Vyper™ **Variable Speed Drives**

Maximizing Compressor Efficiency By Optimizing Speed

Frick®

BY JOHNSON CONTROLS

Take It Slow, Improve Efficiency and Lower Costs

The package mounted Frick® Vyper™ variable speed drive for rotary screw compressors offers superb refrigeration system performance and enhances energy savings by improving efficiency, while reducing maintenance costs.

Reducing Energy Consumption & Cost

There are several things that can be done within a refrigeration system to reduce energy consumption, but do they maintain or improve system efficiency? Compressors are typically the largest consumers of energy in an industrial refrigeration process. Therefore, operating an engine room at peak efficiency is a major step torward reducing a building's or company's energy costs and carbon footprint. A properly applied variable speed drive on each temperature level of the process, along with proper control, will ensure peak operating efficiency.

Superior Energy Savings Through Improved Efficiency?

Consider the two factors that most affect a compressor's energy consumption: heat load and compression ratio. Reducing heat load should allow the compressor to unload. Reducing the compression ratio by reducing the operating discharge pressure will reduce energy consumption. However, reducing consumption through unloading the compressor does not necessarily mean that the process is efficient.

A constant speed compressor reacts to a reduced heat load by unloading the capacity slide valve. While this action does reduce the total energy consumed by the compressor, the energy required per ton of refrigeration increases. Simply put, your cost per ton of refrigeration is rising and continues to rise as the load falls off and the capacity slide valve unloads even further. While the energy consumption was reduced, which is good, so was the efficiency, which offsets the total gain of the reduction. Reducing energy consumption is as much about efficiency as it is simple reduction.

Optimal Volume Control

Screw compressor efficiency is linked directly to proper Volume control, also known as Vi or Volume Ratio. On constant speed compressors, the Vi is optimal when the slide valve is fully loaded. By using a Vyper™ VSD for your primary capacity management component, the slide valves on all compressors that are on line stay fully loaded. The result is that the Volume Control or Vi remains optimal throughout the capacity range.

Maximize Efficiency By Optimizing Speed

Managing a reduced load by controlling the speed of the compressor is a far more efficient way to operate a rotary screw compressor. If all of the capacity reduction can be met by speed control (while keeping the slide valve loaded at all times), up to 75% of the losses that occur with mechanical unloading could be recovered. Using speed control to manage your fluctuating system capacity requirements is the most efficient way to operate at less than full load.

In systems with more than one compressor, a Vyper™VSD managed Frick® compressor can be used in conjunction with constant speed compressors on the same suction level. The constant speed compressors will base load at 100% capacity controlled by the slide valve. All of the part load management will be provided by the Vyper™ VSD compressor. This configuration of variable speed and constant speed compressors, along with Frick® Volumizer volume control (which is integral to all Frick® rotary screw compressor designs), will provide the longest lasting, lowest maintenance, most energy efficient engine room in the industry. In addition, Frick compressors offer up to an industry-best 5:1 capacity turndown by speed alone.

Economizing

Economizing a rotary screw compressor provides substantial capacity boost with minimal added horsepower and cost. On a constant speed compressor, the full benefit of economizing is only realized at the higher capacity conditions when the slide valve is completely or near completely loaded. As the slide valve is unloaded, the economizer becomes less effective to the point that it provides no net benefit once the economizer port is opened to suction pressure.

Economizing with a compressor that is managing capacity by speed will always provide economizer boost that is proportional to the need throughout the capacity range. This is to say that as the load drops off and the compressor slows down, so does the sub-cooling load of the liquid that is being delivered to the evaporator.

Economizing and side loading are different in that side loading is pulling from a load that is most likely not proportional to the main suction load. Be sure to specify whether the application is economizing or side loading.

Package Mounting

Package mounting provides several advantages. The NEMA-4 (Indoor Use) rating of the Vyper™ VSD enclosure allows the drive to be mounted directly to the package for use in any nonhazardous classed area. The NEMA-4 enclosure prevents intrusion from dirt, dust, water spray, and refrigerant resulting from leaks, to name a few. Lower NEMA rated air-cooled VSDs cannot provide this level of protection.

Package Mounting means...

1. **Lower Installation Cost –** The only connection that needs to be made in the field is for the 3-phase power and ground to the input of the drive.
2. **Less Mounting Space –** Liquid cooling allows the drive to be smaller. The combination of a smaller VSD along with package mounting reduces the overall footprint by as much as 33%.
3. **Extended Motor Life & System Integrity –** Except for the input power and ground, all wiring is done at the factory under rigid processes and inspection.
4. **Superior Motor and VSD Current Overload Protection –** At least four layers of motor and VSD overload protection are provided which include:
   - Main Disconnect Circuit Breaker / Main Input Fuses
   - Motor Stator Temperature Monitoring / Safety
   - High Motor Current Stop Load; Force Unload; Alarm and Shutdown setpoints in the Quantum™HD.
   - High Current Shutdown by the Vyper™ VSD @ 105% of the drive's maximum continuous output.
5. **Main Circuit Breaker Disconnect**
   - Provides immediate shutdown protection right at the compressor package

Turn Downtime Into Uptime

If you want consistent, reliable performance, Vyper™ VSD delivers it by the ton. Vyper™ VSD virtually eliminates unscheduled downtime by reducing compressor maintenance over that of reciprocating compressors, since there are far fewer moving parts subject to failure.

In the long run, you get greater reliability while avoiding sky-high annual rebuild expenses that accompany reciprocating compressors.

Flexible As Well As Variable

Spec Vyper™ VSD as your primary compressor or as the trim compressor to complement constant-speed compressors handling base loads at 100% slide valve. It will increase process efficiency, as well as the life of other compressors in service.

Liquid cooling of the VSD enhances reliability, takes up less space, and protects the drive from high temperatures in the engine room.

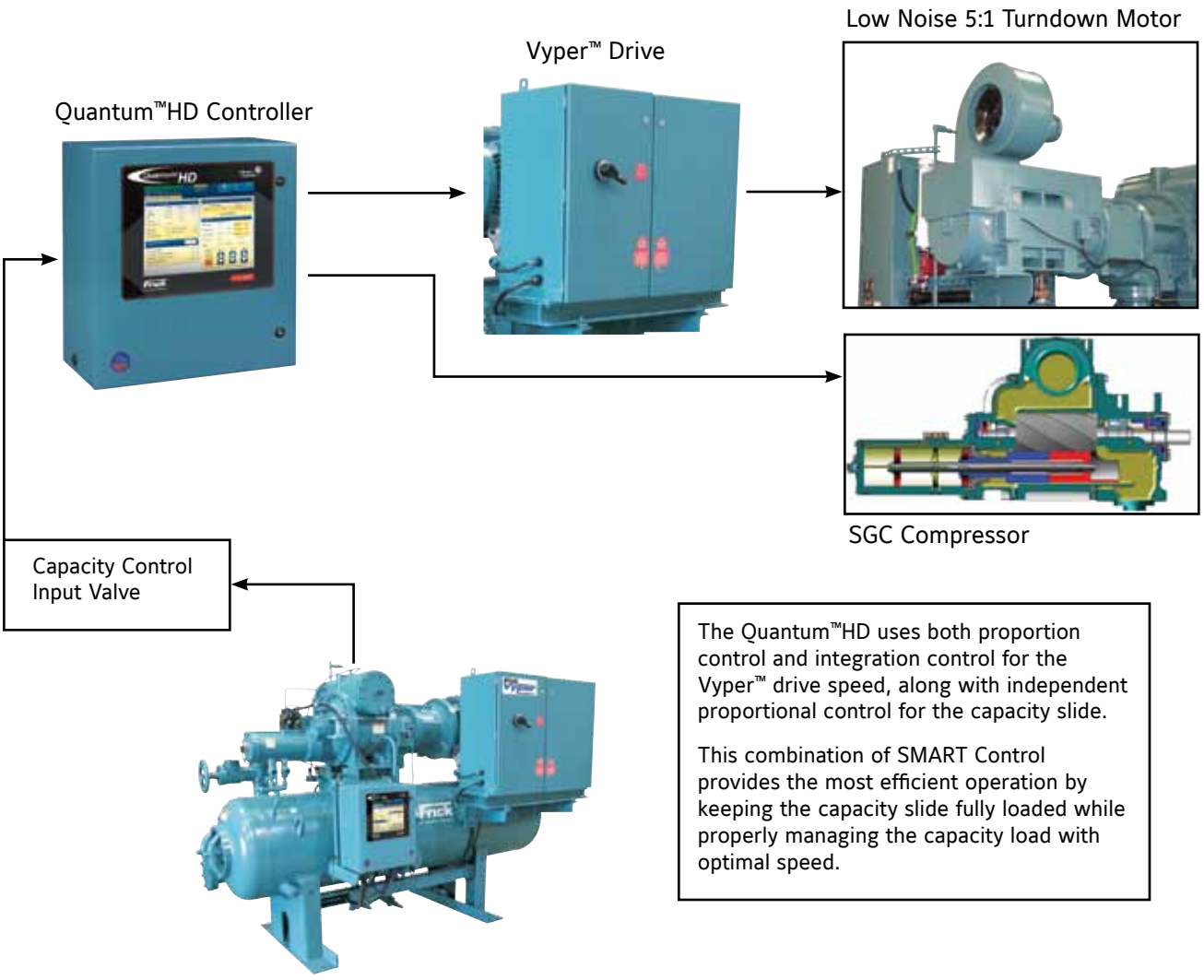
Efficiency is enhanced with tunable PI settings on the Quantum™HD control panel that eliminate capacity overshoot.

SMART Control Pulls It All Together!

SMART Control, which is provided by the Quantum™HD controller, pulls it all together. The Quantum™HD controller is equipped with control logic developed through years of applying variable speed drives to rotary screw compressors. It sets the benchmark for a variable speed control which is unrivaled not only from the standpoint of performance, but from compressor protection as well.

By using separate controls settings for each capacity management component (slide valve and speed), the Quantum™HD controller ensures that the slide valve stays fully loaded until every ounce of capacity management from the Vyper™ VSD is fully exhausted. Since all Frick manufactured rotary screw compressors used in the food and beverage industry have the potential to run down to 720 RPM, there is little practical capacity reduction to be achieved by unloading the slide valve at that minimum speed.

Since the capacity slide valve on all Frick® manufactured compressors is hydraulically driven, not motor driven as are some other compressors, full physical loading of the slide valve is guaranteed.



The Quantum™HD uses both proportion control and integration control for the Vyper™ drive speed, along with independent proportional control for the capacity slide.

This combination of SMART Control provides the most efficient operation by keeping the capacity slide fully loaded while properly managing the capacity load with optimal speed.

5:1 Capacity Turndown by Speed Alone Best in the Industry

Minimizing Capacity Overshoot

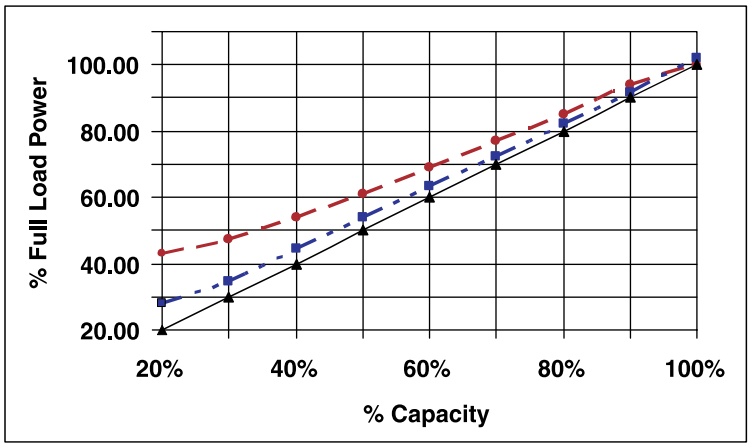
While often neglected, any and all overshoot relative to the capacity control setpoint is non-value added energy consumed by the compressor. This aspect of operation is often dismissed since it is not easily tracked and therefore hard to quantify. However, capacity overshoot beyond what is required is waste. Minimizing capacity overshoot adds another dimension to the benefit of a compressor running with Vyper™ VSD capacity management.

In order to prevent continuous movement of the capacity slide valve, most constant speed compressors will use a dead band above and below the control setpoint. This use of dead bands creates constant potential for capacity overshoot.

Since the capacity slide valve runs fully loaded when managing the compressor's capacity by speed, no dead band is required to prevent constant movement of the slide valve. This, along with the SMART Control provided by the Quantum™HD controller, allows almost all overshoot to be removed. While hard to quantify, the removal of nearly all overshoot is, without doubt, an added benefit of using a VSD as your primary capacity management component.

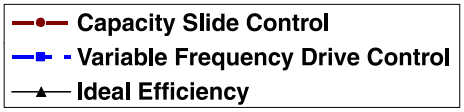
Part-Load Efficiency

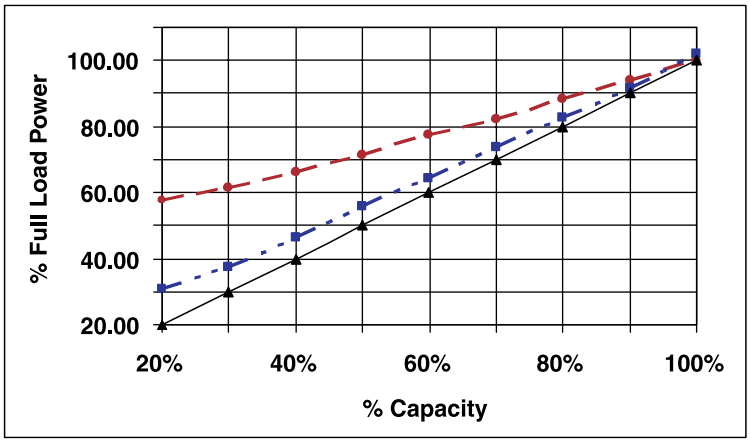
The following charts display the improvement in part-load efficiency between 20% and 100% capacity of a Frick® RWF II 270 compressor package with Ammonia as the refrigerant. The conditions of the first chart are 20°F (-6.7°C) SST to 95°F (35°C) SDT. The conditions of the second chart are -20°F (-29°C) SST to 95°F (35°C) SDT.



A Significant Improvement In Part-Load Efficiency

RWF II 270
Conditions:
20°F (-6.7°C) SST to 95°F (35°C) SDT





RWF II 270
Conditions:
-20°F (-29°C) SST to 95°F (35°C) SDT

Vyper™ Variable Speed Drive gives you the kind of control you need, today, to respond to the unique load demands of your Process Cooling Requirements.

There are many processes that could benefit from the use of the Vyper™ VSD. Some examples are:

· Carbonated Beverage · Cold Storage · Meat Processing · Dairy · Poultry Processing · Industrial Bakeries · Seafood · Fruits & Vegetables · Breweries · Ice Making

Contact your Frick® sales representative to better realize the potential of this technology when applied to your process.

Manage Capacity By Controlling Speed

Let's look at an example in the carbonated beverage bottling industry where production line loads change very rapidly. The most efficient way to meet these changes is a Frick® rotary screw compressor using a Vyper™ VSD.

The Vyper™ VSD, which is available only from Frick®, responds to changing capacity by changing motor speed instead of moving the slide valve. The Vyper™ VSD is more efficient and fast. In fact, it's almost instantaneous.

- Increase Capacity from 20% to 100% in 8 seconds
- Provides more precise capacity management than step machines of any type
- The Stand-by feature allows the Vyper™ VSD to idle at 0 speed. This unique feature keeps the capacitors and DC bus fully charged during off-cycles up to 24 hours. This means no delay to recharge the capacitors and DC bus when the Vyper™ VSD is called upon. It is back to business and full capacity in seconds, if needed.

The Overall Result...

By choosing a Frick® Rotary Screw Compressor combined with the Vyper™ VSD, you will save energy by providing better part-load efficiency over what can be provided by conventional rotary screw compressor control methods. You will further reduce energy consumption by practically removing overshoot and eliminating the need for Hot Gas Bypass to assist in suction pressure control. You will also reduce maintenance costs by removing practically all movement of the slide valve, even on your constant speed compressors.

With Vyper™ VSD, when your process slows down, so does your electric meter. When your process goes back to work, so does your compressor, without time wasted to reach full operational readiness and capacity.

Making The Difference To Your Process

Since all processes are not the same, the SMART Control provided by the Quantum™HD control panel allows you to tune this response to your exact needs. SMART Control keeps the slide valves loaded and removes overshoot, while providing the reaction that best fits your process and energy saving goals.

Retrofitting...

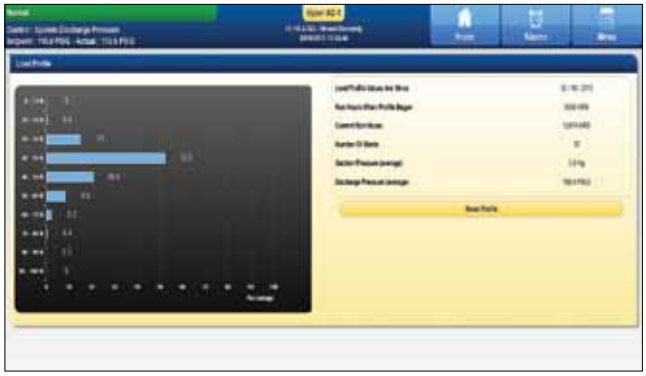
You can also reduce energy costs by adding an aftermarket Vyper™ VSD to an existing system compressor. Significant energy savings can be experienced on older systems the same as on new ones. Gathering the load profile of the existing system is the key to determining if retrofitting with a Vyper™ VSD and a new High Efficiency, Low Noise, Inverter-Duty Motor will provide those savings.

Frick supports the retrofitting of RXF and RWF compressor packages with variable frequency drives.

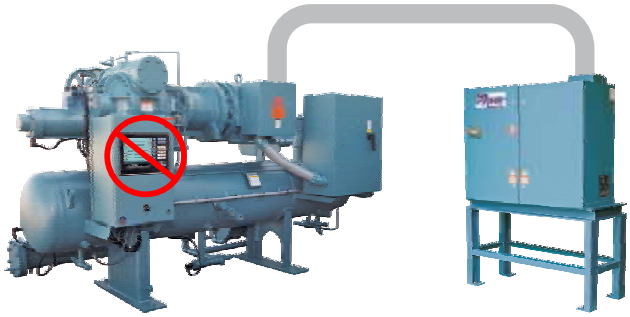
The Quantum HD controller can record the part-load profile over any period of time, long or short. The load profile gathers the date the profile began along with:

- Run hours when profile began
- Current run hours
- Number of starts during profile
- Average suction and discharge pressures

Once this information is pumped into the VSD savings calculator, the return on investment or payback time is estimated. In most cases, payback times are surprisingly fast.



The Quantum HD VSD Energy Savings Screen provides a complete part-load profile of the slide valve operating position as well as the days, run hours, and number of starts during the profile period.



To run the load profile on an operating compressor package the controller must be a Quantum HD or a Quantum LX. Use this chart as a guide to what type of retrofit would be required based on the current controller type.

Current Controller	Retrofit Option
RXF, RXF Plus, RWBII Plus	Quantum HD Controller
Quantum (28 x 18 x 12" enclosure)	Quantum HD Controller
Quantum (22 x 18 x 10" enclosure)	Quantum HD Field Retrofit Kit
Quantum LX (22 x 18 x 10" enclosure)	(Not Necessary) Quantum HD Field Retrofit Kit
Quantum LX (other enclosure dimension)	(Not Necessary) Quantum HD Controller

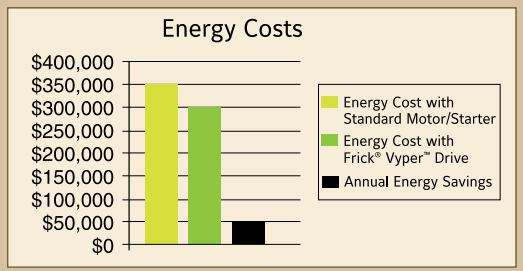
*If unsure, contact your Frick brand rep to confirm requirements.

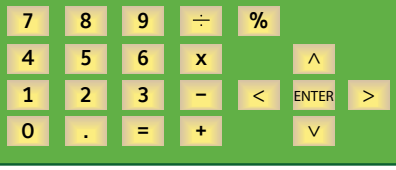
The First Step... a Quantum™HD Controller

Compressor Model:	RWF II 316
Cost Premium for Vyper™ Drive vs Standard Motor/Starter:	$88,900
Temperature Profile:	0°F / 95°F
kW/hr $:	0.1

Capacity	% Load in a Day	Operation Hours/Day	Days per Week
100%	20%	20	7
75%	40%		
50%	30%		
25%	10%		
0%	0%		
	100%		

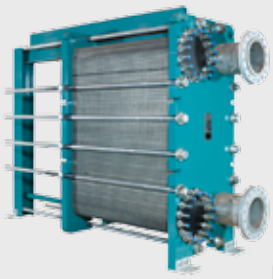
Energy Cost with Standard Motor/Starter:	$355,441
Energy Cost with Frick® Vyper™ Drive:	$307,232
Annual Energy Savings:	$48,208
Percent Savings:	13.60%
Payback Time (Yrs):	1.8





Single Source Industrial Refrigeration Solutions!

Heat Exchangers



Packaged Equipment

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