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Compressed Air & Gas Institute

TECHNICAL BRIEF

Technical Brief on Variable Speed Drive

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 (VSD) compressor.

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 occurs, the air compressor output capacity must be regulated or stopped. With units 15 hp or larger, it is not recommended to stop and start the air compressor motor several times an hour throughout the day, so a form of inlet control regulation is required. Whether you run the unit with a load/no-load control (inlet valve fully open (loaded) or inlet valve fully closed (unloaded) with bleed-down) or with a modulation control (throttling the inlet valve) to accomplish a partial load operation, these control systems may not be the most efficient way to operate the compressor.

Operating a car provides a very good example. Highway driving is similar to full-load operation of a compressor. When you exit the highway, you go from highway speed (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 stoplight. As the light turns green, city driving begins and brings a very fluctuating ride, starting and stopping, but idling at every stoplight. Similarly, a compressor that faces a varying demand . . . city driving . . . cannot operate at full load but must respond to the widely fluctuating demand by stopping, starting, or restricting its capacity while all the time keeping the motor running at a constant speed. This is similar to a car idling at a stoplight. Now, think of your car sitting (idling) at stop signs and lights for 60 to 100 hours per week, which is how many air compressors operate.

Properly sized VSD 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 slows down the motor and lowers the delivered air flow as well as the electrical power consumption. The change in delivery and the change in energy consumption vary in a direct relationship and are largely linear in proportion. This reduces energy consumption to a minimum when fluctuating demand is the norm. Due to the low in-rush current inherent in VSD motor designs, VSD motors can tolerate several cold starts per hour without overheating as would be the case with a fixed-speed motor. Accordingly, some VSD compressors will stop at the lower compressed air demand vs. idling in an unloaded condition, virtually eliminating energy-wasting idling time.

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 to 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.

Energy costs, already on the rise in recent years, have garnered the attention of facility managers who are continually charged with finding new ways to cut costs. Many corporations have instituted "green" policies with aggressive annual energy reduction targets. In addition, many local municipalities and state utilities offer rebate incentives for energy saving, compressed air solutions, for which VSD technology qualifies.

Consider the situation where a manufacturer operates a single 200 horsepower air compressor. The facility operates 24 hours a day and has widely fluctuating air demand amongst shifts. When the compressor was purchased, power cost was $0.075 kWh. Over the last 5 years, these costs have increased to $0.12 kWh with additional increases on the way. The annual cost to operate that compressor at 7.5 cents per kWh was $103,184. Today, at 12 cents per kWh, that same compressor costs $165,094 to operate every year, or approximately $825,000 over five years. After a detailed compressed air assessment was performed by a compressed air professional, it was shown that the average system demand averaged 65% of the full capacity of the compressor and that the maximum demand never exceeded 90% of the full load compressor rating. For this operation, upgrading to a properly sized VSD compressor could potentially save this facility $33,019 annually or more in energy costs, if the current conditions remain similar over that time period. That is a 5-year savings of $165,095.

Combine these savings with the greater efficiency that is realized when you replace older equipment with newer, more reliable 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. The best way to begin your quest for efficiency upgrades to your existing compressed air system is to hire a trained, compressed air professional to perform a compressed air system assessment upon your system. Armed with the data that this assessment will deliver, you can determine if an upgrade to VSD compressors provides the efficiency, reliability, and payback that you desire. In summary, manufacturers who choose a properly sized VSD compressor as part of their compressed air system can realize significant and immediate energy savings that will only compound over time.