at about 45% utilization	
Estimated Original Energy Cost	$11,414/yr at 45% utilization	
Current Energy Cost	$123,131/yr at 45% utilization	
Net Increase in Energy Cost	$111,716/yr at 45% utilization	

Figure 4. Increase on Conveying Air / Particle Velocity

average **(velocity up to 3,825 ft/min),** and sustained peaks of 2,600 scfm ***(velocity 6,640 ft/min).*** The outcome? This plant unknowingly converted their dense phase system to dilute phase. These air velocities and probable particle velocities are high even for a dilute phase system. The calculated conveying air velocity is based on the entry pressure, but with all the booster feeds and higher volume of air the estimate of pipeline pressure to calculate particle velocity is rough at best.

Results After Plant Modifications

Product quality has faced issues. The scrap rate of the product conveyed increased about 20% over the last three years, according to plant personnel. No specific value was available. Pipeline repair, maintenance and downtime have gone from a non-issue to a constant problem. no specific value was available.

Future Short Term Action Plan: Measure the "actual particle velocities" of each product at critical locations with a non-invasive, particle velocity monitor and control system to set up an accurate particle velocity profile. Simultaneously at strategic locations, measure the actual pipe line pressure and using the measured inlet flow, calculate the conveying air velocity. This will provide an accurate conveying air velocity/particle velocity profile.

Identify the operating profile of the particle speed to find the safe zones and try to maintain these levels. Keep production levels up along with minimizing quality and maintenance issues.

Future Long Term Action Plan: With proper data, plant personnel can evaluate the economics to convert to an improved dilute phase system - or add additional dense phase systems as required to reach the production levels.

At this point, the plant has the worst part of both types – high energy cost of compressed air for dense phase, but high volume of dilute (scfm) phase at the same expensive air, and high particle velocities driven issues of dilute phase. The measurement data acquisition plan will not only help to get to the optimum system, but will be a key in maintaining optimum performance on a long term basis. BP

For more information contact Hank van Ormer at email: hankvanormer@aol.com.

To read similar articles on ***Pneumatic Conveying Technology*** visit http://www.blowervacuumbestpractices.com/technology/conveying

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

Pfeiffer Vacuum Breaks Ground for New Headquarters in North America

Pfeiffer Vacuum, one of the world's leading providers of high-tech vacuum solutions for the semiconductor, industrial, coating, analytical and R&D markets, is breaking ground in Nashua, New Hampshire, on a new, two-story, 27,000 square foot building. This modern construction will house the North American headquarters for administration, sales, product management, marketing and customer care. In parallel, the existing 24,000 square foot building will be converted to a Service Center of Excellence, bringing together under one roof all service activities of the entire Pfeiffer Vacuum product portfolio. State-of-the-art automated cleaning and test equipment will be utilized to produce the highest quality repairs in a timely manner.

Breaking ground for the new state-of-the-art building at the Pfeiffer Vacuum headquarters in North America.

"These investments are further evidence of our ongoing commitment to support our valued customers throughout North America, while at the same time providing a modern, best-in-class work environment for our staff for many years to come," said Dr. Matthias Wiemer, Management Board Member at Pfeiffer Vacuum Technology AG.

About Pfeiffer Vacuum

Pfeiffer Vacuum was founded in 1890 in Asslar, Germany. It has about 2,400 employees worldwide and more than 20 subsidiaries. Its service program extends from vacuum pumps and chambers through measurement and analysis equipment, right up to leak testing and leak detectors and complete vacuum systems, as well as service and technical support.

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

Busch COBRA BC 0100 Achieves Milestone at Global Foundries in Germany

For twelve years of continuous operation, amounting to over 18.9 billion rotations, a Busch COBRA BC 0100 dry screw vacuum pump passed this remarkable milestone in a semiconductor foundry in Germany. Thus, living up to its reputation for robustness, reliability and low maintenance.

The COBRA BC 0100 in question has been in continuous operation at the Global Foundries production site in Dresden, Germany, since 2005 and is the longest-operating COBRA BC 0100 at the site, known as Fab 1. Fab 1 in Dresden was the world's first fab to manufacture microchips with copper wiring in industrial quantities – a technology now the basis for semiconductor production throughout the world.

A total of two-hundred and three (203) COBRA BC 0100 dry screw vacuum pumps are installed at the Dresden site, producing 300 mm wafers for the semiconductor industry. Thirty-one (31) of these COBRA BC 0100s have been in continuous operation for over 10 years, and fifteen (15) of the COBRA BC 0100s have passed the milestone of 100,000 operating hours (over 11 years of operation). Generally, continuous operation over five or six years is the industry expectation in load-lock applications.

COBRA BC 0100 vacuum pumps are predominantly used in the load-lock applications of epitaxy and physical vapor deposition (PVD) processes. They are also used in other contamination-free processes for wafer handling and metrics to assure the quality of the lithography process.

The COBRA BC 0100 is a dry screw vacuum pump within the proven COBRA BC 0100 series portfolio that is a compact state-of-the-art load-lock solution with additional process capabilities for the most demanding solar, flat panel and semiconductor applications. It has excellent powder handling capabilities as a result of its unique screw pump design.

The COBRA BC 0100 series is also available in a COBRA BC 0100 Premium Efficiency class with a reduced energy footprint resulting in lower electrical energy use of up to 40%. The Premium Efficiency class is based on the proven technology platform of the COBRA BC 0100.

Busch Vacuum Pumps and Systems maintains a service team in Dresden, consisting of nine service technicians and one team leader in a 24/7 shift system, ensuring very high system availability of the nearly nine-hundred (900) installed Busch vacuum pumps. Furthermore, the service team maintains the waste gas abatement systems.

Global Foundries is among the top semiconductor companies in the world and manufactures at its Dresden fab 40 nm to 22 nm nodes. The Dresden fab is Europe's largest fab for the production of microchips.

To learn more about Busch products and services, please visit www.buschusa.com.

Busch COBRA BC 0100 vacuum pumps are predominantly used in the load-lock applications of epitaxy and physical vapor deposition (PVD) processes.

Gardner Denver Robuschi Wins 2017 Motion Control Industry Award for Energy Efficiency

Vacuum and pressure manufacturer, Gardner Denver, has won the prestigious Environmental and Energy Efficiency award for its ROBOX energy screw compressor, at this year's Motion Control Industry Awards 2017. Now in its second year, the Awards, held in Birmingham, U.K., are designed to celebrate outstanding achievement and product innovation within the motion control industry.

The Robuschi triple-impact ROBOX compressor is ideal for the energy-intensive wastewater treatment sector, offering energy savings of up to 30 percent. This factor particularly impressed the judges, since the award is given in recognition of a product, system or service making a significant contribution to environmental issues, such as energy savings, emissions control, noise reduction or life-cycle costs.

The team accepted this award as an important milestone in the company's history and its efforts to promote green technologies. Gareth Topping, Gardner Denver Redditch's vacuum and blowers sales manager explained, "At Gardner Denver, we are continually developing new technologies and the ROBOX energy screw compressor is one of our latest successes. We are therefore delighted that the product has been awarded for its environmental and energy-saving credentials. Moreover, we are proud that this award demonstrates our commitment to working with our customers to implement the best energy-saving solutions that deliver low life-cycle costs for their application."

Wastewater treatment plants are high-energy users. In the U.K. alone, more than 3 percent of the nation's gross national product is spent on purifying public and industrial wastewater. Vacuum pumps, blowers and compressors are essential for many processes in these plants, and any reduction in their energy consumption can have a significant impact on overall operating costs.

ROBOX energy screw compressors offer energy savings of up to 30 percent by combining a series of technological advances such as the permanent magnet motor, and the intelligent management of system components.

The acclaimed ROBOX energy screw compressor is already well-proven in many such applications, offering energy savings of up to 30 percent. Combining a series of technological advances, such as the permanent magnet motor, helping to reduce costs, with the intelligent management of system components. The Robuschi design team has brought a product to market capable of lowering a site's cost of ownership, while reducing carbon emissions significantly.

Robuschi's smart-process control-tool, with HMI interface, optimizes airflow and is essential in achieving the energy savings so important in reducing life-cycle costs. The new machine has a smaller footprint than comparable equipment and can be easily installed in existing compressor rooms, helping to avoid additional capital expenditure.

About the Gardner Denver Industrials Group

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

Gardner Denver Industrials Group, part of Gardner Denver, Inc., is headquartered in Milwaukee, Wisconsin. Gardner Denver was founded in 1859 and today has approximately 7,000 employees in more than 30 countries. For further information, please visit www.gardnerdenver.com.

For further information about the ROBOX energy screw compressor and Gardner Denver's range of energy-efficient technologies, or to find a local partner, please visit www.robuschi.com.

Carnegie Mellon University Nanofabrication Facility Inaugurates Leybold Conference Room

Being at the forefront of university research is very important for innovating next generation vacuum technology products. As a local partner with Pittsburgh based Carnegie Mellon University (CMU), Leybold has not only been a supplier, but also a generous and benevolent sponsor for years. As an acknowledgement for this close cooperation,

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the CMU community named one of the new conference center and reception rooms 'Leybold' and celebrated this inauguration with a presentation and reception held at the CMU Nanofabrication Facility.

Matthew Moneck, Carl Brockmeyer, Gianluca Piazza as well as other CMU and Leybold colleagues unveiling the dedication plaque at the CMU Nanofab.

CMU started in 1900 with a donation of one-million dollars from steel-pioneer Andrew Carnegie. With some 15,000 students, they are not on the same population scale of larger institutions in the USA, but in achievements they are ranked globally 23rd overall, and for top US colleges and universities they are ranked 19th. U.S. News & World Report currently ranks CMU 5th in their category Best Graduate Engineering Schools. This is primarily due to their leading R&D in areas of computer science, robotics, and general engineering technologies.

As with many universities, CMU has multiple halls with multidisciplinary labs ranging from biology, biomedical engineering, chemistry, electrical and computer engineering, materials science, physics, robotics, mechanical engineering and others. Each has its level of vacuum needs ranging from the rough vacuum regime to ultra-high vacuum requirements. This includes vacuum pumping equipment from several key suppliers, including local partner Leybold, providing vacuum pumps, instruments and vacuum consultation.

Leybold, like CMU, is a leader in its field. As a pioneer in vacuum technology, celebrating 167 years, Leybold supports industry and research throughout the world with vacuum engineering consultation, vacuum pumps and systems, thin-film equipment, instrumentation and related services. CMU employs such Leybold equipment in their new Nanofabrication Facility.

"CMU is not known as a large research university, but instead we are recognized more for our R&D successes in disciplines such as computer science, engineering and robotics. The new Nanofabrication Facility will allow us to compete with much larger universities for research grants in the areas of thin-film technology, nanomanufacturing and Nano/Micro systems," said Gianluca Piazza, CMU Nanofabrication Facility's faculty director. "This would not be possible without the generous support of partners, such as Leybold, and other local suppliers. We are excited to continue our collaboration with Leybold in areas of process development where we can use their expertise in vacuum sciences for thin-film deposition as well as other R&D activities throughout CMU."

Carl Brockmeyer, Leybold USA Inc.'s general manager adds, "We at Leybold value the importance of thin-film and Nano/Micro device research and we thank the CMU community for the close association and ongoing partnership with Leybold, and offer our congratulations on their accomplishment in realizing the new Nanofabrication Facility, a premier research laboratory in the world. My colleagues and I at Leybold are committed to nurturing a strong partnership with CMU for many years to come. CMU has our commitment for continued collaboration and support of their Nano research".

About Leybold

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

About Atlas Copco

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and services focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 180 countries. In 2016, Atlas Copco had revenues of 11 billion euros and more than 45,000 employees. Since 1952, Atlas Copco is present in Germany. Under the roof of two holdings located in Essen, more than 20 production and sales companies are gathered (February 2017). By end of 2016, The Group employed about 3,800 people, including about 100 trainees. For more information, visit www.atlascopco.com.

About Carnegie Mellon University – Nanofabrication

A premier research laboratory in the College of Engineering, the Carnegie Mellon Nanofabrication Facility is one of the most well-equipped university-based facilities for

thin-film and Nano/Micro device development in the United States. The Nanofab counts approximately 10,000 square feet of class 10/100 cleanroom space where faculty, staff, and students access the lab and collaborate on projects originating from a multitude of disciplines. The Nanofab also welcomes external industry and government users.

Pfeiffer Vacuum Presents Leak Test Solutions

Leak testing plays a vital role in quality control for a wide range of applications. Reliable integrity packaging is crucial in the pharmaceutical industry to guarantee sterility and to protect drugs from any microbiological substances, oxygen or moisture with potential of ingressing. In the automotive industry, leak testing ensures various components are operating perfectly, including parts guaranteeing the supply of gasoline. Pfeiffer Vacuum is one of the leading providers of vacuum technology and leak testing solutions. The corporation benefits from more than 50 years of experience in the leak detection field. At the Interpack and Control fairs, Pfeiffer Vacuum presented test technologies satisfying numerous leak detection and measuring method requirements: leak detection using air, leak detection with a tracer gas and optical emission spectroscopy.

Leak testing with patented Micro-Flow technology: E-PDQ

Leak Testing With Air

At the trade fairs, Pfeiffer Vacuum presented products made by its new subsidiary Advanced Test Concepts, Inc. (ATC) from Indianapolis, USA. The leak detectors exhibited work on the basis of leading leak testing technology using air, and do not require any special tracer gases.

The devices operate according to patented Micro-Flow technology. This technology consists of an integrated micro sensor working on accelerated flow. A sensitivity of up to $5 \cdot 10^{-4}$ mbar l/s is achieved with this method. This technology is used in the automotive industry, such as for testing power trains and gearbox housings.

A specific use of the Micro-Flow sensor is the Mass Extraction technique, which works on the principle of rarefied gas flow. Testing takes place in vacuum conditions to attain higher sensitivity. This type of testing is particularly suitable for packaging or enclosed objects, such as pharmaceutical packaging and electronic components. These products require testing for watertightness. Sensitivity of up to $5 \cdot 10^{-6}$ mbar l/s can be achieved with this method.

Micro-Flow and Mass Extraction technology offer a number of advantages over other leak testing methods working with air. The speed of testing and their low susceptibility to ambient changes are notable examples of this. They also stand out due to their higher sensitivity and accuracy, and do not require calibration on a daily basis.

Leak Detection With Tracer Gas

The ASI 35 leak detector delivers excellent performance in integral and localizing testing methods, as well as combinations of the two, using helium or hydrogen as a tracer gas. The device combines high performance, reliability and repeatability with extremely short cycle times. This leak detector is designed for demanding testing situations with minimal background signals and enables short overall cycle times. The robust iridium filaments also ensure durability. Particular applications for this device are the automotive industry but also the field of electronic and mechanical components, and refrigeration and air conditioning.

Optical Emission Spectroscopy

It is important for packaging to preserve the stable condition of particularly moisture-sensitive medication such as dry powders for inhalation; at the same time, it must also prevent biological substances in the packaging from ingressing into parenteral drugs. This necessitates the use of high sensitivity integrity testing. The method used by the AMI measures leak tightness using a patented process not requiring a tracer gas. Instead, this method uses the existing gas mixture from the cavities inside the packaging to perform high-sensitivity testing over an extended measuring range. The procedure offers great flexibility. A variety of packaging types such as blister packs, pouches, vials, plastic bottles and sealed parts such as battery casings, can be tested in this way.

About Pfeiffer Vacuum

Pfeiffer Vacuum (Stock Exchange Symbol PFV, ISIN DE0006916604) is one of the world's leading providers of vacuum solutions. In addition to a full range of hybrid and magnetically levitated turbopumps, the product portfolio comprises backing pumps, leak detectors, measurement and analysis devices, components as well as vacuum chambers and systems. Ever since the invention of the turbopump by Pfeiffer Vacuum, the company has stood for innovative solutions and high-tech products used in the Analytics, Industry, Research & Development, Coating and Semiconductor markets. Founded

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Blower & Vacuum Best Practices is a technical magazine dedicated to discovering Energy Savings in industrial blower and vacuum systems and in municipal wastewater aeration blower systems. Our editorial focus is on case studies and technical articles where application and system knowledge drives technology selection, creating energy savings in projects delivering excellent ROI's.

"A more recent innovation is to control the aeration blowers off of total air flow instead of header pressure."

– Julia Gass, P.E., Black & Veatch (September 2016 Issue)

"Busch designed a customized central vacuum system for the furniture manufacturer, consisting of eight identical Mink claw vacuum pumps, each equipped with a suction capacity of 300 m³/h."

– Uli Merkle, Busch Vacuum Pumps and Systems (feature article in July 2016 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.

"Our engineering optimizes blower packages for each field – identifying, for example, the optimal conveying velocities for over 50 types of wheat flour!"

– Todd Smith, General Manager, Coperion K-Tron (Powder Show Report in a 2016 Issue)

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in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of approximately 2,400 people and has more than 20 subsidiaries. For more information, please visit www.pfeiffer-vacuum.com.

ULVAC Technologies Inc. Opens California Office

ULVAC Technologies, Inc., a leading supplier of production systems, instrumentation and vacuum pumps for technology industries, has opened an office in Santa Clara, California. The Silicon Valley office location gives West Coast ULVAC customers easier access to the company's sales and service operations. It also locates company operations closer to the Japanese headquarters and various Asian markets. The new location will include a vacuum pump and leak detector repair center to serve the regional customer base.

The new California location will include a vacuum pump and leak detector repair center to serve the regional customer base.

A new product line for ULVAC Technologies, Inc. is Vacuum Cooling Systems for use in large-scale farms to extend the product shelf-life of fresh agricultural products, flowers and meats. These systems are also used in the processed foods industry as well, to extend the life of products, such as airplane meals. Local demonstration capability of the new Vacuum Cooling System is planned for the Santa Clara location.

"Much of the vacuum cooling market is located in California, and the new Santa Clara office puts us in close proximity to major customers," said Wayne Anderson, ULVAC Technologies, Inc.'s President/CEO. "The Santa Clara office will serve as a business development hub within a technology-rich region, enabling us to expand our market share in semiconductor, MEMS and other high-technology industries."

About ULVAC Technologies, Inc.

ULVAC Technologies, Inc. is an international corporation designing and manufacturing systems for industrial and research applications utilizing vacuum technology. Our products cover a broad spectrum of markets including, equipment for semiconductors, MEMS, solar, flat-panel display, automotive, medical, electrical, and refrigeration industries. ULVAC Technologies uses a class-10 process development laboratory and customer-demonstration-facility to meet the unique needs of their different markets. ULVAC Technologies is a subsidiary of ULVAC, Inc., made up of 39 companies engaged in most sectors of the vacuum industry. For more information, visit www.ulvac.com.

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