The Lab Manager

VACUUM PUMPS RESOURCE GUIDE

2017

Lab Manager®

What to Know Before Buying a Vacuum Pump

Different processes require varying amounts of vacuum or flow to operate properly.

By Ryan Ackerman

MAINTENANCE TIP:

VACUUM PUMPS

Regularly checking for wear and tear in your vacuum pump is critical to ensuring a long, problem-free life for the instrument. Wearing parts should be monitored and replaced based on both their time in service and on the application. It's important to identify maintenance issues before they lead to downtime. With the high quality of most vacuum pumps however, basic maintenance generally only needs to be done every one to two years.

How will the method of analysis affect which vacuum pump should be used?

Different processes require varying amounts of vacuum or flow to operate properly. If working with an instrument such as a lyophilizer, which requires a very low amount of ultimate vacuum, a rotary vane pump may be required (for oil-free applications, a dry scroll pump can be used). For most other laboratory purposes, a diaphragm pump can be a more robust option, as they are easier to maintain and can have chemical-resistant coatings applied. For specialty processes such as field emission microscopy, high and ultra-high vacuum models may be best.

Will the chemicals and reagents used in the sample preparation process influence which type of vacuum pump is best?

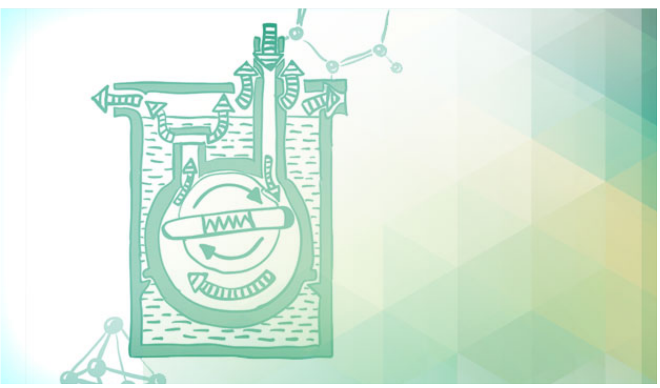
Depending on the process or reagents used with the vacuum pump, certain precautions must be taken. Pumps which use oil—such as the rotary vane pump— run the risk of vapors from the process breaking down the oil, necessitating changing and disposal. Likewise, diaphragm pump vacuums can break down when in the presence of certain vapors. In this case, it is wisest to purchase a diaphragm pump which is resistant to the reagents or chemicals being used.

How do highly sensitive samples/processes affect which type of vacuum pump to use?

The sensitivity of the sample, process, or a requirement for accurate control over the conditions of the vacuum pump can impact the configuration required. Some pumps come with no control option, which assumes the vacuum pump will always be operating at maximum potential. Manual control pumps may have adjustable control options with either pinch or bleeder valves, giving an approximate control. Electronic two point control gives the researcher the ability to configure a set point for vacuum, which the pump regulates by turning on and off, or opening a solenoid to control pressure. Electronic adaptive control allows for completely automated control, where set points are regulated by controlling the motor speed to give highly accurate vacuum pressures.

Vacuum Pumps: Size, Capability, Green Factors, And More Come Into Play

By Mike May, PhD



Scientists started using true vacuum pumps more than 350 years ago, and investigators used suction pumps for more than 400 years before that. Consequently, removing gas to create a vacuum is not new in science. Nonetheless, the way of removing that gas keeps changing. "There's a movement away from house-vacuum systems and toward smaller lab systems or dedicated individual pumps, partly for energy efficiency," says Roland Anderson, laboratory products manager at KNF Neuberger (Trenton, NJ). "This change provides vacuum where it's really needed." Other experts agree. For example, Peter Coffey, vice president, marketing and sales, Vacuubrand (Essex, CT), says, "We have noticed that a lot of new science buildings do not include central vacuum systems."

Part of that transition arises from the complexity of central systems. "A central vacuum relies on a couple of very large pumps, usually in the basement, that provide vacuum to lab benches through a network of pipes that run throughout the entire building," Coffey explains. In some cases, though, simpler solutions create their own problems.

Waste With Water

One of the simplest ways to create a vacuum involves water. A Venturi vacuum pump, or aspirator, uses running water to create a vacuum. In fact, a Lab Manager survey published in July 2012, reported that 36 percent of the respondents still use aspirators in their labs. Coffey adds, "I recently heard of a major research facility that is being built without a central vacuum supply and for which the scientists plan to use aspirators."

Although aspirators seem like a simple fix in some cases, these devices can make poor choices. As Coffey points out, aspirators "waste and pollute massive amounts of water. For example, a single water-jet aspirator used 10 hours a week in a lab will waste 45,000 gallons of water a year, and contaminate it with solvent vapors as it does so." He adds, "Water-jet aspirators are much cheaper than buying a vacuum pump, but the operating cost and environmental impacts more than offset the purchase cost savings—in some areas in a year or two."

Selecting A System

Lab designers still select large systems in some cases. "Though they are inefficient and not costeffective, house vacuums are still very popular when developing new research buildings with dedicated lab space," Anderson says. "When renovating labs, scientists are considering smaller, local multi-user vacuum systems or individual pumps for common laboratory applications."

Coffey says that central vacuums get bypassed for several reasons. "The vacuum from a central system is one-size-fits-all, even though chemists, biologists, and physicists all need vacuum of a very different character," Coffey says. "In the modern multidisciplinary science building, the different disciplines need different vacuum." That's not all. Coffey adds, "The different requirements of the different scientific disciplines often end up leading to conflicts, with the uses made by one discipline compromising the vacuum characteristics needed by other scientists."

A central system can even create environmental problems in some cases. "The vacuum system sucks vapors into the walls, so there is risk of cross-contamination between labs and condensation of toxic vapors in the piping," Coffey says. As Anderson mentioned above, central systems also use more energy. In some installations, the pumps for a central system run all the time, even when no one is in the building.

In addition, individual pumps provide more flexibility over time. "With a fixed installation," Coffey says, "the vacuum utility cannot adapt as the science, space needs, or budgets dictate." Individual pumps even keep labs up and running longer. "If there's a problem with such a system, only one pump needs to be changed," Anderson says.

Some vendors also offer systems that bridge central and individual vacuum pumps. Jacquie Richardson, Ph.D., director of organic chemistry teaching labs at the University of Colorado at Boulder, describes using such a system: "Each student bench has a connection. The one downside is that if one student leaves their vacuum spigot open, it messes things up for the other students at their bench." She adds, "That's easy enough to remedy with [teaching assistant] oversight, though." Overall, she says that she's very pleased with such a system.

Transitions In Technology

Beyond moving from aspirators to pumps, the technology inside the latter even changes. For example, rotary vane pumps use oil and others use a diaphragm, which is oil-free. Anderson calls the oilfree approach greener, adding that it "provides enough vacuum for many labs."

With rotary vane pumps, Anderson says, working with wet vapors "gets moisture in the oil and it starts to break down, like the oil in your car." Then the oil needs to be changed and the old oil must be disposed of, and it can be contaminated by the vapors.

Although Anderson points out that rotary vane pumps supply higher flow and deeper vacuum than diaphragm pumps, he says that the latter provides enough suction for most applications. Nonetheless, he adds that researchers still need rotary vane pumps for some applications such as lyophilization.

When it comes to evolving vacuum-pump technology, other features also matter. As Coffey says, "Users often are looking for a quieter pump than they have, because vacuum pumps are often one of the noisiest pieces of equipment in the lab." Many users agree. For instance, Faleh Salaymeh, staff scientist II at Relypsa (Santa Clara, CA), wants a vacuum pump that is accurate, durable, reliable, and quiet. He says, "I like the silence or quietness of [our pump's] operation, considering it is running all day in a laboratory with personnel around." His system also includes a remote control pad that he calls "a welcome addition."

In the end, picking the right vacuum pump changes life in the lab and beyond.

Vacuum Pumps: Advanced Features

Scientists developed vacuum pumps—and their cousins—centuries ago. Until relatively recently, though, the instruments didn't include many controls.

By Mike May, PhD

Advanced features modernize this ancient technology

"Uncontrolled vacuum is usually not optimum for most applications and can lead to sample loss, inefficient applications, and a lot of time wasted in manual oversight," says Peter Coffey, vice president of marketing at VACUUBRAND (Essex, CT). "Scientists are increasingly using electronic controls for vacuum applications."

Other experts agree. For example, Roland Anderson, laboratory product manager at KNF Neuberger (Trenton, NJ), says, "New options, including speed control and remote-control options, are making vacuum pumps more versatile for use in a wider variety of applications."

Tougher technology

Some of the advances in vacuum pumps arise from where they are used. As Kevin Marzano—global vice president, RocKing Piston, Gast Manufacturing, part of the IDEX Corporation (Benton Harbor, MI)—says, "These instruments are used in more and more harsh environments, including high heat and exposure to corrosive materials." For instance, a vacuum pump might be used to remove waste from medical equipment. To operate under such conditions, developers use, for example, improved coatings around the pump and materials that withstand higher heat.

Even under ordinary conditions, today's pumps prove more robust. Part of that comes from a transition from AC to brushless DC motors. "The brushless DC motors have a much longer life, are quieter, and can be plugged in anywhere in the world," says Marzano.

Similarly, Coffey points out, "Traditional pumps employed fixed-speed motors, but variable-speed vacuum pump motors allow vacuum pumps to operate only as much as needed to maintain the desired vacuum level—pumping at full speed to quickly create vacuum and ramping back pumping automatically to maintain vacuum. This can reduce energy used by vacuum pumps in labs by as much as 90 percent."

One user of a VACUUBRAND pump commented on Amazon, "This pump works great! The installation was a breeze. It pumps down very quickly. I could not be happier unless it was free."

Determine the duty cycle

The best vacuum pump for a specific situation, Marzano says, depends on the duty cycle. "If it runs for just a short period of time over an eight-hour shift," he says, "then the pump's life is not an issue." If a pump must work much harder, the expected lifetime gets more significant in a purchase decision. "A pump should last 4,000, 6,000, maybe even 10,000 hours," says Marzano.

For the longest pump life, Anderson says, "Ensure that all fittings and connections are leakproof, install inline traps to prevent liquid and wet vapors from entering the pump, regularly inspect your pump for damage and signs of wear, and perform regularly scheduled maintenance based on experience and manufacturer recommendations."

In the buying stage, though, don't forget a couple of other details. "In some cases," Marzano says, "how a pump connects with other equipment matters. Is it easy to connect and disconnect for service?" Those details could make the difference in getting the best pump for your job.

How to Select the Best Vacuum Pump for Your Lab

Buying a vacuum pump isn't as straightforward as you might think

Join Linda the lab manager and her team as they review what features the best vacuum pumps can (and should) offer in this short video sponsored by KNF Neuberger.

Click Here to Watch the Video

High-Vacuum Situations

In complicated applications of high vacuum, the technology must really fit the situation.
By Mike May, PhD

Get Expert Advice to Pick the Right Pump for a Specific Application

"In the case of high vacuum, the pump system needs to meet the process demands and subsequent customer's requirements," says Christina Steigler, head of corporate communication at Germany-based Oerlikon Leybold Vacuum. She adds that the desired features are "in general, the same as for all industrial products: higher, faster, and with reasonable cost, and, if possible, 'plug and play.'"

Where high vacuum is required, scientists face some specific challenges. One, says Keith Webb, engineering manager at Tuthill (Springfield, MO), is "carryover of process media that the user is trying to pull through the pump." He adds, "In lab applications, that could be argon through the whole inert-gas range to condensable gases." He adds that corrosion from chemicals can cause problems. "If you don't have the right material construction, you'll have corrosion in a short period of time," he says.

A variety of variables come into play with high vacuum, but the particular needs depend intimately on the project at hand.

Scientific searches

A variety of research applications require high levels of vacuum. In Switzerland, for example, scientists at CERN use high-vacuum technology to search for black holes.

Instead of looking out, vacuum can help researchers look in, say, with electron microscopy. At the Central Microscopy Research Facility at the University of Iowa at Iowa City, director Randy A. Nesser helps scientists explore nature in very fine detail with electron microscopy. "Different electron emission sources require different vacuum environments for operation," he explains. "Thermionic emitters have the least vacuum requirements; cold cathode field emission sources need vacuums approaching deep-space levels."

So even similar applications can require different vacuums. As Nesser says about electron microscopy, "There are a host of different vacuum-generating technologies employed, depending on the final vacuum needed."

Picking the product

"The art is in the understanding of the customer's process demands and tailoring the system to the best technological outcome," Steigler says. "The latest advance in this area is our software PASCAL. This enables us to calculate and simulate systems based on existing products, but also to configure products which will then be tailor-made for the processes." She adds, "This is especially interesting for all R&D and analytical applications, which require high vacuum in most of the cases."

Webb agrees that scientists need the right pump for the job. "The key is the up-front selection process," he says. "You need the right pump for the application, and that means the right vacuum level, flow rate, and gases you will use." He adds, "We have a tool on our site where you can provide your requirements, and then one of our engineers looks at it from an application standpoint to help the customer select the right equipment." Webb points out that every pump comes with pros and cons, which makes it even more important to get the one that fits your specific needs.

To enhance the range of pumps, Oerlikon developed its TURBOVAC i/X line. "The flexible concept is the basis for adapting this pump to customers' needs," Steigler says. "Within 12 weeks we are able to create specific pumps for process applications."

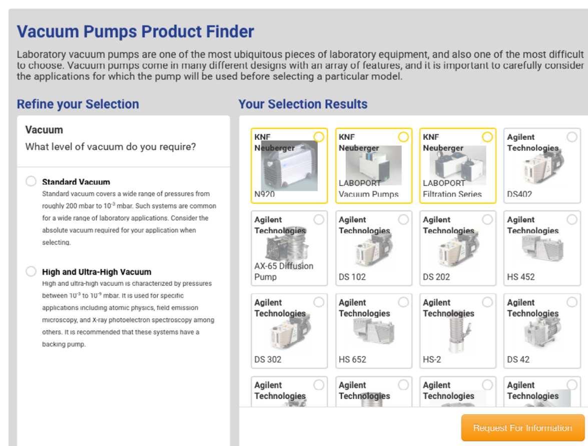
For lab applications, Webb says, "Our two-stage, oilsealed rotary piston pumps are more robust and durable than most other technologies that are in existence." As examples, he mentions the KC and KTC series.

As Nesser concludes, "The keys to ensuring the correct vacuum level are selecting the appropriate vacuum technology and using the correct vacuum-monitoring gauges." All of these need to be tailored to the science or engineering at hand to keep the appropriate vacuum and make your processes run right.

Vacuum Pumps Product Finder

Laboratory vacuum pumps are one of the most ubiquitous pieces of laboratory equipment, and also one of the most difficult to choose. Vacuum pumps come in many different designs with an array of features, and it is important to carefully consider the applications for which the pump will be used before selecting a particular model.

Product Finder: Vacuum Pumps



Featured Manufacturers

KNF

KNF Neuberger, Inc. is a leading manufacturer of reliable oil-free laboratory vacuum pumps, systems, and controllers; liquid dosing/metering and transfer pumps; and rotary evaporators. All KNF laboratory products offer compact design, long service life, and dependable performance. Contact KNF Neuberger today to discuss your specific laboratory needs.

2 Black Forest Rd,
Trenton, NJ 08691,

www.knf.com

Gast Manufacturing	**gastmfg.com**
IDEX Corporation	**www.idexcorp.com**
Oerlikon Leybold Vacuum	**www.leybold.com**
Relypsa	**www.relypsa.com**
Tuthill	**www.tuthill.com**
Vacuubrand	**www.vacuubrand.com**