# ROTARY VANE VACUUM PUMPS

By Daniel Pascoe

This article is intended as a general guide and as with any industrial application involving machinery choice, independent professional advice should be sought to ensure correct selection and installation.

The rotary vane type vacuum pump is one of the most popular vacuum pumps in use today. Manufactured by many companies throughout the world, this type of vacuum pump is commonplace in most industrial vacuum environments including packaging, thermo forming, hospital systems, and vacuum-handling applications. Fig 1 shows a typical lubricated vacuum pump.

The simple construction of vane pumps makes them rather inexpensive to manufacture and offer relatively good value to the vacuum user. There are two basic types: (1) lubricated and (2) non-lubricated, which is sometimes referred to as "oil-free." Both of these pumps operate using the same basic principles but are designed for different applications. And this is important to understand and appreciate as the wrong selection could lead to malfunction of the equipment.

The obvious reason for selecting an oil-lubricated rotary vane vacuum pump is because the user requires a higher vacuum level than that offered by an oil-free version. Oil-free vacuum pumps are quite capable of generating a vacuum level of 27-in. Hg (90% vacuum). Of course, there are oil-free models that offer slightly higher vacuum levels than this, but fundamentally, 90% is about as much as you'll achieve out of the box. Of course, as with any vacuum system, the application has to be sealed or the pump "dead headed" to achieve this maximum vacuum.

The reason for the oiled pump achieving a higher vacuum is quite simple. The oil in the pump creates a liquid seal between the vane and the stator (pump housing). In non-lubricated pumps, air "slippage" occurs between the vane and the stator, and as vacuum creation is the action of removing air from a known volume (such as vacuum cups in material handling), air "leaks back" between the vane and stator, and therefore, a higher vacuum can never be achieved. Fig 2 shows this using an exaggerated scale.

A common request of the customer with a new application is that they require the highest vacuum level possible. As a salesman or specifier of the vacuum pump, two simple questions should be asked of the user to remove a lot of discussion and confusion: what exact vacuum level is required and what is the application--two fundamental questions that will determine whether you shall be supplying an oil-free pump or an oil-lubricated unit. Basically, an oil-free unit is less expensive and easier to maintain. So if the application is simple vacuum cup handling, then an oil-free unit is the way to go. The customer may state they need maximum vacuum but they simply don't in vacuum handling. If the cups are undersized, then use larger cups or more of them.

However, if the application is more process-based, such as meat packaging where the vacuum requirement is >29-in. Hg, then a lubricated unit is the way to go. However, just because an oiled pump can pull a higher vacuum does not mean it should be used in all applications. There are two fundamental problems when a lubricated pump is used at a low vacuum such as <20"hg. The oiled pump system requires a vacuum to be generated within the pump to pull the oil through to lubricate the vanes. There is not a mechanical oil pump doing this. Consequently, if the vacuum level is not high enough, poor lubrication occurs. Furthermore, and one that is often more apparent to the user, is that if an oiled pump is run at a low vacuum, the airflow through the pump is excessive and oil carryover can occur.


FIGURE 1

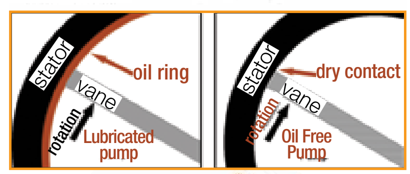


FIGURE 2

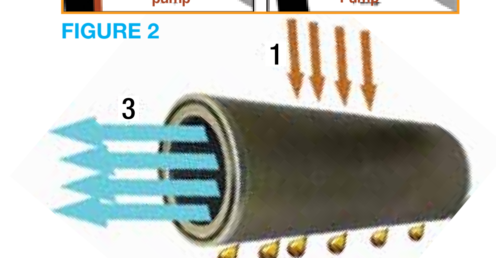


FIGURE 3

Basically, oil is separated from the air stream in a vacuum pump by gravity, baffles, and also the final stage, which is a coalescing oil separation filter element. All of these are internal to the pump. Consequently, the excessive air picks up oil, carries it though the baffle area, and then saturates the outside of the coalescing element. Eventually, this oil is forced through the element, and an oil smoke appears at the exhaust of the pump. This is what the user will be calling you about, and nine times out of ten, if the element is relatively new, it's because the vacuum level is not high enough in the system. Fig 3 demonstrates this: (1) oil-saturated air enters outside of element, (2) oil coalesces and falls back into the oil reservoir, and (3) clean air exits the pump exhaust.

One of the benefits of a rotary vane pump is the simplicity of construction and therefore, maintenance. There are, of course, obvious periodic maintenance items such as seals, bearings, and other rotary machinery failure, but this is a pump breakdown or overhaul requirement. The standard service replacement is the vanes, which, depending on the manufacturer, are normally manufactured from aluminum or in the majority of cases, carbon. Most vanes will last in excess of 10,000 hours of service and in some cases, in excess of 20,000 hours. This is dependent on the way in which the pump is used, the vacuum levels the pump experiences, and the actual application. For example, a pump running a low vacuum will experience a fair amount of vane wear as the vanes are continuously under load and experience a lot of force put upon them by the amount of air they are continuously moving through the pump. A sliding vane vacuum pump will last longer when it's continuously pulling a high vacuum, a common misunderstanding by users. Higher vacuum means lower airflow.

If a vane pump is continuously cycled on and off, the vane life will be affected due to constant stop start operation. This cycling is also detrimental to many other components such as bearings, motor couplings, elastic joints within the coupling, and even the electrical motor. In conclusion, and as with other types of vacuum pumps, a rotary type unit cycling on and off more than 10 times an hour is not recommended. Checking with the pump manufacturer is always wise in these types of applications.

Another advantage of lubricated vane pumps is their ability to handle a certain amount of liquid vapor (steam) from the application, normally non-corrosive, such as water. If water vapor was to enter an oil-free pump, the vapor would mix with the fiber dust from the vanes, a paste would be created, and eventually the blades will fracture. A gas ballast valve installed on the compression side of a lubricated vane pump prevents the vapor from turning into a liquid, and therefore, this vapor exhausts with the air.

So in a comparative conclusion, use an oil-free vane pump for low-vacuum applications and a lubricated vane pump for applications that require a higher vacuum.

As with most machinery, the larger the model means the larger the capacity of its intended use. This is the same for rotary vane vacuum pumps. They are sized based on their airflow rate through the pump. Many model numbers have the airflow as part of the part number. For example, the Vuotecnica model MV200 is able to flow $200m^3$/hr (meters cubed per hour) of air or 118 scfm. This figure is based on a standard volume of air at atmospheric pressure. As the vacuum level in the system increases, the scfm rate drops, as there is less atmospheric air passing through the pump. That is why under a "full" vacuum condition, there is zero airflow coming out of the exhaust as there is no "air" in the system.

The largest rotary vane pumps have a flow capacity in excess of 1,000 scfm. The pump size selection is based on the speed in which the air in the system needs to be evacuated. A large vacuum pump and a small vacuum pump of the same design offer the same vacuum level. It's simply how quickly it can achieve it that determines model choice.

Therefore, in selecting the correct size rotary vane pump, consideration needs to be made of the actual application, the time in which the air needs to be evacuated, and the final vacuum degree the user requires.

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