A Compressed Air & Gas Institute Q&A Session. Is a Variable Speed Drive (VSD) Compressor the Right Choice for Your Facility?

By Compressed Air Best Practices® Magazine

Compressed Air Best Practices® Magazine recently discussed variable speed drive (VSD) air compressors with the Compressed Air and Gas Institute's Technical Director, Rick Stasyshan and with CAGI member – Bob Baker of Atlas Copco. Their inputs should provide you with some insight to this energy-saving technology.

Where does one start with evaluating a system?

The simple economic model of matching supply with demand optimizes productivity and helps control costs. This makes sense not only in the economic world, but also when considering how compressed air is produced and used in a manufacturing facility.

Compressed air is critical to a wide range of functions within manufacturing. But poorly designed and maintained compressed air systems, by some estimates, account for significant energy losses and waste every year. One quick and easy way to ensure your facility is not squandering energy in its compressed air production process is to consider the benefits that can be provided by a properly sized variable speed drive compressor.

Is a VSD compressor a good trim compressor?

Variable speed drive compressors use an adjustable-speed drive or inverter (figure 1) to control the motor speed to modulate compressor's output. The simple advantage of this technology is that it allows the compressor to have relatively linear cfm output to kW input efficiency curve. This makes VSD compressors ideal trim compressors to supply a variable demand in the plant on top of the stable base compressed air demand.

While many plants require continuous, round-the-clock operations seven days a week, there likely are times when lulls in production present opportunities for energy savings. For example, there are 168 hours in a week and many compressed air systems only require full capacity between 60 and 100 hours, or about half the time. When this partial demand load event occurs, the air compressor output capacity must be regulated or stopped. With units 15 HP or larger, it is not feasible to stop and start the air compressor motor several times an hour throughout the day, so a form of inlet control regulation is the choice. Whether you run the unit with a Load/No-load control (fully loaded or a closed inlet for unload and bleed-down) or Modulation (cutting back the inlet throttle plate) to accomplish a partial load run-time, these control systems may not be the most efficient.

Operating a car is a very good example; when you exit the highway, you go from highway speed (let's say optimum full load at 55 MPH) and then you come to a stop at the bottom of the ramp. There, the car is idling and wasting energy as long as it sits at the stop sign. City driving is even worse or similar to a very fluctuating demand – starting and stopping, but idling at every stoplight. Now, think of your car sitting (idling) at stop signs and lights for 60 to 100 hours per week. (figure 2)

A compressed air energy audit or assessment including a review of the demand profile, compressed air usage patterns, available air storage capacity and piping network, and the operating environment, all play an integral role in determining if a VSD compressor can provide the energy efficiency that you desire.

Can VSD compressor power consumption match air demand?

Properly sized variable speed drive compressors, offer the capability to fine-tune a compressor output precisely to fluctuating compressed air demands. By varying the speed of its drive motor, as air demand decreases, the VSD lowers the delivered air flow as well as the electrical power consumption in that largely linear fashion. This reduces energy consumption to a minimum when fluctuating demand is the norm. In fact; due to the comparatively low in-rush currents inherent in variable speed drive motor designs, some VSD compressors will stop at the lower compressed air demands vs. idling at unloaded conditions. Even with several starts per hour there is not an issue, so wasteful energy (idling time) is virtually eliminated. (figure 3)

The Compressed Air & Gas Institute (CAGI) is an association of manufacturers of compressed air system equipment: compressors, blowers, air drying and filtration, and pneumatic tools. Links to member websites are provided on the CAGI site. The members' representatives

What is the business case for a VSD?

Statistics compiled through compressed air system assessments and performance analysis show that many air compressor applications are ideal for VSD. Compared to a fixed speed drive compressor, a VSD compressor, properly sized for the same end use, can yield significant power savings. In some cases, based on the demand profile, compressed air costs have been reduced by one-third. Another thing to remember is that, due economic cycles and shifting of manufacturing to other countries, many facilities have significantly reduced the volume of compressed air needed and are therefore operating oversized air compressors. This highlights the need to review the facility compressed air needs when significant production and compressed air demand profiles change. In addition, many local municipalities and state utilities offer rebate incentives for energy savings compressed air solutions, of which VSD technology qualifies.

Energy costs, already on the rise in recent years, have garnered additional attention of late as facility managers are continually charged with finding new ways to cut costs. Many corporations have instituted "green" policies with aggressive annual energy reduction targets.

Let's consider a situation where a manufacturer's compressor system was running a single 200 horsepower air compressor. The operation has fluctuating compressed air demands 24 hours a day at 3 cents per kWh. These energy costs have doubled in the last five years, increasing in some areas to 8 cents per kWh or more. The annual cost to operate that compressor at 3 cents per kWh was $41,273. Today, at 8 cents per kWh, that same compressor costs $110,062 to operate every year, or more than a half a million dollars over five years. After a detailed compressed air demand assessment, it is determined that the fluctuations were within the control range and averaged 35% less than the full capacity of the compressor and the factory had inadequate storage. In this case, switching to a properly sized VSD compressor could potentially save this facility $38,521 annually or more than $192,000 in five years, if the current conditions remain similar over that time period.

Combine these savings with the greater efficiency that is realized when you replace older equipment with newer, more efficient machines and the return on investment with many of these installations is often realized in less than two years. Not every installation can yield this kind of payback, that is the purpose of a professional air demand assessment and proper compressor selection, but for sure…it is worth the consideration.

In summary, by varying output to meet compressed air demands, manufacturers who choose a properly sized VSD compressor as part of their infrastructure can realize immediate energy savings that will only compound over time.

are readily available to assist users in recommending the proper equipment to meet your compressed air needs. CAGI's mission is to be the united voice of the compressed air industry, serving as the unbiased authority on technical, educational, promotional, and other matters that affect the compressed air and gas industry.

For more detailed information about VSD technology applications, compressed air system audits or answers to any of your compressed air questions, please contact the Compressed Air and Gas Institute. The Compressed Air and Gas Institute is the united voice of the compressed air industry, serving as the unbiased authority on technical, educational, promotional, and other matters that affect compressed air and gas equipment suppliers and their customers. CAGI educational resources include e-learning coursework on the SmartSite, selection guides, videos and the Compressed Air & Gas Handbook. For more information, visit the CAGI web site

So technically, how does it work?

The VSD concept simply measures the system pressure and maintains a constant delivery pressure within a narrow pressure band. This is achieved by regulating the motor speed of the compressor by frequency conversion, which results in a varying air flow delivery. With today's advanced VSD electronic controls, the delivery pressure is kept within a + 1.5 psi band - this is another benefit of systems with a VSD compressor; systems with all fixed speed compressors typically have a minimum a 10-15psig pressure fluctuation. Therefore, a lower air compressor delivery pressure can be used to maintain the required minimum working pressure of the system -- which results in increased energy savings and profitability. Remember, for every 2 psi reduction in pressure, power consumption is reduced by 1 percent. That's more than a 6 percent energy savings just due to the lower operating pressure often made possible by having at least one VSD compressor.

The inverter in the VSD system performs a "soft" start operation by ramping up the motor speed, thus eliminating amperage draw peaks that are typical when a fixed speed motor is started. Power companies usually will impose penalties for these amperage peaks in the form of higher rates. The soft starting utilized by a VSD compressor also helps protect electrical and mechanical components from the starting mechanical stresses that can shorten the life of an air compressor.

In all cases, it suggested that the plant consider a compressed air system audit to best match the production compressed air equipment to the plant compressed air demands. This would also highlight potential production events that could be impacting the compressor system efficiency. (figure 4)

Figure 1: VSD inverter

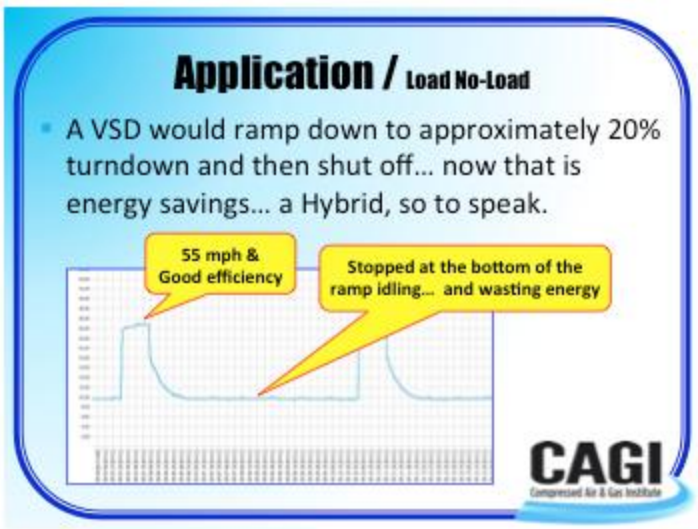

Figure 2

A closer look at this scenario and using a “car on the highway” analogy, we can see that the loaded time (55 mph) is approximately 20% of the time and… the unloaded (Idling time at the bottom of the ramp - stop light) is approximately 80% of the time. At this particular facility, the unit ran this way 5 days a week 50 weeks per year. Big energy wastes resulted.

Solution: A properly sized VSD would ramp down to approximately 20% and then turn off (a Hybrid so to speak). Also, VSD compressors virtually have unlimited starts per hour due to the low inrush current (Starting Amps) when starting and ramping up to operating speed. They can also start under load and the air-oil receiver tank does not have to bleed down, that is additional savings because you don’t have to fill the air-oil receiver tank every time the unit starts. Due to this low inrush current, low or “no” current peak demand costs are also a fact.

The Technology is fairly simple; in the illustration above, the Air Net (1) is requiring more compressed air the Pressure Sensor (2) senses the drop in pressure and sends a message to the unit Controller (3) and the controller sends a message to the Frequency Converter or Inverter (4) to speed up the compressors Variable Speed Drive Motor (5) which drives the compressor element to add more Free Air Delivery (6) back into the system’s air net.

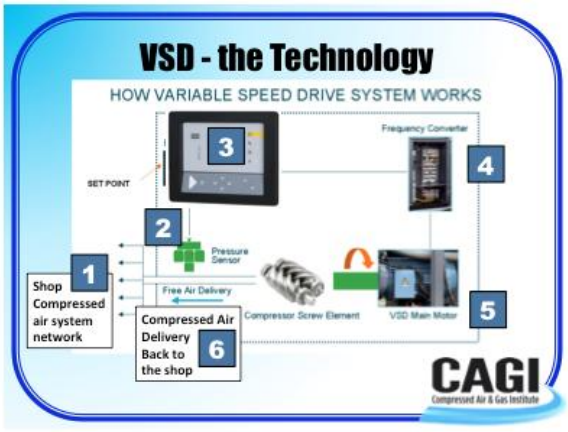

Figure 3

Figure 4

For more information, visit the [CAGI web site]

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