The Magazine for ENERGY EFFICIENCY in Blower and Vacuum Systems

BLOWER & VACUUM BEST PRACTICES

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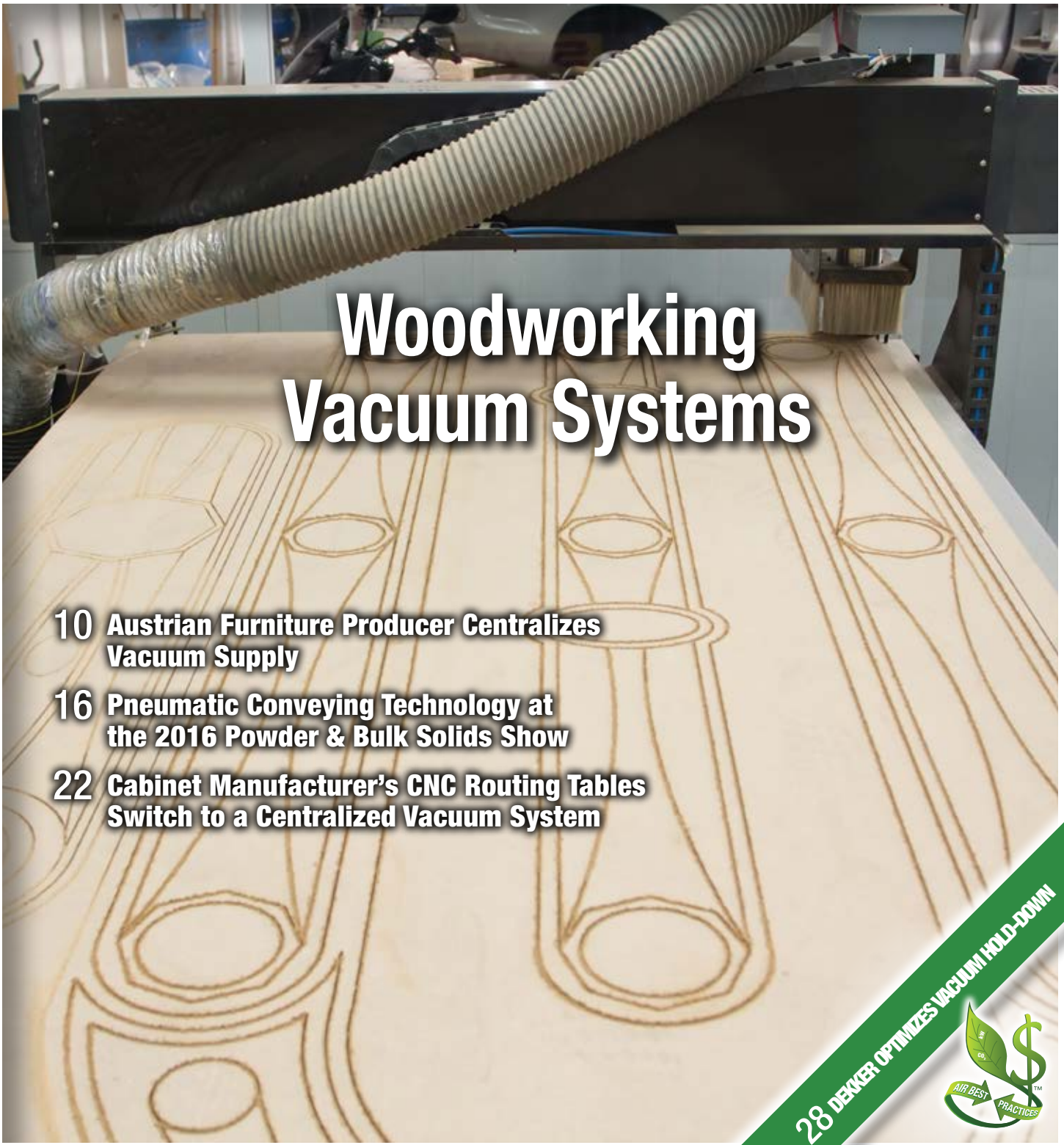
July 2016



Woodworking Vacuum Systems

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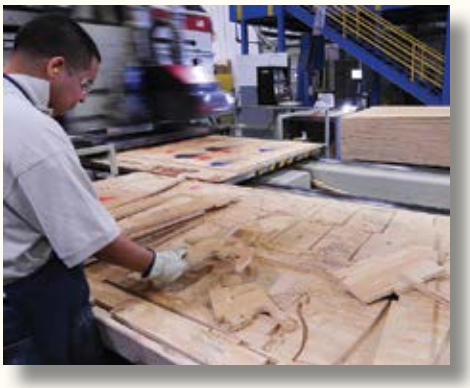
Using vacuum blowers for better hold down in CNC router table applications



PROBLEM:

For many years, the compressed air system for an industry leader in furniture manufacturing relied on vacuum instead of flow to provide hold down for their CNC router tables.

Despite having multiple rotary screw vacuum units providing up to 27" Hg vacuum, there was still significant scrap materials and downtime since the sheets would move after portions were cut away. The 40 hp vacuum screw units were upgraded to 100 hp units and special roller bars were added to keep the sheets in place, but the problems continued.

Additionally, the leather fibers and dust that go hand-in-hand with this type of installation were harsh on the vacuum screw units. Filters collapsed and airends had to be replaced due to contamination.

SOLUTION:

Kaeser provided a unique solution – it's not the vacuum that provides the hold down, it's the flow that keeps the sheets of wood in place. Kaeser recommended an Omega DB 236 with optional external STC controls and additional DB 236C units with integrated controls to replace the multiple vacuum screw units.

RESULT:

In addition to providing outstanding hold down, the blower packages have a significantly smaller footprint – almost a quarter of the size of the 100 hp screw compressors. These blower packages require less routine maintenance and are less sensitive to the ambient conditions. They also use less oil and require few consumables, making them a greener solution. Finally, the energy savings have been significant – only 120 hp is needed to provide exceptional hold down instead of the 320 hp previously used for the vacuum screw units. To save on space, energy, and maintenance costs, sometimes you just have to go with the flow!

Operating Energy Costs for Previous System:	$119,000 per year
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Additional Savings in Maintenance Costs:	$25,000 per year

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SUSTAINABLE MANUFACTURING FEATURES

FROM THE EDITOR | Woodworking Vacuum Systems

ADA Möbelfabrik, headquartered in Anger, Austria, is one of Europe's largest manufacturers of furniture. The vacuum supply required for securing items to the CNC machining centers is provided via a central vacuum plant produced by Busch. Busch's Uli Merkle writes the story on how and why they transitioned from decentralized rotary vanes to a centralized vacuum system using claw vacuum pumps.

The 2016 Powder & Bulk Solids Conference & Exhibition was held May 3-5 at the Donald E. Stephens Convention Center at Rosemont, Illinois. Sponsored by the Process Equipment Manufacturers' Association (PEMA®) and produced by UBM Canon, this event celebrated its' 40th anniversary as the leading event for the powder industry. Whether for dilute or dense phase pneumatic conveying systems, vacuum, blower and compressed air technologies play an important role in this industry. Our Show Report covers what we learned from both the technology providers as well as the suppliers of pneumatic conveying systems-companies like Coperion K-Tron, Schenk Process and Kice Industries.

Multiple vacuum pumps can be running mostly "dead-headed" in the many production systems that don't require constant flow. Tim Dugan, P.E., from Compression Engineering Corporation, uses CNC routing machines as an example of how to optimize systems where vacuum is used as a motive force or to evacuate a small volume repeatedly. Centralizing a vacuum system involves installing a common piping loop, storage, a vacuum sequencer, and installing automatic shut-off valves for vacuum at each routing machine.

DEKKER Vacuum Technologies has been working with the woodworking industry for many years. CEO Rick Dekker comments it's important to remember that while CNC Routing is an important vacuum application in the woodworking industry, vacuum is also used for laminating, veneering, polishing, drilling, milling, engraving, thermoforming, glass cutting and stone/tile cutting. In our interview article, he then provides us with an interesting review of pod system and nested part CNC router tables. He points out vacuum hold-down systems are often oversized and recommends considering variable speed drive (VSD) solutions to reduce energy costs.

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

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BLOWER & VACUUM SYSTEM INDUSTRY NEWS

Busch Introduces New Generation of Mink MV Claw Vacuum Pumps

Busch Vacuum Pumps and Systems will present the new generation of Mink claw vacuum pumps for pneumatic suction conveying at the Powtech 2016 exhibition in Nürnberg, Germany. In comparison to its predecessors the new Mink MV series offers even lower energy consumption, more compact dimensions and quieter operation.

Mink claw vacuum pumps are available in five sizes with pumping speeds of between 176 to 706 CFM, covering the entire range of pumping speeds required by pneumatic suction conveying systems. Mink claw units are also ideal for use as individual vacuum modules in centralized systems supplying vacuum to several conveying systems located throughout a production facility.

Mink MV claw vacuum pumps can be frequency controlled to match immediate performance requirements, even under changing process conditions. This makes is it possible to precisely maintain a predefined pumping speed and provide constant vacuum at a specified level. This demand-driven control enables the vacuum system to achieve additional energy savings.

Busch Mink claw vacuum technology for pneumatic suction conveying has been the established industry standard for many years. The new Mink MV generation offers all the advantages of previous models, but with even higher energy efficiency, lower noise levels and smaller dimensions. Proven Mink claw characteristics such as dry and contact-

The Mink MV 0312 A claw vacuum pump is one of five models of the new generation of vacuum pumps for pneumatic suction conveying

BLOWER & VACUUM SYSTEM INDUSTRY NEWS

free operation remain unaltered. No oil or other operating fluids are required in the compression chamber, making maintenance tasks such as oil and filter replacement unnecessary. Mink claw units are contact-free, so no component wear occurs and replacement parts are not required. Maintenance is confined to changing the gearbox oil every 20,000 operating hours.

Busch Vacuum Pumps and Systems is a leading manufacturer and retailer of vacuum pumps, compressors, blowers and vacuum systems with a reputation for reliable and high-performing vacuum products. Busch offers the largest variety of pump technologies and also builds complete vacuum systems and blower/pump packages to meet specific application requirements. Busch has a solution for any application that requires vacuum for industrial and medium/high vacuum markets.

For additional information visit www.buschusa.com

Hoffman & Lamson introduces MAX Seal for Multistage Centrifugal Blowers

Hoffman & Lamson has introduced MAX Seal, an innovation in dry seal technology that reduces fugitive emissions by up to 67% when compared to traditional seal options. Ideal for landfill gas and other applications where toxic and explosive gases are present, the MAX Seal improves the safety of your operation while extending bearing life and lowering total cost of ownership.

MAX Seal is a dry running mechanical axial seal, constructed of 316 stainless steel with replaceable wearing components. The dry running MAX Seal does not require a gas purge, reduces lubricant contamination and eliminates bearing contamination from process gas.

MAX Seal is available as an upgrade to new and existing Hoffman & Lamson multistage centrifugal blowers. As an aftermarket upgrade

Hoffman & Lamson MAX Seal for multistage centrifugal blowers

for existing blowers the MAX Seal can be installed on-site, and without replacing any major components on your blower.

About Hoffman & Lamson by Gardner Denver

Hoffman & Lamson has been setting industry standards for reliability and customer satisfaction for over 110 years. Lamson, established in 1880, and Hoffman established in 1905, are now combined under Gardner Denver. Hoffman & Lamson continues to offer innovation in centrifugal technologies through their multistage, high speed and regenerative centrifugal blowers, engineered to order systems, and engineered vacuum systems. Through a global network of sales, service and engineering support Hoffman & Lamson offers innovative solutions, preventative maintenance, and emergency for demanding industry applications worldwide.

For additional information visit www.HoffmanandLamson.com

Edwards Launches New Variant to XDS Dry Scroll Pump Range

Edwards has launched a special variant to its XDS range of dry scroll pumps, suitable for use in more aggressive applications. The new XDS-C dry scroll pumps are fitted with a Chemraz® gas ballast non return valve pad and exhaust valve pad, and a stainless steel exhaust flange. These new features enable them to be used on applications where the exposed standard fluoroelastomer valve pads may be affected by the media being pumped, and cause rapid deterioration.

XDS35iC and XDS45iC dry scroll pumps, with peak speeds of 35 and 40 m^3h^{-1} respectively, can handle up to 240 grams per hour of water vapor, and are ideal in harsh processes including wet chemistry applications, such as rotary evaporation and distillation processes. The simple, single-sided scroll design allows routine maintenance to be done in minutes for maximum uptime.

"We have seen an increase in demand for scroll pumps which are suitable for more challenging gases and vapor loads. The new XDS-C will ensure we can support our customers in more aggressive applications", said David Goodwin, Product Manager Edwards. "We have also introduced two new spares kits which can be used in conjunction with a tip seal change kit to allow customers to upgrade existing XDS variants."

Edwards' XDS dry scroll pump provides an alternative to oil-sealed rotary vane pumps and other dry technologies. It is lubricant free and hermetically sealed, so it provides a

The new variant to the XDS range of dry scroll pumps can handle more aggressive applications, such as rotary evaporation and distillation processes.

totally clean and dry vacuum to prevent cross contamination. Unlike other scroll pumps, the bearings in the XDS range are isolated by the bellows so that any aggressive chemicals involved in the process will not attack them.

The XDS35iC and XDS45iC extend the existing range of nXDS-C dry scroll pumps with pumping speeds from 6 to 40 m^3h^{-1}.

For more information, visit www.edwardsvacuum.com.

Pfeiffer Vacuum Introduces HiPace 30 and 300H Turbopumps

Pfeiffer Vacuum, a leading global supplier of vacuum technology, will be introducing new turbopumps and new diaphragm pumps at the analytica show in Munich from May 10 to May 13. "In an increasingly changing competitive environment, Pfeiffer Vacuum is regarded as an ideally placed and very sound company. We are proud that our product developments for use in laboratory technology, analytics and biotechnology have been setting new standards across the entire vacuum industry for years. We are therefore looking forward to introducing the new turbopumps and diaphragm pumps at the analytica", said Manfred Bender, CEO of Pfeiffer Vacuum Technology AG.

HiPace 30

With a pumping speed of 32 liters per second, the HiPace 30 is currently the most powerful turbopump of this size on the market. Due to the small footprint and low vibration level, the pump is particularly suited for integrating in compact analysis systems

Pfeiffer Vacuum turbopumps for use in laboratory technology, analytics and biotechnology

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such as portable mass spectrometers, small electron microscopes, and leak detectors. At just 2 kg total weight, the HiPace 30 is ideal for portable applications.

Thanks to the sophisticated rotor design of the HiPace 30, high gas throughput and extremely good compression of light gases are achieved. This ensures a low residual gas background, which is ideal for mass spectrometry applications.

HiPace 300 H: Turbopump with high compression specifically for light gases

With the new HiPace 300 H, Pfeiffer Vacuum presents the most powerful compression turbopump currently available in the pumping speed class of 300 l/s. With a compression ratio of 10_7 for hydrogen, it is suitable for generating high and ultra-high vacuum. Due to the high compression ratio, a low residual gas spectrum is created in the chamber, which is desirable for mass spectrometry applications, for example.

Thanks to the advanced rotor designs, the HiPace 300 H has a very high critical backing pressure of 30 hPa. This allows the pump to reach ultra-high vacuum, even when operating with high backing pressures, as occurs in combination with diaphragm pumps. Due to the integrated "intermittent operation" function, the HiPace 300 H switches on a connecting backing pump only if the backing pressure is no longer adequate. This reduces the energy consumption of the entire vacuum system by up to 90 percent.

The HiPace 30 and HiPace 300 H have a so-called hybrid bearing. This combination of a ceramic ball bearing on the fore-vacuum side and a permanent-magnet radial bearing on the high vacuum side creates a particularly robust bearing concept. This in turn leads to very high reliability and a long service life.

Diaphragm pumps for HiPace turbopumps: Clean, dry vacuum

Since the HiPace turbopumps are equipped with a 24 V DC power supply, the diaphragm pumps of the MVP DC series are the ideal backing pumps. The brushless DC motor allows adjustments of the speed to the specific needs of a particular application. In the automatic boost mode, the pump runs at full speed and reduces once a certain vacuum is reached. In this way, high performance, long maintenance intervals, and low noise and vibration levels are achieved.

The installation of the system is simple and inexpensive thanks to unified communications via a D-sub connector. Due to its light weight and compactness, pumps of the MVP DC series are ideal for integration in increasingly small analytical systems and turbopumping stations and mobile applications.

The two-stage pumps are equipped with a magnetic gas ballast valve, so that improved process reliability and service life are achieved. The operating temperature ranges from 5°C to 40°C, and therefore covers a wide range of applications. The easy maintenance of the pumps and the long service intervals, of about two years, guarantee very low operating costs.

Another important advantage of diaphragm pumps is their long service life. At sensitive locations, diaphragm pumps do their work not only reliably, but also at a low vibration and noise level. The noise level is well below that of rotary vane pumps. In addition to individual components, Pfeiffer Vacuum offers compact, high-vacuum pumping stations. The HiCube pumping stations are delivered ready for operation.

Pfeiffer Vacuum – North America

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

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

Oerlikon Leybold Supplies Vacuum Pumps for Li-Battery Manufacturing

A well-known Korean group producing lithium-ion batteries has awarded its contract for the supply of vacuum systems to Oerlikon Leybold Vacuum. The company will equip several production lines. The delivery of these systems for electrode drying is expected for summer 2016.

With a system combination of the dry compressing screw vacuum pump DRYVAC DV 450C and the proven Roots RUVAC WH2500, the customer will optimize its production

The lithium-ion battery manufacturer will use a combination of the DRYVAC DV 450C and the Roots RUVAC WH2500.

Vacuum technology has a major impact of the efficiency of battery cell manufacturing.

lines. Decisive factors for awarding the contract were the superior process capability at low operating costs and the services offered. "Moreover, the smooth, interactive communication between customer, sales and application support showed our commitment," said HY Moon, Head of Sales Oerlikon Leybold Vacuum Korea.

In the manufacture of battery cells, vacuum technology is used for several production steps and has a high importance for the efficiency of production. During their entire life cycle, batteries need to maintain a high quality, therefore high-performance vacuum systems are necessary in order to provide the conditions for high-quality batteries (e.g. in specified drying processes). These quality requirements are increasingly important for lithium-ion cells for electric vehicles, as the demands for volumetric storage capacity, lightweight and safety are growing. Apart from electrode drying, the vacuum-assisted manufacturing steps comprise cell assembly and leak detection testing.

The vacuum pioneer from Cologne expects further business transactions in the current year. "With this order we position ourselves clearly in the fast-growing, attractive business field of modern energy storage for electric mobility," says Dr. Martin Füllenbach, CEO of Oerlikon Leybold Vacuum. The business potential for the current year shows positive aspects, especially since the market for lithium ion batteries is generally expected to grow at sustainable rates during the next three years.

For more information, visit www.oerlikon.com/leyboldvacuum/usa.

Austrian Furniture Producer CENTRALIZES VACUUM SUPPLY

By Uli Merkle, Busch Vacuum Pumps and Systems

ADA Möbelfabrik, headquartered in Anger, Austria, is one of Europe's largest manufacturers of furniture. Upholstered furniture, beds, mattresses and slatted frames are produced for the Austrian market and for many other European countries in two shifts, using modern manufacturing techniques. The vacuum supply required for securing items to the CNC machining centers is provided via a central vacuum plant produced by Busch. By opting for this vacuum system, ADA has integrated an extremely economical and reliable vacuum supply into the production process.

Starting from humble beginnings as a rope manufacturer around 1900, ADA has evolved into an ultramodern furniture producer that is still run as a family firm. In addition to its factory in Anger, ADA also has production sites in Hungary and Romania. Until 2009, there were two CNC portal machining centers installed at the production site in Anger with grid-based clamping tables for NBM (nested-based manufacturing), featuring two dry-running rotary vane vacuum pumps on each table and a suction capacity of 500 m^3/h per pump.

> "A further advantage of Mink claw vacuum pumps is that, thanks to their non-contact operation, they use less motor power, which in turn has a highly positive effect on energy consumption."
>
> — Uli Merkle, Busch Vacuum Pumps and Systems

Fig. 1: One of the two CNC processing centers with NBM clamping tables.

These vacuum pumps were continuously in use across the two shifts and as they were each powered by 15 kW electric motors, they consequently consumed a large amount of energy. Furthermore, the vanes in the rotary vane vacuum pumps had to be replaced once a year due to wear. The management at ADA decided to look for a more economical alternative for their vacuum supply system and they placed particular importance on obtaining a new CNC router, which would be equipped with two additional rotary vane vacuum pumps with 4kW motors.

They looked into the Mink® claw vacuum pump technology from Busch in close detail. In contrast to regular rotary vane vacuum pumps, Mink claw vacuum pumps operate using a non-contact process. This means the rotating parts within the vacuum pump do not touch each other. The advantage of this is the Mink claw vacuum pump creates a vacuum without any wear occurring, so no operating fluids, such as oil or water, are required in the compression chamber. The need for

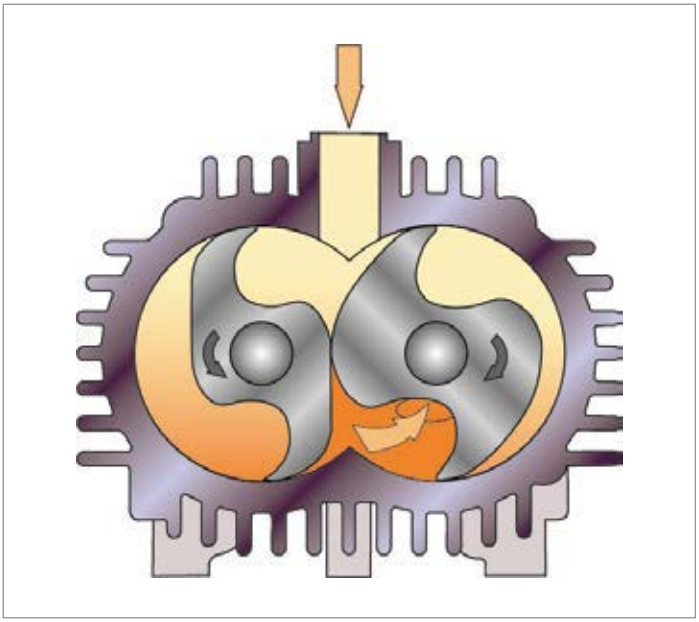

Fig. 2: Cross-section of a Mink® claw vacuum pump. Two claw-shaped pistons rotate in opposite directions within housing, without touching each other.

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maintenance and part replacement is reduced to a minimum. The only maintenance task that remains is an oil change in the gear unit, which must be performed every 20,000 operating hours. A further advantage of Mink claw vacuum pumps is that, thanks to their non-contact operation, they use less motor power, which in turn has a highly positive effect on energy consumption.

During the discussions with Busch, the idea of centralizing the vacuum supply was put forward. Busch designed a customized central vacuum system for ADA, consisting of eight identical Mink claw vacuum pumps, each equipped with a suction capacity of 300 m^3/h. This vacuum system provides a sufficient vacuum supply to the two CNC machining centers with NBM clamping tables and to the additional machining center with vacuum blocks. An additional Mink acts as a back-up pump. This pump is hardly ever used, but if required, it can be used to increase the suction capacity of the system such that an additional CNC router can be connected to the vacuum supply.

The suction capacity required varies greatly and is dependent to a large extent on the materials used and the size of the work pieces. For example, when materials with a high level of air permeability are being machined simultaneously on each of the three connected machining centers, a higher suction capacity will be required than when solid wood is being machined on all machines at once. The control system for the vacuum system is therefore designed in such a way that at any one time only the pumps required to supply the power currently needed are in operation. All other pumps are automatically switched off.

Fig. 3: Eight of these Mink® claw vacuum pumps provide the vacuum supply for the ADA production plant in Anger, Austria.

AUSTRIAN FURNITURE PRODUCER CENTRALIZES VACUUM SUPPLY

Fig. 4: CNC processing centre for solid wood processing at ADA.

The energy consumption level for the vacuum supply system would have added up to 68 kW with the two portal machining centers each equipped with two 15 kW rotary vane vacuum pumps. The proposed CNC router was installed, featuring two other small rotary vane vacuum pumps, each with 4 kW motors. The central vacuum system supplied by Busch requires 44kW for the eight Mink claw vacuum pumps, which represents a theoretical energy saving of 35%. Thanks to the on-demand control system, individual Mink vacuum pumps are only in operation for an average of 10 out of the 16 hours of the two shifts. This enables a further energy saving of approximately 38%.

The Mink vacuum system from Busch has been in operation since May 2009 and it has been running fault-free since. By the end of 2009, the management team at ADA had already thought about purchasing another vacuum system for the production site in Körmend, Hungary due to the cost-efficiency and reliability they had experienced with their existing Busch system. BP

For more information, please contact info@buschusa.com.

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SHOW REPORT: PNEUMATIC CONVEYING TECHNOLOGY

at the 2016 Powder & Bulk Solids Conference & Exhibition

By Roderick Smith, Blower & Vacuum Best Practices Magazine

The 2016 Powder & Bulk Solids Conference & Exhibition was held May 3-5 at the Donald E. Stephens Convention Center at Rosemont, Illinois. Sponsored by the Process Equipment Manufacturers' Association (PEMA®) and produced by UBM Canon, this event celebrated its' 40th anniversary as the leading event for the powder industry. Whether for dilute or dense phase pneumatic conveying systems, vacuum, blower and compressed air technologies play an important role in this industry.

Tuthill Blower & Vacuum Systems was showing a new M-D Pneumatics™ Enclosed Blower Package for their PD Plus, Qx or CP Series. Three standard cabinets for roughly 500, 1000, and 2000 cfm models accommodate pressures to 18 psig, vacuum to 17 in. Hg and flow to 2200 cfm. Planned to launch in mid-2016, the package is designed to make the optional enclosure and cabinet-mounted controls a better value. Product Manager John Coghlan also reviewed their upgraded

> "Whether for dilute or dense phase pneumatic conveying systems, vacuum, blower and compressed air technologies play an important role in this industry."
>
> — Roderick Smith, Blower & Vacuum Best Practices Magazine

M-D Pneumatics™ CP Series, optimized for up to 20% more flow and now rated for 18 psi (was 15 psi) discharge pressure or 16 in. Hg dry vacuum. John stated the new CP Series has added many standard features designed to reduce maintenance costs. They added a triple-lip seal, standard magnetic plug (used to be optional) and sight glasses on all four sides for oil monitoring. Lastly, I had a great talk with Regional Sales Manager Adam Crampton about "walk-through" blower system assessments - which will be reviewed in the future. You can see some of his thoughts in our May article on Tuthill's work optimizing systems in food plants.

Atlas Copco isn't kidding when they say they are "Committed to Sustainable Productivity". Visiting their booth, I was greeted by a blower specialist (Brian Hill), a vacuum specialist (Steve Nash), a direct sales engineer (Dane Koch), and since we were in Chicago – by the legendary gentleman Mr. Jack Maly, who always sends us encouraging notes. They shared my excitement over how their clients see so much cross-over between blowers, vacuum, air compressors and cooling systems. Dane talked about a major corporation he works with, who has set a huge internal target for energy and water consumption reduction – and each plant feels the pressure (or should I say heat)! He's currently working on a big project to reduce kW and water consumption for this company – by replacing liquid ring vacuum pumps with rotary screw pumps (which don't need cooling water).

The technology offerings, by Atlas Copco are vast and I'll name a few we reviewed: ZB VSD direct-drive centrifugal air blowers (135-335 hp), ZM oil-free multistage centrifugal and vacuum blowers (5-3600 hp), and ZS oil-free positive displacement rotary screw blowers (10-500 hp). Brian Hill explained the ZS+ VSD is positioned as "the energy efficient lobe replacement." Atlas Copco's long history with air compressor packages is now being used by the ZS Screw blower. They claim energy savings exist (vs. lobe blowers) in the transmission (drive gear vs. belt), the motor, and in compression efficiency (screw vs. lobe). The ZS has a standard TEFC IP55 motor and the VSD targets the market reality that while varying air demand is seen in 92% of air compressor and blower installations, most users have fixed-speed blowers-ideal for only 8% of applications!

The Roots brothers started Roots blowers in 1854. Think about that. A Roots positive displacement blower has become one of those terms like a "Kleenex" – the brand/technology is indistinguishable. In July of 2015,

Brian Hill, Dane Koch, Jack Maly and Steve Nash (left to right) at the Atlas Copco booth.

Steve Dagowitz, Tracy Carter, Kim Pulford and Stephen Horne (left to right) at the Kaeser booth.

Shraddha Jayakumar, Russ Ristow, Adam Crampton and John Coghlan (left to right) at the Tuthill booth.

SHOW REPORT: PNEUMATIC CONVEYING TECHNOLOGY AT THE 2016 POWDER & BULK

Cher Tan, Laura Golubski, Paul Kearney and Rebecca Gibson (left to right) at the Howden Roots booth.

Doug Cagney and Scott Trail hosting clients from a major chemical company at the Aerzen booth.

Paul Mosher, Kayla Power and Kenny Reekie (left to right) at the Gardner Denver blower and vacuum booth.

Roots was integrated into Howden and today operates as Howden Roots. Howden Roots today offers a huge portfolio of PD, centrifugal, and turbo fans to service low-pressure applications in pneumatic conveying, gas separation, wastewater aeration, steam compression and petrochemical production with API Certifications.

Howden Roots inside and outside personnel are all extremely well-versed as application engineers – including the systems consulting service they offer. People like Paul Kearney, for example, (North American Sales Manager) and Mike Neiswender (Regional Sales Manager), have spent their careers with Howden Roots advising clients on blower performance optimization. They are also proud of their ability to custom engineer and fabricate PD and centrifugal blowers from their production facility in Connersville, Indiana. One particular package they were talking about is the fully enclosed Roots™ EasyAir™ X2 package.

Kaeser Compressors exhibited both their air compressor and blower packages able to cover dense and dilute phase conveying applications. Blower Product Manager Stephen Horne kindly took some time to get into some engineering details on the quality details built into their Omega positive displacement rotary lobe blower. He explained Kaeser uses spur-cut gears permitting the use of roller bearings featuring longer bearing LIO life. According to Stephen, many PD blowers use helical gears with ball bearings requiring rebuilds with greater frequency. He also pointed out the one-piece casting on the "head", which reducing "airend slip" and increases the efficiency of the package. Kaeser demonstrated their packages with and without enclosures. Their blower enclosures with "Industry 4.0 controls" look just like their air compressors! At Kaeser, I always enjoy their attention to the smallest details – details which make the difference.

Gardner Denver had a massive booth for their blower, vacuum and air compressor technologies. Gardner Denver has an incredibly strong position in what Blower and Vacuum Products Director Kenny Reekie described as "conveying solutions." There's no end to unique applications/materials in pneumatic conveying which is why Gardner Denver manufactures so many technology styles ranging from side channel regenerative, Sutorbilt bi-lobe with/without dual splash lube, Duroflow solid bi-lobe, RBS Series tri-lobe, Heliflow twisted tri-lobe, Cycloblower and Cycloblower H.E. rotary screw. I really liked their "trophy case" showing all the unique airend profiles they manufacture.

SOLIDS CONFERENCE & EXHIBITION

This broad technology is clearly why, as I learn more about the pneumatic conveying equipment providers/OEMs, I keep seeing Gardner Denver units integrated into their systems. To assist OEMs, they've developed the QuickPik sizing tool to allow design engineers to compare and contrast blowers. Kenny Reekie particularly pointed out the new CycloBlower H.E. Series featuring patented, highly-efficient 3 x 5 helical screw rotor profile which is food-grade PTFE coated. Three discharge port options optimize efficiencies based upon specific performance needs. The CycloBlower has over 25,000 installations world-wide. The H.E. takes this rotary screw technology to another level offering pressures to 36 psi, vacuum to 22 in. Hg., and flows to 2650 cfm.

I enjoyed meeting the folks at Hardy Pro-Air Systems and reviewing their blower and vacuum packages. Joe Soling and Scott Stevenson explained Hardy Systems was founded in 1983 and merged with their service/repair organization in January of 2015. They were exhibiting their Pro-Closure sound attenuation package for pressures to 15-18 psi. All their standard Pro-Pack blower packages are "Made-in-the-USA" out of their Antioch, Illinois plant. They explained their focus is on industrial applications, such as mine and tunnel ventilation, wastewater aeration and agitation, pneumatic conveying, combustion air pressurization and industrial vacuum systems. The company is in an expansion mode, aggressively seeking new reps and distributors.

Tom Hodanovac, from Eurus Blower, spent some time talking about OEM applications onboard trucks . We discussed their rugged Bulkmaster 6800 dry bulk truck blower. Tom explained the unit is designed to fit onto tractors/trucks to work with fine powders, large pellets, and food products. Due to it's 20 psi continuous duty pressure and wide speed rating, it's also suited for cement, sand, fly ash, flour, sugar, grain, pebble lime and plastic pellets. Using different speeds, this tri-lobe rotor uses helical timing gears to provide pressures from 2 to 20 psi and vacuum from 2 to 17 in. Hg. It's also a rugged unit designed to withstand a pounding.

The Aerzen booth was very busy with a large contingent of engineers, from a major chemical corporation, who were not only enjoying a German Lager but asking Doug Cagney and Scott Trail about the Delta Hybrid system. This rotary lobe compressor is described by Aerzen as "a technology synergy between the rotary lobe blower and the screw compressor." It uses a 3+4 rotor profile for low-pressure applications

John Halvorsen at the SMC booth

Tom Hodanovac at the Eurus booth.

Scott Stevenson, Joe Solving and Dean Pederson (left to right) at the Hardy Pro-Air booth.

SHOW REPORT: PNEUMATIC CONVEYING TECHNOLOGY AT THE 2016 POWDER & BULK

Charlie Solberg at the Solberg booth

Todd Smith at the Coperion K-Tron booth

John Prator (SAS Automation), Kirk Briggs and Robert Vanocker (left to right) at the Mollers booth.

or a 3+3 twisted rotor profile. These belt-drive units offer a 4:1 turndown with the use of a VFD. The Delta Hybrid provides pressures to 22 psi and vacuum operation has been extended from 15 in. Hg to 21 in. Hg.

Solberg is a filtration and separation specialist based in the Chicago area. CEO Charlie Solberg reviewed their JRS AND JST/JCT Series vapor-condensing systems designed to protect vacuum pumps from harmful vapors and liquids. The units use a heat exchanger pack and coolant jacket combination (or a cooling coil system), to condense vapors in the process flow. Any remaining vapors are then separated by dual-type activated carbon filter elements or demisters. He also showed me their SpinMeister™ (great name) ST Series extreme duty vacuum filters. They are designed for high-dust environments.

SMC had a booth and Marketing Director John Halvorsen spoke to me about their point of use ionizer used to remove static electricity present in conveying. Due to the charge, material will bridge or get stuck and the ionizer takes care of the problem. It requires very clean, dry compressed air and is pretreated by a SMC membrane dryer with pre-filters. He also confirmed the growing demand for on-machine compressed air flow and pressure metering instruments which they integrate into the SMC air preparation units.

Last but not least was Möllers, who builds bag and unit load material handling systems. Their pneumatic packing systems uses bag gripping technology designed by SAS Automation. A core component is the 3-stage PIAB vacuum generator which they say creates more vacuum flow than other brands due to lower cup porocity and is energy-efficient thanks to a pneumatic valve shutting off compressed air supply when idle.

Pneumatic Conveying Equipment Companies

Coperion K-Tron has been a leader, since its creation in 1964, in material handling applications in the process industries. Their division based in Salina, Kansas manufactures the Aerolock™ rotary valves, filter receivers, bin vents, cyclones, blower and vacuum packages, bag dump stations, diverter valves and custom system controls. General Manager Todd Smith was kind enough to walk me through their vacuum blowers, pressure blowers and vacuum sequencing packages. They

SOLIDS CONFERENCE & EXHIBITION

provide blowers for 38 mm (1.5 inch) through 400 mm (16 inch) conveying systems up to 700 mBar (20 in) Hg vacuum and 1 Bar (15 psig) pressure in 3 to 250 hp packages. Figuring out which system is optimal takes a lot of engineering. Did you know there are 50 types of wheat flour? Todd used that as an example to explain each application has to establish at what velocity it can be conveyed (in feet-per-minute), at what positive or negative pressure, and what level of abrasiveness can be tolerated (vacuum is often used for more delicate product) by the product.

Kice Industries focuses on dilute phase conveying (6-15 psig). They provide all the conveying equipment required in the wheat flour milling, oil seed processing and general applications in the wood, plastic and food industries. Southeastern Regional Sales Manager David Kice explained they have been designing and building their own blower since the late 90's and the design reflects their application experience. They focus their designs on slower speeds (much slower than 3000 rpm) allowing bearing life estimates to be 150,000 hours, heavy cast-iron bodies with castings from the Kice foundry, oversized shaft, reduced slip allowing lower operating temperatures, unique oil seals and oversized long-life bearings. I was particularly impressed to learn their sales force is made up primarily by former flour mill managers. This has allowed them to successfully introduce an Air Audit program designed to help mills discover how much air they really need! There will be a follow-up article on this topic.

I had a very interesting meeting with Schenk Process. Their test lab is based in Kansas City where they can help clients figure out what conveying velocities and material-to-air ratios work best. They manufacture both dilute and dense phase conveying systems and provide the blower, vacuum and low-pressure air compressor systems required. Having acquired Mac Process, they also manufacture the process air filtration (bag and cartridge) systems used in dust collection systems. At their booth, I was given a crash course on their CMD airlock technology. The CMD is perfectly suited for food and pet food applications due it's high process rates and features suited for sanitary processes. BP

To read similar articles on ***Pneumatic Conveying*** visit
www.blowervacuumbestpractices.com/industries/conveying

Dale Garthus at the Gardner Denver Compressors booth

Greg Huffstetler and Jessica Marick at the Schenk Process booth

Ben Kice at the Kice Industries booth

Dead-Headed Vacuum System Assessment Cabinet Manufacturer's CNC Routing Tables Switch to a Centralized Vacuum System

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

➤ Introduction

There is an old adage, "An engineer never got fired for sizing a pump too large!" That applies to another process that is even easier to oversize, vacuum systems. Because of uncertainty of required flow, they are usually oversized. Vacuum pumps can waste about 80% of full load power when there is no flow requirement, just static hold. The more horsepower you have running and the lower the actual flow requirement on the units, the more you are wasting your hard-earned money.

Multiple vacuum pumps can be running mostly "dead-headed" in the many production systems that don't require constant flow. Any system that evacuates a small volume and then holds a product down while it is being machined, or sucks a bag shut to seal will spend the majority of its time not moving much mass of air. This type of operation is found everywhere in secondary wood processing, machining, food packaging, and many other industries. Anywhere vacuum is used as a motive force or to evacuate a small volume repeatedly. This paper will apply to any of these types of systems- and not apply to constant-flow vacuum applications in the process industries.

There is a shroud of mystery around vacuum systems, a veritable black-magic to some engineers. The reason is that many are trained in HVAC principles, where they deal with incompressible flow. However, HVAC engineers understand pumping systems, and the concept of a "system" curve" with variable head and flow. Other readers of this journal might be familiar with compressed air technology and terminology, and uncomfortable with vacuum. The reason is that they are dealing with essentially a constant head system. But they are familiar with "icfm" and "scfm", and how they relate to each other. I will attempt to demystify vacuum very briefly, by using the system curve concept that the HVAC engineer knows and the scfm/icfm relationship that the air compressor engineer knows. With just these two fundamental principles, I will show how to optimize a typical dead-headed vacuum system in a typical manufacturing environment.

Basic Principles

The first principle is the scfm/icfm relationship. "Scfm" is merely a set of units that is used to describe a "normalized flow", the flow if we adjusted the pressure and temperature of the gas to "normal" or "standard" conditions. Gas expands and contracts proportionately (single-order for the math geeks), directly with temperature and indirectly with pressure. In other words, if the gas state in your process is higher than "standard" temperature, say 68 degrees F, you would have to compress it a bit to get it there. If it is lower pressure, say 25"Hg vacuum (5"Hg absolute) instead of the "standard" pressure of 29.92"Hg, you would have to expand it a lot, to get it there. In this article I will neglect the temperature factor, since we aren't changing it with optimization. The principle is summarized as follows:

- Normalized flow is directly proportional to inlet absolute pressure
- Or, Q (scfm) = Q (icfm) x (Pamb – Vacuum, "Hg) / 29.92

The reverse is also true:

- Inlet flow is inversely proportional to inlet absolute pressure
- Or, Q (icfm) = Q (scfm) x 29.92 / (Pamb – Vacuum, "Hg)

For example, the inlet flow required at 400 scfm, sea level (Pamb = 29.92"Hg), and 20"Hg is:

- Q (icfm) at 20"Hg = 400 x 29.92 / (29.92 – 20) = **1,206 icfm**

That would require about a 100 hp vacuum pump (86 bhp).

The second basic principle is the "system curve". It is based on Bernoulli's law which tells us that the sum of the velocity and pressure energy are a constant in a fluid system, and that pressure is proportionate to velocity squared.

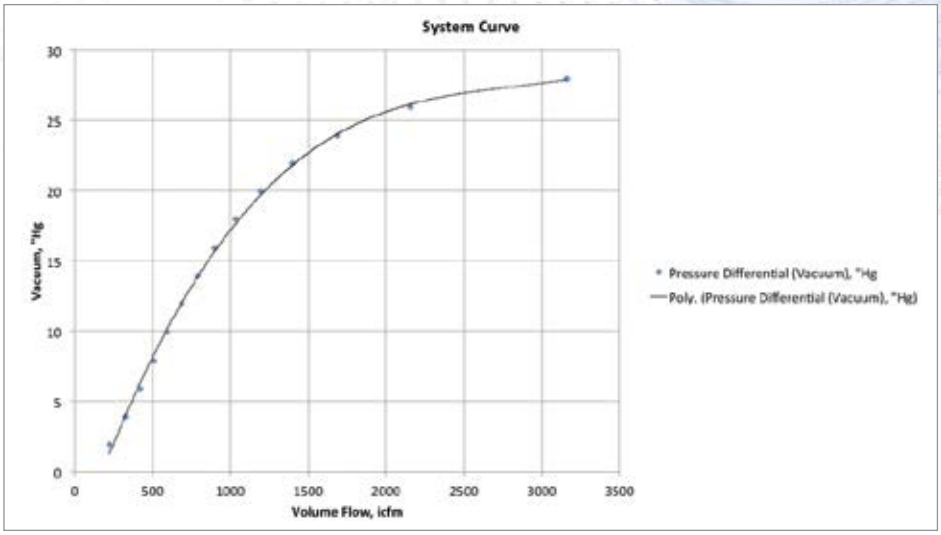


Figure 1. Typical Vacuum System Curve

The constants don't matter. Just remember:

- Pressure differential is directly proportional to mass flow times density squared, all other things being equal
- In a vacuum system, this means that flow is proportional to the square root of absolute pressure: Q2 (scfm) = Q1 (scfm) x [(Vac1 / Vac2) x (P1abs / P2abs)]^0.5
- Then convert to Qicfm as described above (vacuum pump curves are all in "icfm")

TABLE 1. ADJUSTED FLOW AND POWER FOR VARYING VACUUM LEVELS (SEA LEVEL SYSTEM)

Assumptions:

1 System equivalent orifice is not changed
2 DP is proportional to Qm^2 / density
3 Qm is proportional to (density x DP)^0.5
4 Power is proportional to icfm and vacuum
5 Pamb 29.92 "Hg

PRESSURE DIFFERENTIAL (VACUUM), "HG	ABS PRESS, "HG	MASS FLOW, LB/MIN	NORMALIZED FLOW, SCFM	INLET VOLUME FLOW REQUIRED, ICFM	APPX VACUUM PUMP POWER REQ'D	PERCENT OF HP AT 20"HG
30	0	0.0	0	infinite	infinite	
28	2	15.9	211	3160	317	373%
26	4	21.6	288	2153	200	236%
24	6	25.5	339	1689	145	171%
22	8	28.1	374	1400	110	129%
20	10	30.0	399	1194	85	100%
18	12	31.2	415	1034	67	78%
16	14	31.7	422	902	51	60%
14	16	31.7	422	789	39	46%
12	18	31.1	414	688	29	34%
10	20	29.9	398	596	21	25%
8	22	28.1	373	508	14	17%
6	24	25.3	337	420	9	10%
4	26	21.5	285	328	5	5%
2	28	15.6	207	221	2	2%

CABINET MANUFACTURER'S CNC ROUTING TABLES SWITCH TO A CENTRALIZED

Figure 2. Routing Table, Full

Figure 3. Routing Table, Empty

I didn't need to know the orifice coefficient, temperature, just the changed pressure differential. Note that I used mass flow units, not volume flow (like "cfm"). You can draw a curve of that looks like Figure 1. Note that it doesn't keep ramping up vacuum with icfm. That's because the density is dropping as the vacuum is increasing.

The third principal is that power is proportional to volume flow (icfm, not scfm) and vacuum.

If I just change the vacuum from 20"Hg to 16"Hg, and adjust the mass flow by the system curve and calculate the new icfm, I get ***40% less,*** for the same exact system:

- Q (scfm) at 16"Hg = 400 x [(10/14) x(16/20)]^0.5 = **422 scfm**
- Q (icfm) at 16"Hg = 422 x 29.92 / (29.92 – 16) = **902 icfm**
- Power at 16"Hg = 85 x 902 / 1194 x 16 / 20 = **51 bhp**

If the change was 8"Hg, from 20 to 12"Hg, the reduction would have been 66%, only requiring a 30hp motor. Wow! See Table 1 for more detail.

Then why not change your vacuum level by 8"Hg and put a new vacuum pump in there 1/3 of the present unit's size. Whoa!! This analysis is at one operating point. Your system is dynamic, and still has to meet a peak condition.

Typical Routing Table Description

A typical routing table is essentially a hard sponge, and vacuum is drawn on the bottom of it. Work pieces set on top of it are held down by the vacuum caused by air sucking through. The more coverage, the less flow required. It acts like a varying leak (like

VACUUM SYSTEM

a varying orifice, or "system"), with less coverage there is more demand on the vacuum pump in mass flow, so the system needs to be designed for no coverage, full flow. As typically designed, there are dedicated vacuum pumps for each process. But is it the goal of manufacturing to run the tables empty? Of course not! Figures 2-5 show a typical table, and the resulting change in vacuum from open to covered at the vacuum pump. This 40 hp vacuum pump couldn't keep up when the table was open, and dead-headed when the table was fully utilized. Power at the vacuum pump only drops by 20% from full to no load.

Example with Four Vacuum Pumps

Let's develop an example from real life, with some simplifications. This example is drawn from a cabinet manufacturing plant at 4,000 ft elevation. The plant has four routing tables, and vacuum is used to hold panels down while routing. See Table 2 for an equipment list and Figure 6 for a simplified diagram.

TABLE 2. PROJECT VACUUM PUMPS

SYSTEM	VACUUM PUMP
NORTHWOOD #1 VAC PUMP	Quincy 40hp
NORTHWOOD #2 VAC PUMP	Travaini 40hp
NORTHWOOD #3 VAC PUMP	Dekker 40hp
NORTHWOOD #4 VAC PUMP	Travaini 40hp

Determine Reduced System Load at Lower Vacuum

To determine the average system demand for a vacuum pump, you won't learn much about the flow from power-logging, except what you're paying in electricity. Vacuum pump curves are fairly "flat", so if the current is at 80%, the unit could be making anywhere from 0% to full flow. The best way to determine average load is to log the vacuum while running. If you can

Figure 4. Vacuum Gauge, Table Full

Figure 5. Vacuum Gauge, Table Empty

CABINET MANUFACTURER'S CNC ROUTING TABLES SWITCH TO A CENTRALIZED

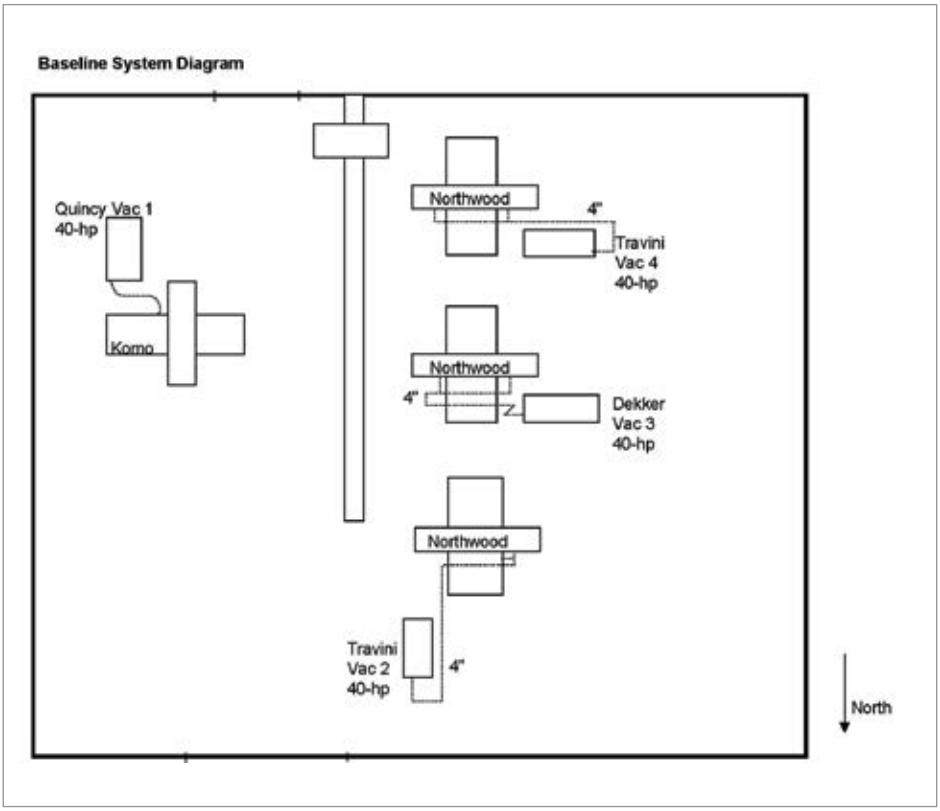


Figure 6. Existing Vacuum System Diagram

TABLE 4. ADJUSTED FLOW AND POWER FOR VARYING VACUUM LEVELS (4,000 FT ACTUAL SYSTEM)

Assumptions:

1 System equivalent orifice is not changed
2 DP is proportional to Qm^2 / density
3 Qm is proportional to (density x DP)^0.5
4 Power is proportional to icfm and vacuum
5 Pamb 25.8 "Hg

PRESSURE DIFFERENTIAL (VACUUM), "HG	ABS PRESS, "HG	MASS FLOW, LB/MIN	NORMALIZED FLOW, SCFM	INLET VOLUME FLOW REQUIRED, ICFM	APPX VACUUM PUMP POWER REQ'D	PERCENT OF HP AT 20"HG
26	0	0.0	0	infinite	infinite	
24	2	16.5	219	2825	243	183%
22	4	22.3	296	1912	189	255%
20	6	26.0	346	1488	133	180%
18	8	28.5	379	1222	98	132%
16	10	30.0	399	1029	74	100%
14	12	30.7	408	878	55	74%
12	14	30.7	408	752	40	54%
10	16	29.9	397	641	29	39%
8	18	28.3	376	539	19	26%
6	20	25.7	342	441	12	16%
4	22	21.8	290	340	6	8%
2	24	15.7	209	224	2	2%

TABLE 3. AVERAGE VACUUM AND RUN TIMES

SYSTEM	VACUUM PUMP	AVERAGE VACUUM, "HG	RUN PERCENT
NORTHWOOD #1 VAC PUMP	Quincy 40hp	18.1	50%
NORTHWOOD #2 VAC PUMP	Travaini 40hp	21.8	36%
NORTHWOOD #3 VAC PUMP	Dekker 40hp	19.4	48%
NORTHWOOD #4 VAC PUMP	Travaini 40hp	18.7	50%
WEIGHTED AVERAGE		**19.5**	**50%**

log current or power at the same time, great. Average vacuum levels while running for the four vacuum pumps in this system are shown in Table 3. Figure 7 shows the trend data.

To make performance adjustments at the project site location, I adjusted Table 1 for 4,000 ft elevation and the calculated total flow for the project (399 scfm at 19.5"Hg). See Table 4. The simplified model shows that dropping vacuum to 16"Hg can save about 45% power, if the system was able to adapt efficiently.

Recommended Project

To save the whole 45%, we have to develop a project that can somehow distribute all the machine centers to one optimized vacuum system. This isn't as hard as it sounds. The following project needs to be implemented – see Figure 8:

1. Install a common piping loop for the vacuum system
2. Install automatic shut-off valves for vacuum to each machine center
3. Install storage
4. Install a vacuum sequencer. Control optimal vacuum pump run time and optimal demand (valve control)

VACUUM SYSTEM

5. A VFD on the Quincy screw vacuum pump can improve the pressure control, but might not be cost-justified.

This allows the system to meet peak and still have one vacuum pump off. The project cost estimate is about $40,000, and savings are about $9,000/yr. It is about a 4-5 year payback before utility incentive, and about half of that afterwards, a good project. It will reduce vacuum pump run time by about 44% and reduce maintenance and noise.

Other Improvements

To reduce load further, the automatic valves for vacuum supply to each machine center can be shut off at times when no vacuum is needed, during lunch or when there is no production required for a table. Vacuum pumps are typically all started and stopped manually at the beginning of the first shift and off at the end of the last shift. The sequencer will reduce vacuum pump run time automatically when that happens.

Conclusions

Dead-headed vacuum systems don't add value when there is no production. In fact, they only waste energy when you're not making product. So find a way to run at the required vacuum, and to turn off vacuum pumps when there is only a static hold requirement. Consolidation and automation is one of the best ways to do that. BP

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

To read more about ***Vacuum System Assessments,*** please visit www.blowervacuumbestpractices.com/system-assessments.

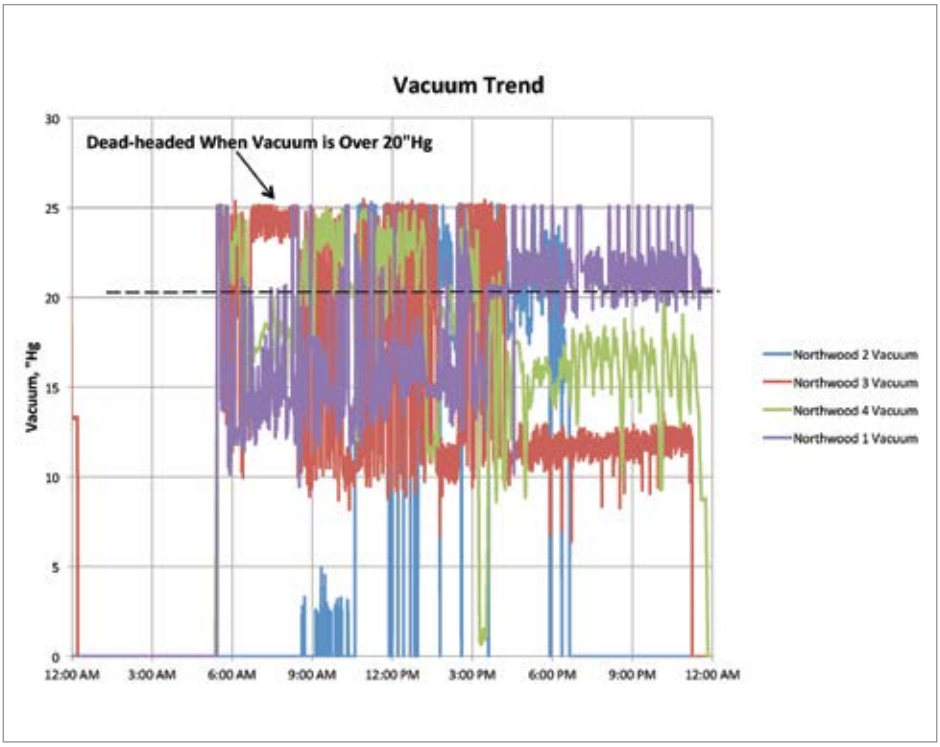


Figure 7. Vacuum Trend Data, Typical Day

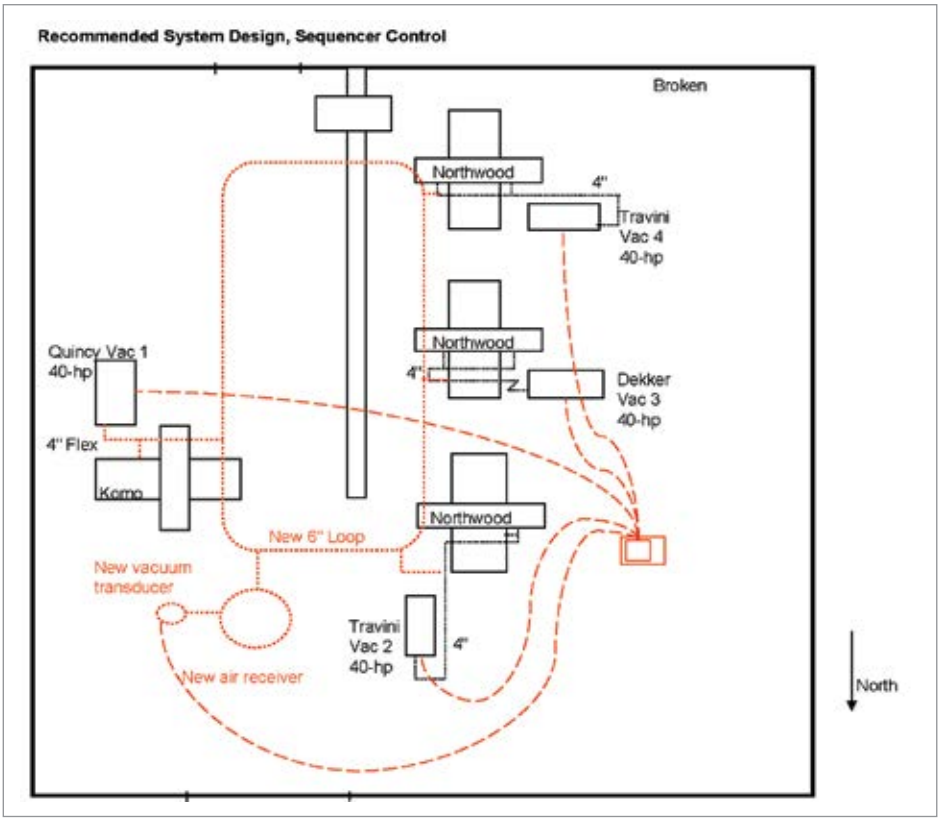


Figure 8. Recommended Improved Vacuum System Diagram

DEKKER Optimizes Vacuum Hold-Down in CNC Routers

By Roderick Smith, Blower & Vacuum Best Practices® Magazine

Blower & Vacuum Best Practices® Magazine interviewed Rick Dekker, CEO of DEKKER Vacuum Technologies.

➤ Good afternoon! Please describe vacuum hold-down in CNC routers.

Good afternoon! DEKKER Vacuum Technologies has a long history serving the woodworking industry and we are glad to review "Best Practices" for vacuum hold-down in CNC routers. Let's back up a little first.

Vacuum chucks and holding devices have been used in many industries for a variety of purposes, from lifting packages to holding items for machining. With the introduction of CNC routing machine-tools for mass production (of wood furniture, plastics and other non-magnetic materials), there was a need to clamp-down large work pieces on the flat router tables. Mechanical clamping was not an option as it caused damage to the work pieces and didn't satisfy the need to quickly place items on the table and clamp instantly.

The solution was to use vacuum to hold-down the work pieces, offering instant clamp-down and removal. The CNC router tables have a flat, machined surface with grooves (or channels) over the whole area and rubber seals. Metallurgical advancement in router tool bits have allowed for higher speed machining, creating a substantial force on the parts on the table, therefore requiring a tremendous hold-down vacuum force on these parts. Vacuum provides the means to create those forces.

What types of CNC routers are used in the woodworking industry?

CNC routers cut and shape wood products and vacuum is used to hold these pieces down as they are cut and/or shaped. There are two designs of CNC routers: pod systems and nested parts.

In deciding which type of router to use a company must look at the shape and type of cutting that will be done. Pod system routers are typically used to cut odd shapes like hand-rails and window/door frames. Nested parts routers are typically used for items like cabinet doors where many doors can be shaped and cut from a single large sheet of wood. This is where the term "nested parts" comes from as many products are cut out of a larger sheet.

Please describe Pod System CNC Routers.

Pod systems use vacuum pods, which are similar to a vacuum cup holding the wood in place. The pods can come in all different shapes, but are usually relatively small with a standard size being 6" x 6".

The advantage of the pod system is that it seals very well with the lip of the pod not allowing any leaks. Since the pods are small and one system may only have 4 to 24 pods, a small vacuum pump is used. There is very little air to be removed and a deeper vacuum provides additional holding force during the cutting of the part without the concern of the part moving.

A lubricated rotary vane vacuum pump is the most common vacuum pump used for a pod system. It has adequate flow and a very deep vacuum for maximum holding power.

Please describe a Nested Parts CNC Routers.

Nested parts routers use a single sheet of porous material, called fiber board, on which the wood to be cut is placed. Vacuum is pulled through the fiber board, to hold the wood in place, as it is shaped and cut. The advantage of this type of vacuum hold-down is no clamps are used and all of the wood being held-down can be used for the finished product – resulting in less scrap.

A typical nested parts router has a table surface of 4'x 8' or 5'x 8'. To help increase capacity, there are even dual tables that allow one side to unload the finished product while the other side is cutting the next parts.

Titan series High-Efficiency sawdust tolerant Liquid Vacuum Pumps (35 to 2,000 CFM)

DEKKER OPTIMIZES VACUUM HOLD-DOWN IN CNC ROUTERS

AquaSeal DVW designed for applications involving cutting or shaping stone, tile, marble, granite, etc

Vmax VFD Oil-Sealed Liquid Ring Pump System with variable frequency drive control (35-5,400 CFM)

How does the type of fiber board impact the vacuum hold-down process?

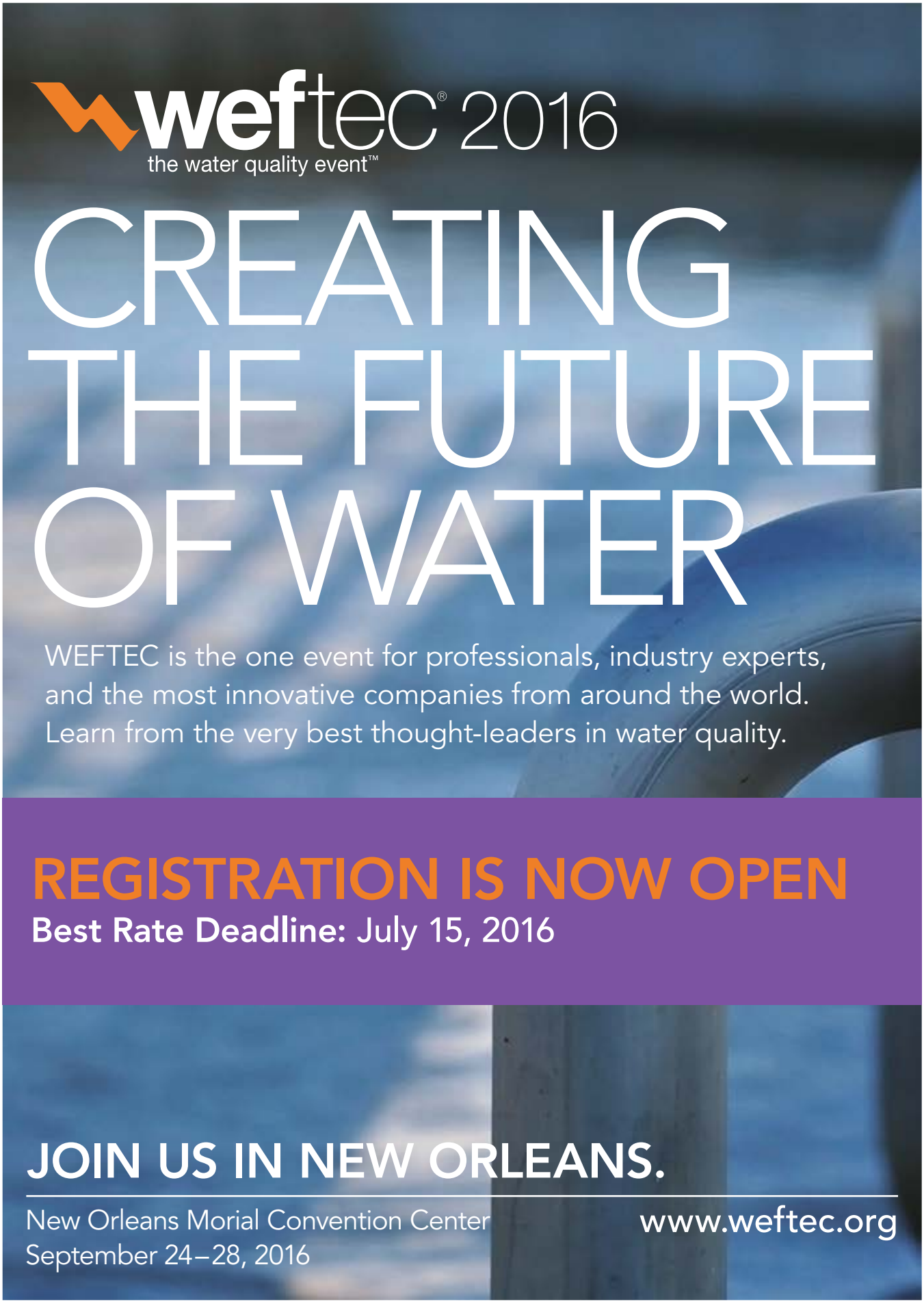
There are three different density-types of fiber board. The different types (low, medium and high-density) are selected depending on the vacuum force needed to hold the product. Each fiber board type allows a different amount of air through it for the vacuum hold-down. The low-density type allows the greatest amount of air through it.

Since there is a continual leak of air through the fiber board, a much larger capacity vacuum system is needed. A table with a fiber board of 4'x 8' usually uses a vacuum system that can deliver a minimum of 300 ACFM and as much depth of vacuum as possible. Many systems have a low vacuum alarm that shuts the system off if the vacuum level starts to drop and is too low to hold the parts safely. It is also critical that the ends of the fiber board are sealed to prevent leakage.

How do you protect vacuum pumps from ambient contaminants like sawdust?

In this application an inlet air filter is a must. Woodworking may be the most difficult application for vacuum pumps due to the dusty environment and harsh operating conditions. With a pod system, the vacuum pump can see air directly from the wood that is being held-down. With a nested parts router, the vacuum system will pull a vacuum on the under-side of the fiber board, but as cutting and drilling of holes of the finished product takes place, sawdust can be pulled into the vacuum system

It's important to select durable vacuum pump technology for this contaminated atmosphere. Our Vmax Oil Sealed Vacuum System excels in this application as it can pass small amounts of sawdust without damaging the vacuum pump, however, heat exchanger fouling can become an issue. Other vacuum pump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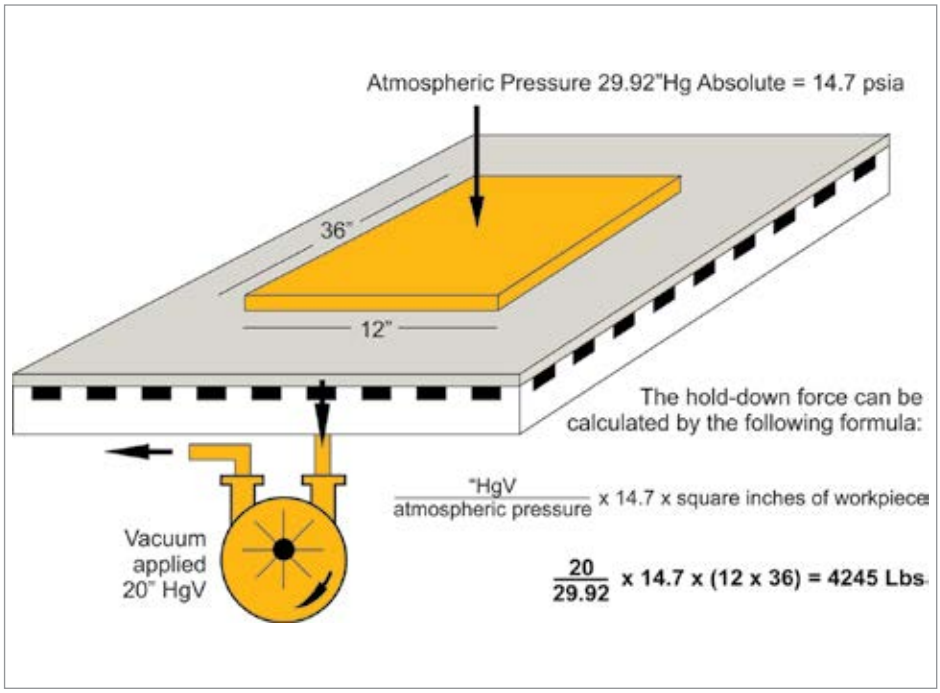
DEKKER OPTIMIZES VACUUM HOLD-DOWN IN CNC ROUTERS

technology types (lubricated rotary screw and dry rotary vane) are totally dependent upon the inlet filter functioning properly as any sawdust ingestion will break the pump. Sound and heat generation are also important vacuum pump selection criteria.

How does atmospheric pressure impact vacuum sizing?

Atmospheric pressure at sea level is 14.7 # / inch² (PSIA) or 29.92 inches mercury ("HgA). When the work piece is placed on the table and a vacuum is applied, a negative pressure is created underneath the work piece. Let's assume we create a vacuum of 20" HgV at sea level, which is the equivalent of 20/29.92 x 14.7 = 9.83 # / inch². In the picture below, we show a schematic layout of a router table with a work piece the size of 12 x 36" or a square area of 432 inch². With 20" Hg vacuum, we create a total force of 432 x 9.83 = 4245 pounds. The degree of vacuum depends on the size of the work piece. Smaller pieces would require a higher vacuum to make up for the reduced surface area or if less machining force is applied.



DuraVane RVL designed for woodworking, vacuum chucking and lifting applications

When operating at a higher altitude, the vacuum pump has to be able to work at a higher equivalent vacuum. For example, let's assume we work in Denver where the barometric pressure is approximately 25" HgA or 12.3 PSIA. To create the same hold-down force, the pump now has to be capable of operating at a higher equivalent vacuum - calculated as follows. At sea level, the absolute inlet pressure measured at the pump inlet would be 29.92 - 20 = 9.92 "Hg absolute ("HgA). At a barometric pressure of 25" HgA, the required absolute inlet pressure measured at the pump inlet would now be 25 - 20 = 5" HgA, or an equivalent sea level vacuum of 29.92 - 5 = 24.92" Hg.

What are some ways to reduce the energy consumption in a vacuum hold-down application?

The largest energy savings opportunity is to select a Vmax system with a variable frequency drive. This offers two advantages, the first being reduced energy consumption (50% turndown on power) when the pump is not in use. So, when the operator is changing parts, or on break, as long as the inlet to the pump is closed, the pump will slow down to minimum speed, saving energy. The pump then speeds back up as soon as the valve is opened.

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Our core audience is comprised of those engineering pioneers implementing energy management in their multi-factory organizations or municipalities. Practitioners of Lean Management and Kaizen Events, our readers have embraced energy management practices as the next step in their lean journey. Our key subscriber and editorial sources come from the U.S. Environmental Protection Agency's ENERGY STAR for Industry Program and members of the Association of Energy Engineers.

"Corning launched a formal Global Energy Management program in 2006. U.S. operations consist of nearly 50 facilities. These management practices have saved more than $328 million in cumulative energy costs."

– Patrick Jackson, Director of Global Energy Management, Corning Inc.

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DEKKER OPTIMIZES VACUUM HOLD-DOWN IN CNC ROUTERS

Second, a VFD helps to eliminate part slippage. On a nested table where lots parts are being cut out of a sheet of wood, leakage increases as the router cuts the parts. Using an appropriately sized Vmax with a VFD means that as the leakage increases from cutting, the vacuum pump speeds up to maintain a constant pressure on the parts, thus eliminating slippage and scrap.

Other areas of opportunity include examining losses in the piping system and moving from a decentralized to a centralized vacuum system. It's important to remember that while CNC Routing is an important vacuum application in the woodworking industry, it's also used for laminating, veneering, polishing, drilling, milling, engraving, thermoforming, glass cutting and stone/tile cutting.

Thank you for your time and congratulations on your new and very informative website. BP

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Pittsburgh, PA 15241

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

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