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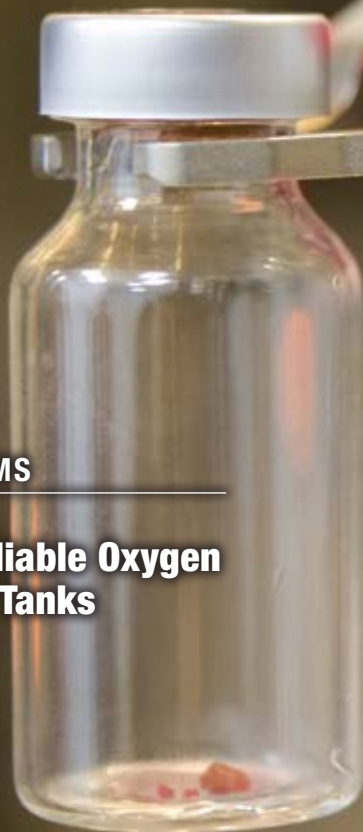
April 2017

INDUSTRIAL VACUUM & BLOWER SYSTEMS

- 13 Integrity Test Solutions for the Pharmaceutical Industry**
- 16 The Heart of Pneumatic Conveying – PD Blower Calculations**
- 20 Vacuum System Fundamentals for “Compressed Air People”**

AERATION BLOWER SYSTEMS

- 25 Busch Provides Reliable Oxygen Supply to Aeration Tanks**



6 Blower & Vacuum Tech Picks





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INDUSTRIAL VACUUM & BLOWER SYSTEMS

**13 Integrity Test Solutions for the
Pharmaceutical Industry**

By Dennis Seibert and Philippe Bunod,
Pfeiffer Vacuum

**16 The Heart of Pneumatic Conveying Systems –
Positive Displacement Blower Calculations**

By Roger E. Blanton, P.E., Howden Roots

**20 Vacuum System Fundamentals for
“Compressed Air People”**

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



13

AERATION BLOWER SYSTEMS

**25 Busch Provides Reliable Oxygen Supply
to Aeration Tanks**

By Uli Merkle, Busch Vacuum Pumps and Systems



16

COLUMNS

4 From the Editor

**6 Resources for Energy Engineers
Technology Picks**

28 Blower & Vacuum System Industry News

33 Advertiser Index



25



FROM THE EDITOR



Pfeiffer Vacuum has over fifty years of experience assisting the pharmaceutical industry with highly sensitive leak detection and integrity test solutions. Dennis Seibert and Philippe Bunod have provided us with an interesting article detailing advances in testing technology to ensure drug stability by protecting it from contaminants such as humidity, oxygen or microbiological ingress.

Dilute phase pneumatic conveying is widely used in the pharmaceutical industry. Pressures do not exceed 15 psig as the material is held in suspension throughout the pipeline. Roger Blanton, P.E., from Howden Roots, has provided us with a useful article about limitations, capacity control, and sizing calculations for “the heart” of the conveying system – the positive displacement blower.

It’s an exciting time for industrial vacuum systems as Energy Managers study which of the optimization techniques they used to optimize compressed air systems (such as VFD, centralization, demand reduction) can be applied to their “rough” vacuum systems. Tim Dugan, P.E., has written a very useful article titled, “Vacuum System Fundamentals for Compressed Air People”. In it he reviews what changes and what doesn’t, what is controlled, and how to design vacuum systems for optimal energy consumption.

Busch Vacuum Pumps & Systems is a market leader in many segments, such as food packaging and processing. What may not be as well known, here in North America, is their involvement with wastewater aeration systems. Uli Merkle provides us with an interesting application story, where their Tyr rotary lobe blowers provide reliable aeration for a treatment facility operated by the Wastewater Association of Rheinfelden-Schwoerstadt in Germany.

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

ROD SMITH

Editor

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- Cost-efficient – no specific tracer gas necessary
- Compatible with different kinds of packaging

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RESOURCES FOR ENERGY ENGINEERS

TECHNOLOGY PICKS

Leybold ECODRY plus – the laboratory whisperer

The requirements for modern analytical instruments and systems are changing: users in laboratories and research facilities increasingly rely on low-noise, oil-free vacuum solutions to avoid contamination and, above all, unnecessary noise in laboratory environments. With the newly developed family of dry-compressing multi-stage Roots vacuum pump ECODRY plus, Leybold has now launched a new fore-vacuum pump for the analytics market. The most striking competitive advantages: apart from its quiet and low-vibration operation, it features a modern, space-saving design with extremely powerful performance.

The basic idea of the ECODRY plus was to develop a clean, compact and low-maintenance pump in the size class 40 to 60 m³ / h, as used in analytical or research laboratories. This pump class is positioned exactly in the transition area between small laboratory equipment and large machines. The most important innovation, however, is undoubtedly the reduction in the noise level that the Leybold developers were able to achieve: “We have managed to build the pump as compact, easy to operate and quiet as is otherwise known only from much smaller devices”, explains the responsible



The new Leybold ECODRY plus vacuum pump for the analytics market.

product manager, Alexander Kaiser, the positioning features of this novelty.

The ECODRY plus was developed to match the requirements for systems such as mass spectrometers and electron microscopes. It is also suitable for large-scale accelerators due to the absence of dust or oil contamination. It offers a high degree of comfort, suction power and flexibility. The pump family, available in the sizes 40 plus and 65 plus, offers short delivery times and can also be obtained via the Leybold Online Shop.

The most important feature of this new vacuum pump range is the extremely low noise level. With an average value of 52 dB (A), it works below the noise limit that is harmful to human health. The sound level of the ECODRY plus is below a conversation at room volume. In every day operation and compared to the relevant competitive products of its class, the pump, which is designed for ergonomic working environments, yields the lowest noise emissions.

Such low values are the result of an ingenious development and construction strategy. Integrated into the pump housing, the ECODRY offers sound insulation, an optimized silencer in the exhaust and a quiet air cooling system. At Leybold, the insulation is installed as standard.

The non-contact rotor design is not only designed for a whisper-quiet operation, but also for energy-efficiency and low vibration. In order to be able to produce high-resolution images, such as in electron and scanning tunnel microscopes, the pump must not transmit vibrations. The elementary



The most important feature of the new ECODRY plus vacuum pump range is the extremely low noise level – an average value of 52 dB (A).

feature is that the rotors and the housing rotate without friction even at high speeds of up to 12600 min⁻¹. In addition, as measured by industry-standard solutions, it generates less heat, which means lower operating costs for air-conditioning.

In class comparison, the ECODRY plus is also one of the lightest and most compact vacuum components. Users appreciate this feature, as systems for research and development have to deliver their performance in a narrow space. Concerning performance, this pump range was designed to deliver what is needed for the relevant applications. “This is why we were able to design compact mechanical components and use a smaller motor and smaller electronic components”, says Alexander Kaiser.

The lubrication takes place only in the area of the bearing of the shafts, which are separated from the pump chamber by a wear-free sealing system. Thus, neither lubricant nor particles penetrate into the pump chamber and the recipient, thereby causing no deterioration of the final pressure or suction. This, in turn, results in only occasional maintenance, as appreciated in ultrahigh-vacuum applications. Users can focus on their experiments.

TECHNOLOGY PICKS

Equipped with two flexible interfaces, the pump can also be remotely controlled. When used in commercial analysis systems, the pump is frequently integrated into the plant control system, and started, stopped, speed-varied and monitored as required.

With the ECODRY plus from Leybold, a new optimized product is launched, which is unrivaled quiet and meets the increasing performance requirements of the applications.

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.

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 3800 people, including about 100 trainees. www.atlascopco.de

To learn more about Leybold, please visit www.leybold.com

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Pfeiffer Vacuum Introduces New Magnetically Coupled Rotary Vane Pump

The Duo 11 ATEX rotary vane pump, which meets ATEX directive 2014/34/EU, was brought to the market by Pfeiffer Vacuum for processes taking place in potentially explosive atmospheres or conveying explosive gases and vapors. It satisfies the most stringent explosion protection requirements.



Pfeiffer Vacuum magnetically coupled rotary vane pump with ATEX certification

The ATEX certification applies for both the interior and exterior of the pump. The Duo 11 ATEX is classified as equipment category 3G and temperature class T4. It can convey all gases up to and including explosion group IIC.

The pumping speed is 9 m³/h at 50 Hz and 10.5 m³/h at 60 Hz. The Duo 11 ATEX is equipped with a frictionless magnetic coupling. The shaft seal rings that are used with other rotary vane pumps can be dispensed with as a result. The extra safety, which the magnetic coupling provides, is important in explosive atmospheres and without shaft seal rings, it is impossible for media inside the pump to escape out through faulty shaft seal rings.

Explosion-proof equipment is required in many types of applications: potentially

explosive gases are used in numerous industrial processes. Hazardous gas atmospheres are present in applications such as research experiments, various industrial processes, biotechnology, and chemistry laboratories. Gas filling machines are also vulnerable to a massive risk of explosion. The new Duo 11 ATEX from Pfeiffer Vacuum can be used in all of these applications.

About Pfeiffer Vacuum

Pfeiffer Vacuum is one of the world's leading providers of vacuum solutions. In addition to a full range of hybrid and magnetically levitated turbopumps, the product portfolio comprises backing pumps, leak detectors, measurement and analysis devices, components, as well as vacuum chambers and systems. Ever since the invention of the turbopump by Pfeiffer Vacuum, the company has stood for innovative solutions and high-tech products that are used in the Analytics, Industry, Research & Development, Coating and Semiconductor markets. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 2,350 people and has more than 20 subsidiaries.

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

New Busch Zebra RH Vacuum Pumps for Laboratories and Production

Busch Vacuum Pumps and Systems has now launched a new series of vacuum pumps for a wide range of applications. The new two-stage oil-lubricated rotary vane vacuum pumps Zebra RH were developed both for research laboratories and for production processes that work in the medium vacuum range.



The Zebra RH 0030 B rotary vane vacuum pump is one of a total of eight sizes in the new Busch series

Robustness and reliability of operation are the outstanding qualities of Zebra RH rotary vane vacuum pumps. The proven rotary vane vacuum technology from Busch has long established itself as the industry standard in the rough vacuum range. With the new series, Busch is now making inroads in the medium vacuum range. All Zebra RH sizes achieve ultimate pressures <0.0076 hPa (mbar). The series includes eight sizes and covers pumping speeds from 2.4 to 90 m³/h. Zebra RH vacuum pumps are thus also highly suitable as backing pumps for turbomolecular vacuum pumps and can be used in this combination in the high vacuum range.

The consistently high vacuum level in continuous operation is ensured by forced oil lubrication, perfectly coordinated materials as well as state-of-the-art precision manufacturing. Its silent operation makes the Zebra vacuum pump series perfectly suited for use in research labs, where a low-noise working environment is essential. The advanced design ensures that only minimal maintenance is required.

A gas ballast valve, that can be manually switched on and off makes it possible to handle gasses with high water vapor load. Some of the application areas are mass

TECHNOLOGY PICKS

spectrometry, leak detectors, glove boxes, vacuum coating and drying as well as various heat treatment processes.

For more information, visit www.buschusa.com

New Nash Model 2BM5 Liquid Ring Vacuum Pump

Nash is pleased to announce the NASH 2BM5 liquid ring vacuum pump & compressor. The 2BM5 offers a full hermetic seal and is offered in addition to the existing 2BM1 models of NASH hermetically sealed pumps. The addition of the 2BM5 extends the capacity of the 2BM series to 35-877 cfm (60 to 1490 m³/h).

Through a magnetic drive with static o-ring seals the NASH 2BM Series achieves non-contact torque transmission, which allows for the hermetic seal. This key feature eliminates leaks while reducing maintenance. With non-contact torque there are less wearing parts, and no wearing shaft seals. The pump uses its own operating fluid for the lubrication and cooling of the bearings and magnetic coupling, eliminating the need for any additional liquid lubrication.

The NASH 2BM series offers a large differential pressure capability, allowing the pump to covers a wide range of operating conditions and industrial applications.



The addition of the 2BM5 extends the capacity of the 2BM series to 35-877 cfm (60 to 1490 m³/h).

With reliable, dependable, leak free performance the 2BM series is an ideal match for process applications including chemical, pharmaceutical, petrochemical and the food industry.

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NASH 2BM5 Performance Specifications

- Vacuum Range: to 1" Hg abs (33 mbar)
- Differential Pressure Capability: ~18.9 psi (~1.3 bar)
- Compressor Pressure: ~21.7 psig (~2.5 bar abs)

NASH 2BM1 Performance Specifications

- Vacuum Range: to 1" Hg abs (33 mbar)
- Differential Pressure Capability: ~20.3 psi (~1.4 bar)
- Compressor Pressure: ~5.8 psig (~1.4 bar abs)
- Certification: ATEX Cat. 1 & 2

About Nash

Nash, a division of Gardner Denver, is a leading manufacturer of liquid ring vacuum pumps, compressors and engineered systems serving the chemical, oil & gas, power, paper, mining, environmental and food industries. Nash also provides global service and technical support for its products through its locations around the world.

For more information, visit www.GDNash.com email: nash@gardnerdenver.com or call 1-800-553-NASH

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The Heavy-Duty AeroLock™ Rotary Valve

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volumetric efficiency at up to 1.0 bar [15 PSI] pressure differential. The HD conveys a broad range of products in the plastics, chemicals, minerals and food industries. The HD Aerolock is used to handle pellets and granular products, and will meter powder materials at over 100,000 lbs./hr.

The Heavy-Duty Aerolock rotary valve has an eight-blade rotor that maintains a minimum two-blade labyrinth seal to minimize air leakage. It is available with relieved tips to prevent material buildup on the housing or non-relieved tips for other larger-particulate products.

About Coperion and Coperion K-Tron

Coperion K-Tron is a business unit of Coperion and is a global leader and single source supplier of material handling and feeding systems. Coperion K-Tron has defined the leading edge of technology for material handling and feeding applications in the process industries.

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

For additional information visit www.coperionktron.com or email info@coperionktron.com.

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Typical applications for a VAC-U-MAX Multi-Ingredient Handling System include



VAC-U-MAX Multi-Ingredient Handling System



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pneumatically conveying bulk materials from and-to the following:

- Storage bins to customers process
- Storage vessels to weigh-hopper, and once the material is weighed the batch is transferred to the process
- From several pick-up points to one batch-weigh receiver
- Transferring bulk material to process via a VAC-U-MAX batch-weigh hopper
- From bulk bag unloader to vacuum receiver incorporating flex-tube diverter valve
- From bulk bag unloader to multiple vacuum receivers incorporating filter separator
- Delivering bulk materials to two batch-weigh vacuum receivers

VAC-U-MAX systems combine modern computerized technology with innovative pneumatic and mechanical conveying, for automated dust-free ingredient handling with little or no human interface. Batch-weigh system accuracies are within 0.5% of the batch size, allowing for greater control of end-product quality and inventory control of bulk ingredients to the process. VAC-U-MAX is a UL-listed designer and fabricator of control panels for general purpose and hazardous locations, with control systems configured to a wide range of batch-weighing applications.

For more information visit www.vac-u-max.com.

Festo Introduces Single Sourced Automated Ball Valve Solution for Process Applications

Festo introduces a competitively priced; single sourced automated ball valve solution for process applications that offers fast delivery, world-class quality, and global support. This is the latest entry in a Festo

development initiative of next generation actuators, sensors, and other accessories.

Festo automated ball valves feature the company's new VZBE ball valves, DFPD quarter turn actuators, VSNC NAMUR pilot valves, and the SRBC family of open/close sensor boxes. For proportional flow applications, Festo offers the feature-rich, yet cost effective, CMSX digital positioner.

End users, OEMs, and engineering companies simply provide the Festo Customer Solutions group or Festo distributors with the requirements of the valve. Festo sizes the components and at the customer's request provides all the pieces in a single box or ships a fully automated valve assembly ready for installation and wiring. A unique part number will be issued for ease of reordering and field support.

The VZBE family of NPT ball valves is available in a two-way or three-way design. With a 316 stainless steel body and Teflon seats, these valves are rated up to 1,000 psi and 400° Fahrenheit (200°C). For sanitary



Automated ball valves are the first in a new generation of process valve solutions from Festo.

environments, Festo also offers the 3A approved VZBD ball valve family with tri-clamp and welding connections. And for fire-safe applications, the API607 approved VZBF is available with ANSI flange connections.

The key customer advantages of the new Festo ball valve solution include:

- One stop shop for automated ball valves
- All components are Festo catalog items with Festo world-class quality, delivery, and support assured.
- The quarter turn actuator, pilot valve, sensor box, and digital positioner either are new or represent recent developments for incorporation of the latest capabilities.
- The components seamlessly integrate.
- The solution is price competitive.
- Aesthetically the solution is superior to automated valves that feature bits and pieces cobbled together from different suppliers. Each component is recognizably from Festo. The integrated valve projects an image of quality and substance.
- Companies that begin working with Festo automated process valves now pave the way for adoption of major innovations and designs that are currently in development.

About Festo

Festo is a leading manufacturer of pneumatic and electromechanical systems, components, and controls for process and industrial automation. For more than 40 years, Festo Corporation has continuously elevated the state of manufacturing with innovations and optimized motion control solutions that deliver higher performing, more profitable automated manufacturing and processing equipment.

For more information, visit www.festo.com/us

Integrity Test Solutions for the PHARMACEUTICAL INDUSTRY

By Dennis Seibert, Head of Business Development Leak Detection and by Philippe Bunod, Product Manager Integrity Solutions, Pfeiffer Vacuum

► Contamination such as humidity, oxygen or microbiological ingress can impact drug stability throughout the product life cycle. To prevent the risks of stability failure of highly moisture sensitive drugs (e.g. dry powder for inhalation), or the risk of biological ingress of parenteral drugs, highly sensitive integrity tests are required. Most test methods are very challenging in regards to time, effort, complexity or the limitation of sensitivity and detection range.

Pfeiffer Vacuum offers a comprehensive portfolio of highly sensitive leak detection and integrity test solutions. The company is benefiting

from over 50 years of experience in leak detection, starting with the introduction of the first commercial helium leak detector ASM 4 in 1966. Dedicated for the pharmaceutical industry, Pfeiffer Vacuum offers its innovative AMI Integrity Test System, which does not require any specific tracer gas. Instead, the gas mixture present in the container headspace of the primary packaging is used to perform high sensitivity tests over a large detection range. Suitable for various packaging types such as blisters, plastic & glass bottles, pouches and more, this method is deterministic, non-destructive as well as easy to set up and use.



INTEGRITY TEST SOLUTIONS FOR THE PHARMACEUTICAL INDUSTRY

To understand the challenges in regards to integrity testing, it is important to get an understanding for the classification of leaks and the potential effects of different leak sizes. Especially important for the pharmaceutical industry is the criteria for „bacteria proof“ and „virus proof“. Therefore, integrity test methods in the pharmaceutical industry are classified with a “Limit of Detection” index, indicating the smallest leaks that can be detected with a certain test method. An overview is given in the chart below.

Historically, dye ingress testing has been the container closure integrity test of choice. The detection limit of this method, with a well trained operator, is around 20 µm. Since the test is strictly visual, the detection limit has been experimentally estimated by using orifices of known diameter. As a consequence, tightness criteria in the pharmaceutical industry are usually expressed as an equivalent hole diameter in µm. However, an equivalent hole diameter is not enough to define the tightness criterion of the packaging. Indeed, the flow leak rate only is directly correlated to the quantity of oxygen or moisture you will get inside a leaky packaging.

Helium leak detection is still the most sensitive method for container closure integrity testing. However, some limitations are related to the

"Limit of Detection" Classification Index	Air Leakage Rate [mbar·l/s]	Orifice Leak Size [µm]
1	<10 ⁻⁶	<0,1
2	10 ⁻⁶ to 10 ⁻⁴	0,1 to 1
3	6·10 ⁻⁴ to 4·10 ⁻³	2 to 5
4	5·10 ⁻³ to 1,6·10 ⁻²	6 to 10
5	0,017 to 0,36	11 to 50
6	>0,36	>50

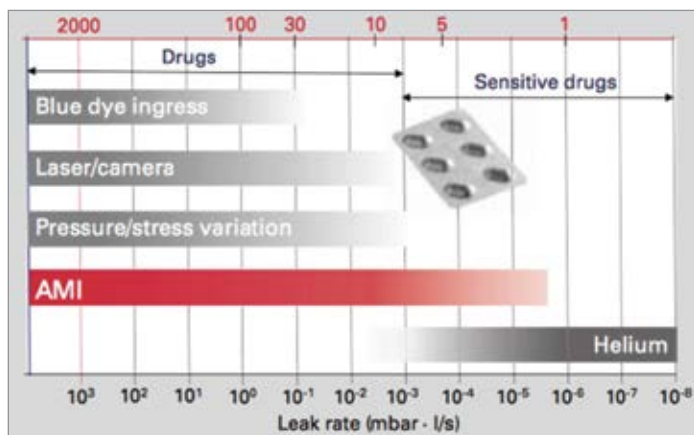
Limit of Detection Classification according to USP 1207.1

admittance of the tracer gas. Consequently, attempts have been made to quantitatively test integrity without any specific tracer gas. These methods are e.g. pressure and force decay or optical methods using laser and camera to measure the deformation of the cavities top foil under vacuum. An overview of leak testing methods used for blister integrity testing is shown in the table below.

Highly sensitive, quantitative measurements in real-time without specific tracer gases

With the AMI Integrity Test System, Pfeiffer Vacuum has introduced optical emission spectroscopy as a method with lower detection limits compared to any other method that uses gas trapped in the cavity. The packaging to be tested is put into a test chamber which also provides a viewport and mechanical support for the package. The test chamber can thereby be customized according to the product formats and the quantity of products tested simultaneously.

After loading the sample, the chamber is evacuated. At pressures lower than 10⁻² mbar, a plasma is ignited and its optical emission analyzed



Equivalent hole diameter (µm)

Leakage Rate Classification							
Description	(PICUTRE) Technically Tight	(PICUTRE) Gas Tight	(PICUTRE) Virus Proof	(PICUTRE) Bacteria Proof	(PICUTRE) Water Tight	(PICUTRE) Water Tight (dripping)	(PICUTRE) Water Tight (fluent)
Air Leakage Rate	10 ⁻¹¹ mbar·l/s	10 ⁻⁹ mbar·l/s	10 ⁻⁷ mbar·l/s	10 ⁻⁵ mbar·l/s	10 ⁻³ mbar·l/s	10 ⁻² mbar·l/s	0,1 mbar·l/s
Escape Time of a bubble with 1cc	> 1000 years	> 30 years	> 100 days	> 1 day	> 15 min	> 10 sec	0.1 sec

Leak Sizes and Classifications



High sensitivity tests over a large detection range are suitable for various packaging types.

with an optical emission spectrometer. The lowest detectable signal corresponds to an orifice diameter of roughly $0.1 \mu\text{m}$ (according to USP <1207.1>). For further coarse leak tests the AMI sensor technology can be complemented with a second dedicated leak sensor integrated into the same test equipment to extend the upper detection limit up to few mm holes. This gives the AMI the broadest detection range in the market.

The software solutions used in the AMI are compliant with 21 CFR part 11. Optional software solutions are available for a manufacturing execution system. Trend analysis can be implemented in the software for early indication of drift production and packaging equipment.

This deterministic method is easy to set up and to use and yields quantitative as well as highly repeatable results. In addition to the information achieved by a simple GO/NOGO test method, the new method of the AMI allows the detection of drifts in sealing parameters in real time. The loss of valuable pharmaceuticals is prevented and production stops for corrective measures are minimized.

The cycle time depends on the desired detection limit. For a leakage rate of $1.0 \cdot 10^{-4}$ mbar-l/s (about $1 \mu\text{m}$ according to USP <1207.1>), a cycle time of 30 seconds can be expected. Automatic calibration is implemented into the test equipment using certified calibrated leaks. Thereby, operator-independent calibration and test results are provided.

Packaging Types and detection ranges

The AMI can be used for different types of packaging and sealed objects like medical devices and battery cases. Thereby different sample sizes

Advantage	Benefit
<ul style="list-style-type: none"> Large detection range with higher sensitivity than conventional tests 	<ul style="list-style-type: none"> Higher production efficiency - can replace gross & fine leak test
<ul style="list-style-type: none"> User independent & deterministic test method with high repeatability 	<ul style="list-style-type: none"> Peace of mind - reliable and user independent test results
<ul style="list-style-type: none"> Trend analysis with 21 CFR part 11 compliant software 	<ul style="list-style-type: none"> Lower cost of non-quality thanks to advanced process monitoring
<ul style="list-style-type: none"> Non-destructive testing, no specific tracer gas needed 	<ul style="list-style-type: none"> Easy to set up Fast return on investment
<ul style="list-style-type: none"> Versatile / Format independent 	<ul style="list-style-type: none"> Flexible tool for production High throughput (Test per batch)

USPs & Customer Benefits

and detection limits are applicable. In regards to blister packages for example, the AMI can detect holes up to $0.4 \mu\text{m}$ respectively $2 \cdot 10^{-5}$ mbar l/s (according to USP <1207.1>). Thereby multiple blisters can be tested simultaneously. About the same detection limit is provided for plastic bottles. Here up to 100 bottles can be tested at the same time. For glass vials the detection limit goes down to even $1/10 \mu\text{m}$ hole or $1 \cdot 10^{-6}$ mbar l/s leak rate (according to USP <1207.1>). Also, no sample preparation or storage time is required and the test results will show within about 1 minute.

For more information on Pfeiffer Vacuum please visit www.pfeiffer-vacuum.com

To read more about **Laboratory Applications**, please visit www.blowervacuumbestpractices.com/industries/medical

The Heart of Pneumatic Conveying Systems – **POSITIVE DISPLACEMENT BLOWER CALCULATIONS**

By Roger E. Blanton, P.E., Sales Manager, Howden Roots

► Pneumatic conveying systems are widely used in manufacturing plants and process industries. They provide a practical method of bulk-solid material transport. A surprisingly wide variety of powders and granular material can be effectively moved from one location to another within the plant. “Compared with

other bulk-solid transport systems, a properly designed pneumatic conveying system affords many advantages, including: flexible pipeline routing, multiple pick-up points (as in vacuum systems), and delivery points (as in pressure systems), little to no cross-contamination, dust free operation, and an inert atmosphere.”¹

The heart of the pneumatic conveying system (air mover, solids feeder, pipeline, and separator) is the air mover. Correctly specifying the volumetric flow rate and pressure levels required to move the material will determine system reliability. One must also look at pipe size, distance, and the weight of the material being moved. A company



“Selecting the correct blower is the most important decision when designing a pneumatic conveying system.”

— Roger E. Blanton, P.E., Sales Manager, Howden Roots

specializing in the design requirements of pneumatic conveying systems is best consulted for evaluating these requirements and specifying the required air or gas flow rate for the system.

Using a high-pressure source, such as plant compressed air, wastes valuable energy. Howden Roots positive displacement (PD) blowers provide a cost effective, efficient solution. They are used extensively in dilute phase applications where the bulk material is conveyed through the pipeline in suspension, and the required pressure does not exceed 15 PSIG. Not all, but several Howden Roots blowers are bi-rotational so they can be used for vacuum or pressure service.

The operating principle of a conventional Roots type blower is quite simple. The reader is directed to previous articles where this is explained in detail, and not repeated here.^{2,3} It's important to note that Roots blowers do not create internal pressure or vacuum, they simply overcome system losses.

PD Blower System Design and Capacity Control

Selecting the correct blower is the most important decision when designing a pneumatic conveying system. The rating of the blower is expressed in terms of required pressure and volumetric flow. Any miscalculation in specifying the above will result in a conveying system that is oversized, isn't capable of achieving the material flow rate required, or experiences pipeline blockage. Blockage occurs where the dynamic air or gas pressure in the system is at its minimum value. The volumetric flow rate from the blower depends on the diameter of the pipe being used and the velocity required to convey

the specified material. For design purposes, standard conditions (68°F, 14.7 psia, 36% RH, 0.075 lbs.ft³)⁴ are typically used in specifying the blower.

Capacity control of PD blowers is limited because the blower is cooled by the mass flow through the machine. Throttling the blower will result in overheating. Effective methods of capacity control include,

- Staging blowers off or on in systems where multiple blowers are used in parallel to attain required flow
- Using a Variable Frequency Drive (VFD) on the blower motor to adjust blower speed within defined limits
- Using a Blow Off Valve (BOV) in the blower discharge piping
- Changing the sheave sizes on belt driven blowers.

PD Blower Limitations

Inherent by their design, a PD blower has both mechanical and thermal limitations because the impellers are machined to close tolerances and the clearances are very small. Therefore, PD blowers have speed, temperature and pressure limitations that must be considered when sizing a pneumatic conveying system. As a general rule, PD blowers have the capability to turndown to roughly 50% of the maximum design speed because temperature rise increases as unit speed decreases, as discussed above. In addition, gear tip speed must be maintained at a minimum of 1,000 FPM and a maximum of approximately 4,700 FPM (varies by model) – which is critical for proper lubrication. Blowers are generally limited



Roger E. Blanton, P.E., Howden Roots

to a maximum average temperature rise of 250°F (121°C) because of issues with thermal growth. Lastly, Roots blowers are limited to a 2:1 compression ratio because as pressure increases there is a corresponding increase in discharge temperature.

Basic Pneumatic Conveying System Calculations

Blower manufacturers do not routinely size pneumatic conveying systems, leaving that task to specialized design companies. However, it is helpful to have some basic understanding of the procedure. Preliminary design of power, air requirements, and pipe size can be developed, but experienced designers add their own unique guidelines compatible with their equipment. The material to be conveyed and the distance required to move the material limit pneumatic conveying systems.

Saturation (S) is defined as the cubic feet of air required to move or convey one pound of a given material for a specified distance. Tables of this value (S), pressure factor (PF), pipe velocity (v), and the horsepower required

THE HEART OF PNEUMATIC CONVEYING SYSTEMS – POSITIVE DISPLACEMENT BLOWER CALCULATIONS

Howden Roots PD Blowers for Pneumatic Conveying

Howden Roots has several blower models suitable for pneumatic conveying applications. A few are shown in the following pictures and descriptions.

URAI DSL (2" – 7" gear size)

The Roots Universal RAI DSL (Dual Splash Lubricated) heavy-duty rotary blowers are designed with detachable, rugged steel mounting feet that permit easy, in-field adaptability to vertical or horizontal installation requirements. Because of the detachable mounting feet, these units can be easily adapted to any of four drive shaft positions: right, left, bottom, or top. The compact, sturdy design is engineered for continuous service when operated in accordance with speed and pressure ratings.



RAM™ (4" – 6" gear size)

RAM™ stands for Reliability, Availability, and Maintainability. Today, more than ever, Howden Roots is committed to supplying our customers with reliable products manufactured with state-of-the-art CNC machine tools. Production and inventory are being scheduled and controlled to ensure these units will be available when you need them. Design improvements such as repositionable rugged steel mounting feet and die-cast aluminum drive end covers and gear covers help to reduce installation costs and make normal maintenance easier.



ROOTS-FLO® (4" gear size)

ROOTS-FLO® rotary positive displacement blowers are heavy-duty rotary units in a compact, sturdy design engineered for reliable pneumatic conveying of grain and similar products.



to convey one ton of material per hour (HP) have been published.⁵ Once the desired total flow rate of the product and distance involved is determined, and the material is defined, a simple procedure can be followed to preliminarily size the pneumatic conveying system components.⁵

A Sample Calculation Sequence (for illustrative purposes only)⁵

1. Determine the Saturation (S), hp/ton (HP), pipe velocity (v), and Pressure Factor (PF) values for the conveyed product from the published saturation table.

2. Calculate the volume of free air (Qs) required

$$Q_s \text{ (scfm)} = S \times \text{conveying rate (lb/min)}$$

3. Calculate the required operating pressure (P, psig)

$$P = \text{HP}/S \times \text{PF}$$

4. Calculate the actual cubic feet per minute (acfm) at the feed point (site elevation = 0 feet asl)

$$\text{acfm} = \text{scfm} \times 14.7 / (14.7 + P)$$

5. Calculate required pipe area (A)

$$A = \text{acfm} / v$$

6. Calculate rotary feeder leakage (L) in acfm

$$L = \text{feeder volumetric displacement} \times \text{feeder rpm} \times 1.3$$

7. Calculate feeder leakage in scfm (Ls)

$$L_s = L \times (14.7 + P) / 14.7$$

8. Calculate total air required by the blower (Q)

$$Q = Q_s + L_s$$

9. Calculate required blower speed (Sb), rpm

$$S_b = Q_s / \text{blower displacement (cubic feet per revolution, cfr) + slip (rpm)}$$

[cfr & slip from blower manufacturer]

10. Calculate required blower horsepower (HP)

$$HP = S_b \times cfr \times P \times 0.005 \text{ BP}$$

For more information please contact Roger Blanton, P.E., Howden Roots, at email: roger.blanton@howden.com or visit www.howdenroots.com

About the Author:

Roger E. Blanton, P.E. is currently a Sales Manager for Howden Roots LLC based in Tulsa, Oklahoma USA. He is a registered professional engineer working for over 35 years with rotating equipment and petrochemical processes. Blanton holds a BS degree in Mechanical Engineering from the University of Tulsa, and an MBA degree from Oklahoma State University. He has specialized for the last 25 years in technical product design, application, and sales; new product development and introduction; sales and distribution management; and international business development. He is a member of the American Society of Mechanical Engineers (ASME), Tau Beta Pi Engineering Honor Society, and past president of the Greater Ozarks International Trade Association.

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Vacuum System Fundamentals for “COMPRESSED AIR PEOPLE”

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

► Introduction

Based on my 28 years' experience, I am an unapologetic “compressed air nerd”. But, I also understand vacuum systems. The reason I do is that I look at every problem from the fundamentals, not from rules of thumb. Any technical field develops a language and a set of “rules of thumb”. It is helpful to do this, to disseminate ideas and practices broadly and

quickly. These ways of thinking get reinforced when they appear to “work”. However, this type of thinking tends to create pathways of thinking that are ruts. These ruts run deep in every field, particularly compressed air.

If you want to understand vacuum systems, you have to get out of the ruts, and slog through the mud and bounce over the rocks a bit.

If you're a “compressed air person”, think outside the box for a few pages with me. I am going to borrow some terms from the “pump people” to explain how vacuum systems are similar, yet different from compressed air systems. There are several ruts to get out of. Remembering what changes and what doesn't, what is controlled, and how to design systems for optimal energy consumption.



“If you want to understand vacuum systems, you have to get out of the ruts, and slog through the mud and bounce over the rocks a bit.”

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

What Changes and What Doesn't: System Resistance Changes

Always start with the system. Pump people teach us to look at a system as an “equivalent orifice”, a resistance that flow and pressure are related to one another, and to develop a “system resistance curve” first. Both vacuum and compressed air systems are essentially a variable leak, a variable hole, with air moving from one pressure to another across it. This seems to be analogous to a variable flow demand. But be careful. The system is really just holes that open and close, or have variable sized holes (control valves). In some limited cases, flow control is part of the system, making it actually a flow-based demand. But that is uncommon. The aggregate of all these variable holes is the “system”. The system gulps what it wants, independent of the vacuum pumps or compressors attempting to serve it. For vacuum systems, air moves from constant ambient pressure to the vacuum pump inlet pressure. For compressed air system, it moves from the compressor’s roughly constant discharge pressure to ambient pressure.

In both cases, the system typically acts as a “choked orifice”. Air is trying to move through the orifice too fast, and is limited based on a maximum pressure ratio of about 53% for air. Basically, a shock wave exists at the point that air is trying to get into the system. For a choked orifice, mass flow is proportional to the inlet pressure. In layman’s terms, this means that if you double either the inlet pressure to the system, you get about double the flow – assuming that you can deliver it. In a vacuum system, you can’t change the “inlet pressure” to the system – it’s ambient pressure. But that’s just theory. You have to be able to magically increase or decrease mass flow to respond to that need to change pressure, and real vacuum pumps can’t do that without a VFD. Or you have to

operate at widely ranging pressures, which compressors don’t do. More on that below.

Figure 1 shows a typical system curve for a vacuum system running at one constant load, or a set of “holes” open. The mass flow stops increasing at the “choked flow” vacuum level.

Compressed Air Implications

- Gas density is fairly constant, because the air compressor’s discharge pressure only changes about 10% of set point.
- The only variable that influences mass flow is pressure, but far less than in a vacuum system. Only about 10%. Thus, you can often neglect the impact of pressure on flow for typical compressed air systems.

Vacuum System Implications

- Since there is a big range of pressure difference (inlet to ambient) that can exist in a vacuum system – often over 20% of an atmosphere or 40% of set point – mass flow is highly related to vacuum level, and vice-versa.

- Since gas density in vacuum systems can change dramatically as the pressure/vacuum changes, there is a big impact of mass flow on density, and density on mass flow.

- Pay attention to the balance of pressure and density, and its impact on flow.

What Changes and What Doesn't: Compression Element Size Doesn't Change

This might seem obvious, but it’s important to understand. In a real system, you are stuck with the iron that you have, unless you are designing a new system. Thus, air compressors and vacuum pumps have to be oversized. Even if you have flexibility on paper now, you will be stuck in the future. For simplification in this article, I will assume we are looking at “positive displacement” vacuum pumps and compressors. Those types have a fairly constant volume flow rate at the inlet, at a given speed. Slip and pressure differential across the compression element don’t affect it that much (less than 5%).

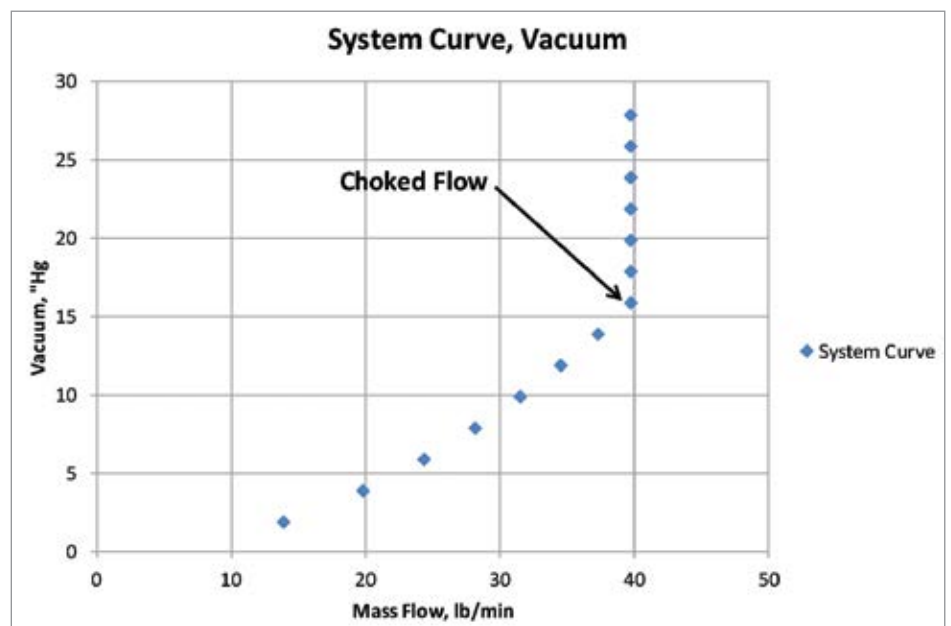


Figure 1. Typical System Resistance Curve for Vacuum System

VACUUM SYSTEM FUNDAMENTALS FOR “COMPRESSED AIR PEOPLE”

All you can do to make the most of a system is to attempt to match the right air compressor or vacuum pump to the right system, which is difficult because you have a widely varying “system resistance”. The compressor or vacuum pump has to be oversized for average demand, or the system will crash at max demand.

Vacuum pumps and air compressors are sized for inlet flow, at full speed and a particular pressure ratio that is optimal. For instance, 1,000 “acfm” and 100 psig for a compressor. That is 1,000 cubic feet per minute at the inlet, independent of density, compressing from ambient pressure to 100 psig. It just takes a scoop of 1,000 ft³ volume every minute, and squeezes it 7.8 times. Typically a curve is not

provided, just a full capacity data sheet. If one is, it shows power versus flow, not flow versus pressure. See Figure 1 for an example. Pressure is magically relatively constant, so the engineer doesn’t think about how it impacts on the flow capacity of the compressor, or how it balances against the system.

A 1,000 “icfm” vacuum pump could use the same compression element as the 1,000 acfm compressor, or one modified with a different compression ratio to optimize for vacuum system operation, 1,000 icfm at 28”Hg for instance. It would have a much smaller motor and a larger separator (if lubricated). Its performance would look flat as a pancake from 10”Hg to about 25”Hg, and decline slightly after that. See Figure 2 for an example. But don’t be fooled. Your real system will not require 1,000 icfm in all vacuum ranges. Recall that the system is just a hole. The vacuum pump will pull down until it balances at whatever pressure differential/density balances with the system resistance at the time.

The vacuum pump curve and system curve can both be shown together, Figure 2. Without using controls, the operating point is the intersection of the vacuum pump curve and system curve.

What Controls What?

In an ideal system, you would control based on optimal process effectiveness. If the process is mass-flow sensitive, then it should be mass-flow control, throughout. If it is pressure-sensitive, then it should be pressure-based. In reality, it is very difficult to control vacuum and compressed air systems by a mass-flow set point. The instrumentation, controls, and mechanical limits of mass-flow control make it applicable to a limited range of applications, usually process compressors/

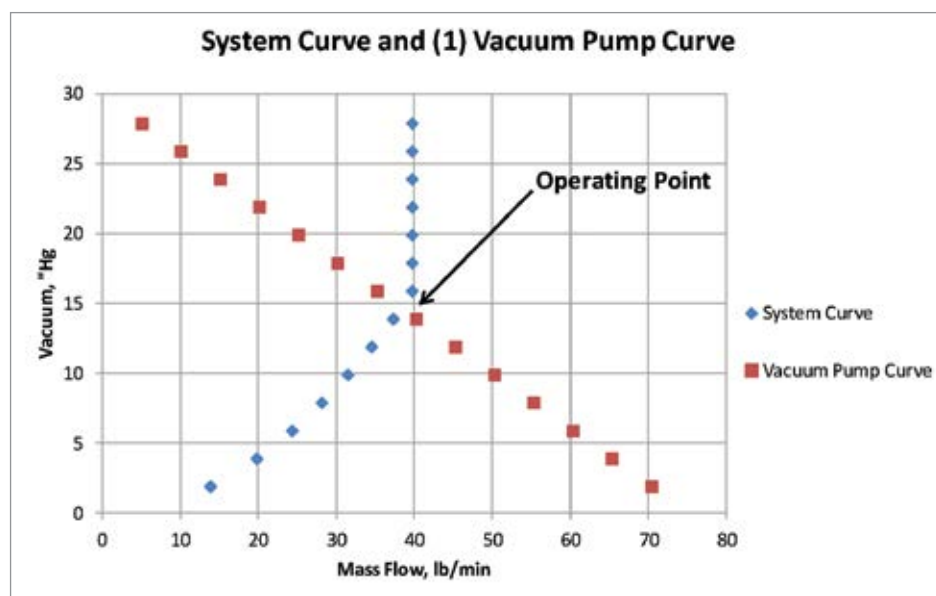


Figure 2. One Vacuum Pump Running Against Demand

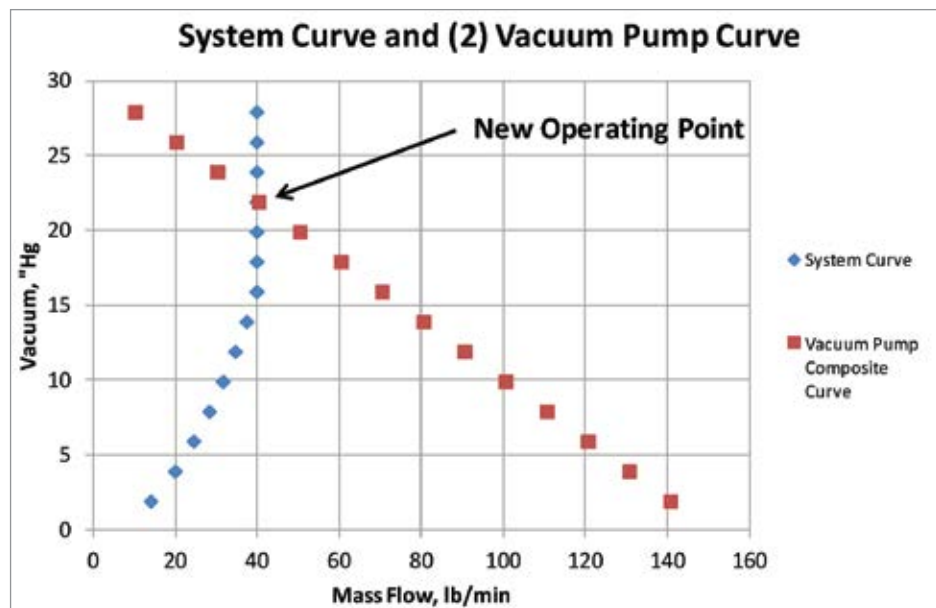


Figure 3. Impact of Running Two Vacuum Pumps on Same Demand

vacuum, and not general plant air vacuum. For this article, we are discussing general plant systems. These systems are pressure-controlled in practice, whether the system needs mass-flow controlled or pressure controlled. But the system does what it does all on its own, and is the “feedback loop” that dominates the actual operation.

Compressed Air Implications

System demand is independent of pressure within the air compressor’s operating range. System demand = A, pressure = B, and flow = C. Control happens A to B to C, essentially $A \Rightarrow B \Rightarrow C \Rightarrow A$. There is a small feedback between pressure and system demand ($C \Rightarrow A$), but not much. System demand changes pressure, just a small amount up or down on the “system curve”, the control system cuts

back or increases compressor flow to match system flow – by stabilizing pressure. As an example, an inlet modulating compressor uses a proportional pilot valve to control its inlet valve to a given plant pressure, and a VFD control controls speed to maintain a plant’s pressure.

Vacuum System Implications

System demand is dependent on pressure in a vacuum pump’s operating range. Typically, pumps are pulling too low of a vacuum, to be safe, and that lower vacuum is causing a false demand on the vacuum pump. Thus, $A \Rightarrow B \Rightarrow C \Rightarrow A$, and it reaches a balance. Even if mass flow is choked, the lower vacuum causes a higher vacuum pump inlet flow (icfm) to hit that same mass flow, and that takes more power. See Figure 3 for the

same system resistance as shown in Figure 1, but with two vacuum pumps running. The system will just balance at a lower vacuum, 22”Hg versus 15”Hg. Power will be about double, and the process wouldn’t even know that the other vacuum pump was on. Unlike a compressed air system that would over-pressurize and cause a compressor to unload, the vacuum pumps essentially “self-throttle” against the system.

Design for Optimal Energy Consumption: Determine the Vacuum Level and Flow Actually Needed

Start at the process, the part that creates the demand, the “holes”. There are multiple types. Fixed and varying demand, pump-down and hold, and constant flow. For instance, in a CNC routing table’s “hole” is the sum of

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a bunch of tiny holes that pull air through the table to hold a work piece down. It is a varying demand because the flow only occurs when the table is not covered, and many different types of work pieces cover the table, leaving a varying area uncovered. In a chemical process, the “hole” is usually a control valve maintaining a particular process variable, and the flow is fairly constant. In a robot application, the “hole” is the suction cup that has a very small volume, and holds a piece to block the hole, zero flow, then drops it and has a high flow.

If you can perform an analysis of all the demands, the best way is to turn them all into equivalent orifices or CVs (a valve sizing term, similar to hole size, but more technical). Then, using the minimum required vacuum

level for the system (the lowest vacuum needed for all), aggregate them and develop a peak and average flow, using the orifice flow formula, up to the choked flow level. An example is in Table 1, for just one 1.783” diameter hole, equivalent to a 1,000 icfm demand at 14”Hg. Obviously a real plant isn’t one hole. This is the equivalent of all the demands. These formulas are available in a variety of toolboxes online. If you do this in a spreadsheet, it would have more columns than these.

For this example, let’s assume the required vacuum is 15”Hg, and max demand is 1,000 icfm. If the average and minimum levels were calculated, let’s assume them to be 600 and 200 icfm at 15”Hg.

Design for Optimal Energy Consumption: Match Vacuum Pumps Against Demand, Full Range

With a variance of 5:1 max/min flow, typical in automation systems, one large 1,000 icfm vacuum pump would be inefficient. In this case, a multiplex is recommended. In many production systems, dedicated, independent vacuum pumps are used, one per production system. This is generally OK if the pump is shut off often or small. But for systems that run often, it leads to a dead-load dominated system. Consolidation and automation with a multiplex vacuum pump system is recommended. Sequencing controls can be used to maintain vacuum within a differential, and pumps can be staged. More details on system design will be in a forthcoming article.

Conclusions

- Understanding system resistance is important to optimizing vacuum systems. It is the “equivalent hole” that the system leaks in from atmosphere. It is the relationship between flow and vacuum in any system, so it is important to understand it first.
- Vacuum pump size is expensive to change, so match it well to demand. Consider multiplex and sequenced system designs for varying demands to reduce dead-load power.
- Vacuum level controls system flow, and pump size draws a system to a deeper vacuum than needed, so false demand is easy to create. Optimizing controls for the required vacuum minimizes that false demand. **BP**

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

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TABLE 1. SYSTEM DEMAND CALCULATIONS, MAX DEMAND

SYSTEM RESISTANCE CURVE 1						
PRESSURE DIFFERENTIAL (VACUUM), "HG	ABS PRESS, "HG	PRESSURE RATIO	INLET DENSITY, LB/FT ³	MASS FLOW REQUIRED, LB/MIN	SYSTEM FLOW REQUIRED, SCFM	INLET VOLUME FLOW REQUIRED, ICFM
30	0	0	0.0000	39.7	528	infinite
28	2	0.067	0.0050	39.7	528	7895
26	4	0.134	0.0100	39.7	528	3948
24	6	0.201	0.0151	39.7	528	2632
22	8	0.267	0.0201	39.7	528	1974
20	10	0.334	0.0251	39.7	528	1579
18	12	0.401	0.0301	39.7	528	1316
16	14	0.468	0.0352	39.7	528	1128
14	16	0.535	0.0402	37.2	495	926
12	18	0.602	0.0452	34.5	458	762
10	20	0.668	0.0502	31.4	418	626
8	22	0.735	0.0553	28.1	374	508
6	24	0.802	0.0603	24.3	323	403
4	26	0.869	0.0653	19.8	263	303
2	28	0.936	0.0703	13.8	184	197

Busch Provides Reliable Oxygen Supply to Aeration Tanks

By Uli Merkle, Busch Vacuum Pumps and Systems

Figure 1: Four aeration channels with a total volume of 7,200 cubic meters ensure aerobic biological wastewater treatment at the wastewater treatment plant in Rheinfelden-Herten.

► The Wastewater Association of Rheinfelden-Schwörstadt operates the wastewater treatment facilities in Schwoerstadt and Rheinfelden-Herten, Germany, as well as several rainwater overflow basins. The wastewater treatment facility in Rheinfelden-Herten has been in operation since 1980 and has been converted and reconditioned in recent years as a result to meet the latest technical standards. This wastewater treatment facility now satisfies the highest requirements, and with a population of

about 47,000, has reached a size that also guarantees sufficient disposal capacity for future generations.

The wastewater treatment facility in Rheinfelden, Germany is the larger of two treatment facilities of the Wastewater Association of Rheinfelden-Schwörstadt, which purifies 4,000 m³ of wastewater a day in dry weather and up to 25,000 m³ in wet weather. For ventilating the aeration



“This wastewater treatment facility now satisfies the highest requirements, and with a population of about 47,000, has reached a size that also guarantees sufficient disposal capacity for future generations.”

— Uli Merkle, Busch Vacuum Pumps and Systems

BUSCH PROVIDES RELIABLE OXYGEN SUPPLY TO AERATION TANKS



Figure 2: Two Tyr rotary lobe blowers, with an output of a volume flow of 2,600 cubic meters per hour each, are in operation on each aeration channel.

channels, the facility relies on Tyr rotary lobe blowers from Busch, which provide the necessary injection of oxygen.

Thanks to a total investment of about \$8.4 million in the latest technologies, the Wastewater Association has reduced pollutants further, which has a positive impact on the water quality of the natural watercourses. The methane gas produced in the digestion tower is used to power a gas engine in the facility's own co-generation plant. The generator driven by this produces an average of 105 kW/h. This means that up to 50% of the energy required can be generated by the facility itself. In addition to this, the facility's own heating system runs on sewage gas.

The aerobic biological wastewater treatment takes place after the primary settling tank in four aeration channels (Figure 1) with a total volume of 7,200 m³ and a depth of seven meters each. Each of these aeration channels is ventilated by a rotary lobe blower, which provides oxygen for the microorganisms in the wastewater to be treated. Air

injection occurs via the aeration candles fitted on the bottom of the tank. In the downstream secondary settling tank, the microorganisms are separated as activated sludge particles from the treated wastewater and fed back into the aeration channels.

In 2008, new rotary blowers were purchased for the four aeration channels and another was installed as a replacement blower. After an operating time of several years, these blowers became increasingly fragile and the amount of maintenance and repair work increased. Operations Manager, Jürgen Nass, realized that the operational reliability was no longer guaranteed, so he searched the market for alternatives and came across the Tyr rotary lobe blower from Busch. He was advised by Busch and in June 2015 replaced one of the existing blowers with a new Tyr rotary lobe blower (Figure 2). This blower has been ventilating one of the four aeration channels ever since. Less than a year later, one of the existing blowers failed and, based on the good experience, Nass also replaced this with a Tyr rotary lobe blower (Figure 3).

All five blowers operate fully automatically via a PLC control system and are connected to the control system of the wastewater treatment facility. The oxygen content in each aeration channel is continuously measured using a sensor. If a minimum value is reached, the rotary lobe blower automatically switches on and ventilates the aeration channel until the oxygen reaches a predefined maximum value. Each blower is switched on and off around 15 times a day by this control system. The blowers are speed controlled. The intensity of the oxygen injection is regulated throughout the operating period, which is around 45 minutes at a time.

Tyr rotary lobe blowers are extremely user-friendly compared to conventional blowers. Oil levels in the gear and bearing unit can be checked outside via level indicators when the acoustic enclosure is closed. An oil change is simple to perform; as the oil-filling holes and the oil drain cocks are easily accessible once the door of the acoustic



“Tyr rotary lobe blowers are extremely user-friendly compared to conventional blowers. Oil levels in the gear and bearing unit can be checked outside via level indicators when the acoustic enclosure is closed.”

— Uli Merkle, Busch Vacuum Pumps and Systems

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Tom Jenkins has over 30 years of experience with aeration blowers and blower controls.

There are many types of blowers used for supplying aeration systems and many methods for modulating blower flow rates. The flow rate and discharge pressure for aeration blowers are determined by fluctuating process demands. This webinar will discuss the methods appropriate for each blower type. The tradeoffs of each method in efficiency, reliability, and energy consumption will be covered. Techniques for analyzing and comparing wire-to-air power consumption will be explained with illustrative examples provided.

Our **Sponsor Speaker** is Stephen Horne, Blower Product Manager for Kaeser Compressors, whose presentation is titled, "Blower Master Controllers – How the IIoT can Optimize Blower Station Performance." This presentation will cover how proper communications between blower packages and a master controller can truly optimize performance, predict future requirements, and increase reliability.



Stephen Horne is the Blower Product Manager for Kaeser Compressors.

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Figure 3: Due to their modular design, Tyr rotary lobe blowers from Busch can be individually adapted to meet requirements.

enclosure is opened. The inlet filter is fitted in such a way that it can be taken out without impurities being able to fall on the blower.

Nass also praises the reliability of Tyr rotary lobe blowers. After a year of operation, there has yet to be a single malfunction, let alone a failure. Therefore, he has no doubt that he will gradually replace all the blowers with the new Tyr rotary lobe blowers. His decision is reinforced by the fact that Busch is an extremely reliable partner that provides him with comprehensive support and advice. Busch offers Tyr rotary lobe blowers in several sizes and output classes, which means that the blower with the right output can be selected for each of the differently sized aeration channels.

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

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



BLOWER & VACUUM SYSTEM INDUSTRY NEWS

Trinos Changes Name to Pfeiffer Vacuum Components & Solutions

As of early 2017, Trinos Vakuüm-Systeme GmbH has a new name: Pfeiffer Vacuum Components & Solutions GmbH. The company based in Goettingen employs some 160 people and has been part of the Pfeiffer Vacuum Group since January 2010. The name Pfeiffer Vacuum has stood for high quality vacuum technology, a comprehensive range of products and first-class service for more than 125 years. With its close customer collaboration and consistent focus on customer needs, Pfeiffer Vacuum is constantly optimizing and expanding its portfolio.



Pfeiffer Vacuum Components & Solutions GmbH, Goettingen

“The objective of the change in name is to further develop and strengthen our market position. Our product portfolio in Goettingen includes vacuum components, custom vacuum chambers, valves and manipulators. We see ourselves as a premium supplier of vacuum components and a specialist for customer-specific vacuum systems with a wide range of functions,” explains Guido Hamacher, Managing Director of Pfeiffer Vacuum Components & Solutions GmbH. “We’ve planned expansive investments at our Goettingen site for 2017 so that we can continue to remain competitive in the future and secure existing jobs as well as create new ones.

We are looking into the future with optimism and expect more growth in the coming months,” added Hamacher.

Vacuum technology makes it possible to produce solar cells, semiconductors, thermal glass and coatings for extremely durable mechanical tools. These are just a few examples of Pfeiffer Vacuum products. Reliable vacuum products and systems are also of major importance for research and development, analytics, environmental technology and the automotive industry.

About Pfeiffer Vacuum

Pfeiffer Vacuum is one of the world’s leading providers of vacuum solutions. In addition to a full range of hybrid and magnetically levitated turbopumps, the product portfolio comprises backing pumps, leak detectors, measurement and analysis devices, components, as well as vacuum chambers and systems. Ever since the invention of the turbopump by Pfeiffer Vacuum, the company has stood for innovative solutions and high-tech products that are used in the Analytics, Industry, Research & Development, Coating and Semiconductor markets. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 2,350 people and has more than 20 subsidiaries.

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

Aerzen USA CFO & Vice President Keith Rolfe Wins SMARTCEO Award

Aerzen USA announced that Keith Rolfe, Vice President and CFO of Aerzen USA Corp., was selected as a winner of a 2016 Executive Management Award by Philadelphia SmartCEO. Rolfe was chosen because of his focus on investing in people and supporting the company’s “triple bottom line” approach to business, which encompasses People, The Planet and Prosperity.

The honor reflects Rolfe’s contributions to Aerzen USA, having served as the Company’s Chief Financial Officer and recently, as Vice President. Rolfe provides strategic leadership and know-how to the Aerzen USA Management team. His efforts made him an ideal candidate for Philadelphia SmartCEO’s Executive Management Awards.

“Employees find our company unique to work for because we support a “triple bottom line” approach to business by focusing on People, The Planet and Prosperity,” Rolfe explains. “Our people are the most important asset in the company and we invest in them significantly, to ensure high quality solutions for our customers. The company occupies a LEED Gold Certified Green building and was a pioneer in making this facility come to life as one of the first in Pennsylvania.



Aerzen USA CFO & Vice President Keith Rolfe

Energy savings, monitoring and reducing waste streams, and producing highly efficient products underpins the company's commitment to being a good steward of the environment and our community. We are active with our community by giving back either financially or in the form of food donations from our gardens and providing our facility for trainings and meetings to groups and organizations, so that they can be part of the growing community.”

The Executive Management Awards program recognizes the leadership and accomplishments of Philadelphia's management all-stars — the CFOs, CIOs/CTOs, COOs, CHROs, and other C-suite executives leading the region's business community. More than 300 local C-level guests celebrated the elite group of executives at a cocktail reception.

For more information, visit www.aerzenusa.com.

Vacuum Technology at Record Setting 2017 IPPE Expo

The 2017 International Production & Processing Expo (IPPE) had a great year with 31,649 poultry, meat and feed industry leaders from all over the world in attendance, setting a new record. There were also 1,273 exhibitors with more than 533,000 square feet of exhibit space, another new record. The Expo is the world's largest annual feed, meat and poultry industry event of its kind and is one of the 50 largest trade shows in the United States. IPPE is sponsored by the U.S. Poultry & Egg Association, American Feed Industry Association and North American Meat Institute.

There were 8,018 international visitors, a third new record, from 129 countries represented at the Expo. The largest group from a single country outside the U.S. was Canada with 1,383 visitors. The largest region represented was the Caribbean, Latin America, Mexico and South America with 3,226 visitors.

“We are very excited about this year's record-breaking exhibit space floor and attendance numbers. The turnout for the 2017 IPPE was exceptional, and the feedback from attendees has been extremely positive regarding time spent on the trade show floor and in education sessions. We expect next year will be even more valuable for attendees and exhibitors alike,” the three organizations said.

Vacuum Technology for Meat and Poultry Processors

Becker Pumps

Becker Pumps was excited to show their brand new booth and to inform attendees about the benefits of their oil-lubricated rotary vane vacuum pumps. Steve Gilliam said they had upgraded the U-4 lubricated vane to the new U-5 vacuum pump featuring deeper vacuum capabilities (0.075 Torr) and improved oil circulation. The U-5 Series has four models rated



Jason Rathburn, Steve Gilliam, Mick Wentzel and Darin Ladd at the Becker Pumps booth (left to right).

for nominal flows from 49.4 cfm to 141.3 cfm (50 Hz at 0.075 max. vac. Torr). The line was described as ideally suited for food vacuum packaging for a range of applications ranging from vacuum chamber machines, form-fill-seal machines and modified atmosphere packaging (MAP). The O Series direct-drive, oil-flooded rotary vacuum pump is used often in tray forming packaging machines. It provides vacuum to 29.9 in.Hg (0.4 Torr).

Booth personnel also said the SV Series of regenerative blowers has been optimized to increase vacuum and/or open flow capacities while using less motor horsepower. Other items mentioned were that all Becker products use IE3 compliant motors. Find more info at www.beckerpumps.com

Gardner Denver Vacuum & Pressure Solutions

Gardner Denver's Paul Mosher described how Gardner Denver deploys their L Series liquid ring vacuum pumps for evisceration applications and for vacuum marinating tumblers. I found their L-BL2 (also known as the Elmo Rietschle “pump in a box”) unit interesting. They are oil



Craig Stokes, John Troyer and Paul Moser at the Gardner Denver Vacuum and Pressure Solutions booth (left to right).

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

free and air-cooled and minimize water use due to the collection of condensate from the exhaust – as a result, many applications require little or no additional water after start-up.

Mosher further explained they then commonly deploy their lubricated vane or dry screw pumps for the downstream vacuum packaging applications. Gardner Denver has such an extensive range of vacuum and pressure products, they can fulfill all the requirements in a plant.

IPPE Conference Program and Bus Service for Poultry Companies

A week-long schedule of education programs, which updated industry professionals on the latest issues and complemented the exhibit floor, helped drive attendance. This year's educational line-up featured 25 programs, ranging from a conference on *Listeria monocytogenes* prevention and control, to a program on FSMA hazard analysis training, to a program on whole genome sequencing and food safety implications.

Multiple poultry companies took advantage of free bus service to transport their employees and growers to the 2017 International Production & Processing Expo (IPPE). More than 260 employees and contract producers from 11 poultry complexes as far away as North Carolina attended IPPE via the bus service. They included Amick Farms, Claxton Poultry, Fieldale Farms, Keystone Foods, Perdue Farms, Pilgrim's and Tyson Foods. The attendees were pre-registered through the Members to Atlanta (M2A) program. In addition, the attendees were provided Chick-fil-A lunch coupons, compliments of IPPE. IPPE will offer the bus service again in 2018 for meat, poultry and feed member companies of the U.S. Poultry & Egg Association, American Feed Industry Association and North American Meat Institute. For more information, please contact Larry Brown at l.brown@uspoultry.org.

Next year's International Production & Processing Expo will be held Jan. 30 – Feb. 1, 2018, at the Georgia World Congress Center in Atlanta, Ga. Show updates and attendee and exhibitor information will be available at www.ippexpo.org.

ABOUT IPPE

The International Production & Processing Expo (IPPE) is a collaboration of three shows – International Feed Expo, International Meat Expo and the International Poultry Expo – representing the entire chain of protein production and processing. The event is sponsored by the American Feed Industry Association (AFIA), North American Meat Institute (NAMI) and U.S. Poultry & Egg Association (USPOULTRY).

New e-Shop from Leybold Worldwide Online

Coinciding with the renaming of Leybold GmbH, the brand new e-shop of the Cologne-based company was launched. This new platform makes it easier for Leybold customers and interested parties worldwide to select and order from the substantial range of vacuum technology products online. The accelerated purchase processing and delivery ensures the optimization of procurement and production processes at the customer's end.

When looking at the new shop, the guiding principles of implementation became clear: An uncomplicated ordering process and a fast delivery of commodity products gains strategic importance especially with vacuum pumps, spare parts, refurbished products, flanges and fittings, as well

as measuring instruments. The new Leybold online shop includes items that can be purchased without extensive consulting efforts. The new shop is available in seven languages in many countries in Europe, Asia and North America via the company's website.

A market for refurbished products is also on sale, with more than 700 items available: each of these products is checked in a Leybold Service Center before the sale, overhauled and provided with the standard warranty of 12 months.



The choice of the right pump becomes much easier. Visitors to the website can now search for the ideal pump using the 'Pumpfinder'. The regulator can be set to the required operating pressure of the application, as well as choosing the necessary pumping speed of the vacuum pump by means of an intuitively operated scale. The 'Pumpfinder' automatically identifies the appropriate product category with a green marking, generating a list of suitable vacuum pumps.

"In the rapidly changing world of online sales in the B2B business, Leybold is also setting standards in the vacuum sector, as the unique Pumpfinder shows," says Steffen Saur, Chief Marketing Officer at Leybold. "Our mission is to provide our customers with all the services related to vacuum; we pay attention to sustainable solutions which optimize operating costs."

The user-friendly shop allows the customer to get a quick overview of the products of different performance classes and to easily contact Leybold sales and service. Another innovation of the e-Shop is the variant configurator: it can be used on the respective detail info page of a product by selecting decisive features such as motor, oil type or flange dimensions. This also simplifies the ordering of optional or necessary accessories.

In order to enhance customer experience and ease to choose from the large number of articles and services, the shop offers a modern and responsive design on all current devices from PC to tablet to smartphones.

Intelligent search functions also facilitate orientation and determination of the desired articles. For items whose availability is not displayed, or where there is a need for additional consulting, an offer can be requested out of the shopping basket. This process results in a rapid and simplified handling of the procurement of vacuum technology products for the customer.

The e-Shop is accessible to all interested parties. However, only registered users can see prices. A request or order can be generated only after registration. Of course, the shop offers a number of payment options, which are to be selected during the information requested for the ordering process. In addition to the purchase via regular invoice, the customer is also offered the credit card option. In some countries of Europe, it is also possible to pay with the bankcard.

About Atlas Copco

Atlas Copco is a world-leading provider of sustainable productivity solutions. The Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and services focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 180 countries. In 2015, Atlas Copco had revenues of BSEK 102 (BEUR 11) and more than 43 000 employees.

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.

*To view the e-Shop, visit www.leyboldproducts.de
To learn more about Leybold, visit www.leybold.com*

Pfeiffer Vacuum and Research Center Present FAIR-GSI Doctoral Candidate Award

Dr. Ingo Tews received this year's FAIR-GSI doctoral candidate award for his dissertation on "Quantum Monte Carlo Calculations with Chiral Effective Field Theory Interactions." This €1,000 prize is funded by Pfeiffer Vacuum. Professor Boris Sharkov, scientific director of FAIR, and Dr. Ulrich von Hülsen, a member of Pfeiffer Vacuum GmbH management, presented the prize on November 1 as part of the GSI colloquium. The speaker at the award ceremony was Professor Johannes Wessels, rector of the Westphalian Wilhelms University in Münster.

In his dissertation, Dr. Ingo Tews focused on gaining a better understanding of neutron stars and neutron-rich nuclei. Neutron stars contain such highly compressed matter the extreme conditions make it necessary to perform systematic calculations of the equation of state of neutron-rich matter. Tews succeeded for the first time in performing quantum Monte Carlo simulations based on the most modern effective field theories of strong interactions. His results are regarded as a milestone among experts.

"I am very pleased to receive this award and feel honored to be presented with the FAIR-GSI doctoral candidate prize for my work. Strongly interactive systems, under extreme conditions, are an exciting field of research, which I am able to contribute to with my results,"



From left to right: Dr. Ulrich von Hülsen, a member of Pfeiffer Vacuum GmbH, Dr. Ingo Tews, FAIR-GSI doctoral candidate award-winner, and Professor Boris Sharkov, scientific director of FAIR

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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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said Tews, who initially studied Physics at the Technical University of Darmstadt and later went on to write his dissertation there. The award-winner is currently conducting research at the renowned National Institute for Nuclear Theory in Seattle, Washington.

“The results are particularly fascinating, since the physics of neutron-rich nuclei and neutron stars is one of the research focuses of the new FAIR accelerator,” said Professor Karlheinz Langanke, GSI scientific director. “The outstanding research opportunities offered by the GSI accelerator and the development of FAIR attract many young scientists from all over the world to GSI. They make important contributions to the development of the new accelerator and detectors with their innovative ideas.”

Dr. Ulrich von Hülsen, a member of Pfeiffer Vacuum management, congratulated the award-winner for his scientific dedication, “Scientific work is held in great esteem by Pfeiffer Vacuum. We are pleased to support research work with vacuum knowhow, and our commitment and dependability, whenever we can.”

Pfeiffer Vacuum and the GSI Helmholtzzentrum für Schwerionenforschung have been linked through a partnership for many years. Vacuum solutions from Pfeiffer Vacuum have successfully been implemented there for decades.

The doctoral candidate award is presented each year for the best doctoral dissertation. Eligible students should have earned their doctorate in 2015 and have been sponsored by GSI Helmholtzzentrum für Schwerionenforschung as part of its strategic partnerships with the universities of Darmstadt, Frankfurt, Giessen, Heidelberg, Jena and Mainz or through the R&D program. There are currently over 300 doctoral candidates working on their dissertation at GSI and FAIR within the scope of the graduate school HGS-HiRe (Helmholtz Graduate School for Hadron and Ion Research).

About Pfeiffer Vacuum

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

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EURUS Blower	11	www.eurusblower.com

markets. Founded in 1890, Pfeiffer Vacuum is active throughout the world today. The company employs a workforce of some 2,350 people and has more than 20 subsidiaries.

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

Piab Acquires Vaculex

Piab has acquired Sweden based Vaculex, a leading manufacturer of lifting equipment based on vacuum technology. With 30 years of experience Vaculex designs, manufactures and sells ergonomic lifting systems for various applications, e.g. baggage handling, packaging, distribution and logistics. Piab and Vaculex have complementary

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

product offerings and the combination will enable accelerated growth. Both companies have strong brands and are recognized for leading technology platforms, innovation, safety and high quality products.

Piab has 13 sales offices and more than 900 partners with well-balanced geographical and segment coverage. Vaculex has a strong high-quality product portfolio that is well positioned in its target segments via its network of sales offices and distributors. The combined company will become a stronger partner for customers world-wide, by providing an extended product portfolio and joint expertise with global reach.

“We are convinced that this is a great match. Our partners around the globe have repeatedly requested Vaculex type products. This market is growing rapidly due to manual lifting operations being increasingly automated. We are very excited about the growth prospects and strength of the combined company”, says Anders Lindqvist, CEO of Piab Group.

“Piab’s long history of innovation in vacuum technology and global market access, combined with Vaculex’s innovative product range, will shape a new and stronger business partner. We strongly believe

that the new formed company will serve the market even better. I am really looking forward to working with the combined group”, says Ronny Holmsten, CEO at Vaculex.

The transaction took place on the 30th of December, 2016.

About Piab

Established in 1951, Piab designs innovative vacuum solutions that improve the energy-efficiency, productivity, and working environments of 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. 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.

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