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# ARE YOU PUTTING A VARIABLE SPEED DRIVEN, OIL-LUBRICATED ROTARY SCREW VACUUM PUMP INTO A VIXED SPEED APPLICATION?


## Author

**Stephen Taylor**
K-Series Product Manager


## Discussion

- VSD vs. fixed speed
- Best applications for fixed speed vacuum pumps
- Savings with a VSD controlled vacuum pump

## Technology Focuses

- Rogers KRVP vacuum pump

Oil lubricated, rotary screw vacuum pumps (shortened to “vacuum pump” for the remainder of this article) have been around for many years and have provided a simple, reliable and efficient source of industrial vacuum for many industries worldwide.

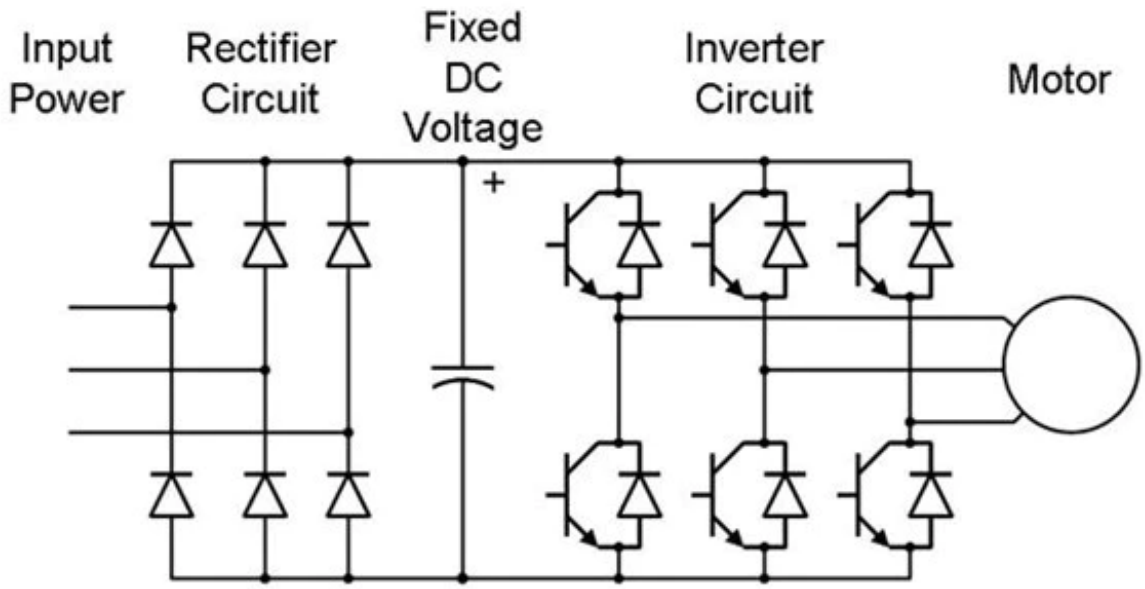
Since their introduction, there have been many improvements to increase the efficiency of these workhorses of vacuum production. One of these improvements has been the introduction and adoption of variable speed drives (VSD) for the main motor. This improvement has become so prevalent in the oil lubricated rotary screw vacuum pump market that some manufacturers only sell VSD controlled oil lubricated rotary screw vacuum pumps.

However, just because it is the only product some manufacturers sell doesn’t mean it’s right for your applications and environment. Let’s start with a little background into VSDs and then address what we consider poor applications of VSD compressors.

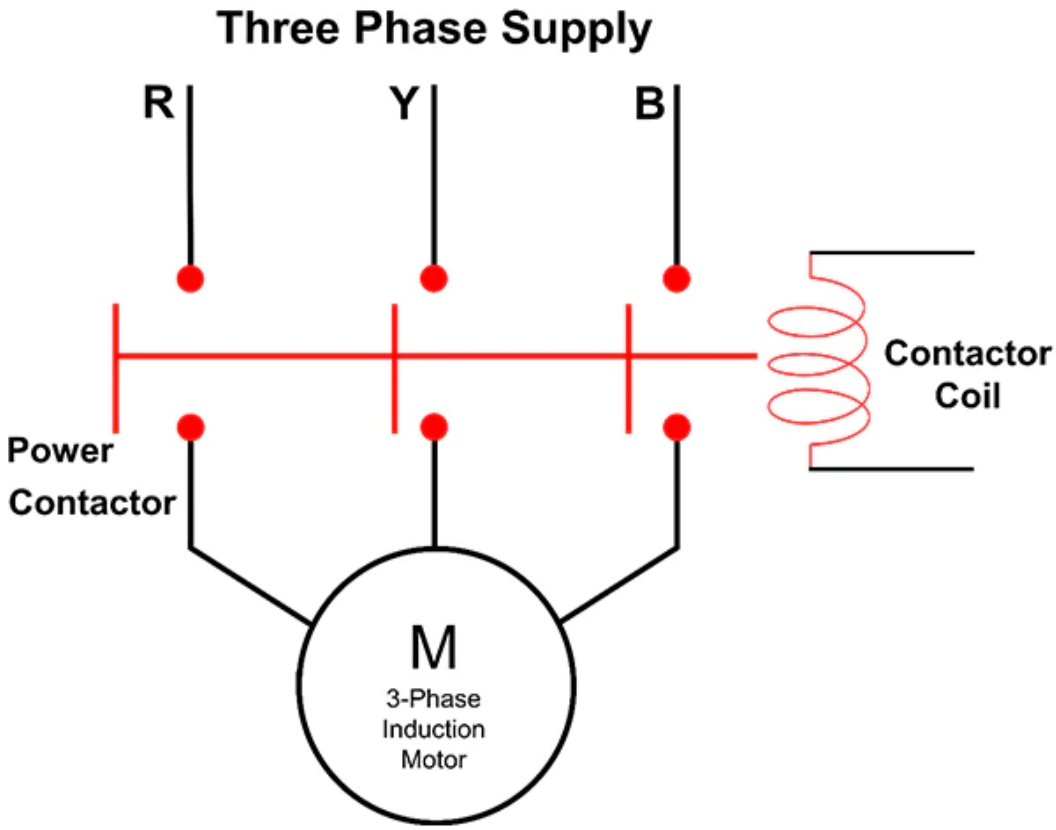
### VSDs can Also be Called Adjustable Speed Drive (ASD) or a Variable Frequency Drive (VFD).

A vacuum pump without a VSD controlled main motor would be called a fixed speed or constant speed vacuum pump. AC, induction motors have a base speed that is relative to the input power frequency and number of poles in the motor.

On 60 Hz power, a motor with 4 poles operates at a nominal 1800 RPM. A motor with 2 poles on 60 Hz power operates at 3600 RPM. This is important because when you couple a motor operating at a fixed speed to an oil-lubricated rotary screw vacuum pump, the volumetric flow through the vacuum pump is also fixed.




*VSDs use 6 rectifiers, a DC bus and 6 IGBTs. The rectifiers and IGBTs can engage and disengage between 7,000 and 15,000 times per minute.*




*A cross the line starter utilizes a solenoid to create a mechanical path of the power to the motor. The solenoid is activated once at startup and then is deactivated to stop the motor.*

In order to keep your vacuum system working effectively, you need to match the flow and vacuum requirements of the system. Using a fixed speed vacuum pump, you can either:

1. unload the pump, or
2. operate the vacuum pump at the lowest vacuum level it attains and modulate the inlet or use a vacuum regulator to control the system pressure

It isn't necessarily obvious, but this second option can be quite attractive in the world of vacuum. As your vacuum level drops, the amount of power required also goes down.

## Why Would You Want to Control the Main Motor with a VSD?

VSD motors save more power. For example:

A 50 HP air compressor requires about 45 kW of power. When running 8,000 hours a year with an electrical rate of 8 cents per kWh, this will cost $28,800 to operate. A system which requires approximately 50% of the output of a vacuum pump will require about 80-90% of the power from a fixed speed vacuum pump (we will estimate 85% for comparison purposes). A VSD controlled vacuum pump would require approximately 50% of the power to produce 50% of the output. This leads to 35% in savings. That 35% translates into $10,080 over the year.

| VSD TO FIXED SPEED COST COMPARISON | |
|---|---|
| HP | 50 |
| Power Required (kW) | 45 |
| Operating Hours Per Year | 8,000 |
| Cents per kWh | 8 |
| Total Yearly Cost | $28,800 |
| Required Power for Fixed Speed @ 50% | 85% |
| Fixed Speed Cost @ 50% | $24,480 |
| Required Power for VSD @ 50% | 50% |
| Variable Speed Cost @ 50% | $14,400 |
| VSD Savings @ 50% | $10,080 |

*Actual systems are never quite this easy a comparison, as process requirements are rarely constant. Work with your Rogers Machinery representative to map your actual system requirements and how they change by shift or day to quantify your savings potential.*

Does that mean you should always buy a variable speed driven, oil-lubricated rotary screw vacuum pump? Or could you be putting a variable speed vacuum pump into a fixed speed application?

## A Few Situations Best Suited for Fixed Speed Applications

### 1 — Hot and/or Dirty Environments

*Hot and dirty environments are not a good location for a VSD. Consider a fixed speed vacuum pump, special packaging or a remote mounted drive to lengthen VSD life in these environments.*

Precise electronics do not like heat and dirt. If some dust gets into the wrong place, the VSD can short-circuit and your vacuum pump will stop working. In addition, in order to dissipate the 3-5% of the total power that is generated by a VSD in heat, you need to have cool air and consistent air flow. Most VSDs have fans with filters that provide air flow to cool the VSD, but those aren't as effective if the air is already hot and if the filters are plugged with dust.

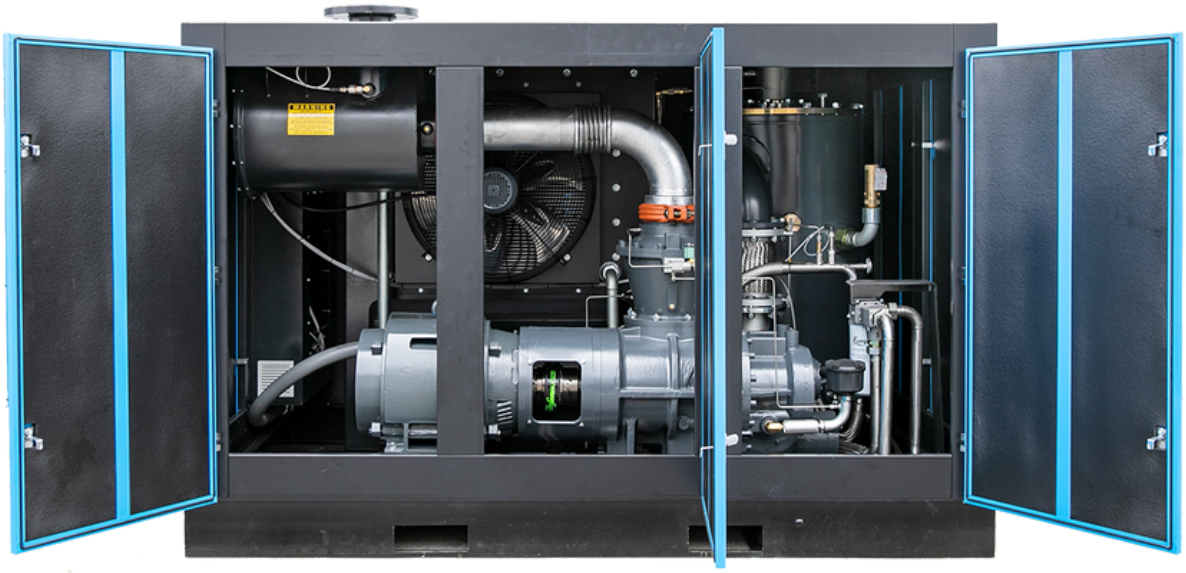

While Rogers Machinery can provide special packaging or a remotely-located VSD to help prolong the VSD's life, not all manufacturers have this option. If you don't want to pay the extra cost for special packaging, a fixed speed unit may be the right choice.

*Dusty environments will cause VSD filters to plug prematurely, reducing airflow and causing premature failure.*

## 2 — Critical Applications or Lack of Redundancy

It is always recommended to have redundancy in a vacuum or compressed air system. However, sometimes that just isn't possible or practical. A VSD controlled vacuum pump has the opportunity for power savings, but VSDs have approximately half the life expectancy of the other major components in your vacuum pump. In addition, VSDs typically don't provide feedback before they fail catastrophically.

Typical motor or airend issues are preceded by heat or noise, which can allow a plan to be implemented before the unit actually fails. Critical applications may also not be candidates for VSD controlled vacuum pumps, where losing a VSD and shutting down your process can cause you to have to scrap a costly batch of product. Depending on your manufacturer, you may have to wait for a proprietary VSD, and that VSD may require special programming, tuning and troubleshooting. Overall, this just loses you more time. Other types of starters can typically be sourced from any electrical supply company and can be plug and play.



## 3 — System Requirements for Greater Than 95% of Vacuum Pump Output

As previously mentioned, VSDs are effective at reducing power when operating at partial loads. However, 3-5% of the energy going into a VSD is lost to inefficiencies, mainly in heat. Therefore, if you have a process in which the VSD is going to be operating at over 95-97% load, then the VSD will actually be using more power for a similar flow.

## 4 — Short Duty Cycles

The savings in utilizing a VSD are in the power consumption. Refer back to the earlier example of the power for a 50 HP compressor costing about $28,800 per year. One of the keys to the assumed savings of a VSD operated vacuum pump is the operating hours.

If you are only operating one 8-hour shift, the $10,080 in savings drops to one third or $3,360 per year. The cost of replacing a VSD can easily exceed 25-50% of the initial purchase, and that might show that the savings in electricity will actually cost you more in VSD replacements over the long run. Ask your vacuum pump supplier what a replacement VSD would cost and compare that to your electrical savings. The math may show that the VSD savings aren't actually there.

## 5 — Pump Down Applications

In most typical pump down applications, you want to get the process to the appropriate vacuum level as fat as possible in order to complete a batch and move on to the next. Unfortunately, most VSD controlled vacuum pumps can't operate at maximum output from atmospheric pressure at the beginning of the pump down process and can slow you down.

With a patented flexible discharge port, Rogers KRVP vacuum pumps can operate at full flow from initial atmospheric pressure all the way down to your system pressure requirements.


*A Rogers Machinery KRVP vacuum pump installed in a facility.*

### 6 — Systems of Multiple Vacuum Pumps

For systems of multiple vacuum pumps, you can combine the energy efficiency of VSD control with the reliability of a fixed speed unit. Use a group of fixed speed vacuum pumps with one or two VSD controlled vacuum pumps to trim the demand.

Don’t get forced into buying multiple VSD controlled vacuum pumps just because that is the only technology available from your supplier. Rogers Machinery KRVP vacuum pumps are available with VSD or fixed speed motor control and can be combined to best fit your application.

## Conclusion

VSD controlled oil-lubricated, rotary screw vacuum pumps provide the opportunity to save power costs, but are not right for all applications. The 6 situations presented here are just some examples where a VSD controlled vacuum pump is being put into a fixed speed application.

Talk to your local Rogers Machinery representative who can help you evaluate whether a fixed speed or VSD controlled KRVP vacuum pump is right for your system.