Technically Speaking: Variable-Speed Motors

by Eric Herman

Variable-speed-drive pump and motor technology has changed the way the pool and spa industry thinks about energy efficiency. Gone are the days when builders, servicers, pool operators and homeowners had only one, two or perhaps three speeds available to power circulation systems.

With the advent of variable-speed-drive technology, the pump rpm can be set to achieve maximum energy efficiency, and the question has become just how much homeowners and commercial pool operators can expect to save by switching to this new generation of pumps and motors.

That now-familiar success story is going a step further. In the past two years, motors using VSD technology have become available that are designed to be installed as replacement motors on traditional pumps as a convenient and affordable way to achieve similar savings as those afforded by VSD pump/motor combinations. That is, the existing impeller and water section of the pump is still used when upgrading the system using a VSD motor and time clock controller.

The Big Picture

According to Gary Gockel, CPO and pool energy efficiency contractor, when considering the overall size of the swimming pool market in states such as California, the advent of VSD technology represents a tremendous opportunity to both save money for pool owners and ultimately reduce the burden on utility companies to meet increasing power demands.

“There are approximately 1.5 residential pools in California using 7.4 percent of the state’s electricity,” Gockel explains. “That’s about the same as the amount of power used for residential air conditioners, or the same as the output of about six medium sized power plants. When you take into account the level of savings that can be achieved using variable speed drive motors and pumps, it’s easy to see just how much difference our industry can make. A big part of our challenge now is convincing utility companies and regulators to embrace the ‘VSD motor only’ replacement technology and partner with the pool and spa industry in our efforts to reduce the energy demand.”

Recognizing that potential, motor manufacturers have made VSD motors available and are working to educate the industry about their use and potential benefits. “So far the concept is being met with great success,” says Ken Osborne, national sales manager for Century Electric Motors (formerly A.O. Smith), an electric motor manufacturer based in Tipp City, Ohio, a division of manufacturing giant Regal Beloit. “As the industry becomes aware of the product and its capability, interest and applications are growing. We anticipate even greater growth as we move forward.”

The concept is relatively simple from an applications standpoint. “It takes an input command and operates at a given speed,” explains Osborne. “By reducing the operating speed of the motor and pump, you greatly reduce energy consumption and can enhance overall system function lower motor temperatures and lower system pressure.”

“In general, these products are great,” affirms Gockel. “The VSD motors now give us the ability to calculate savings and then provide those savings to pool owners without altering the plumbing entire system. They’re

particularly useful for basic everyday residential pools and some commercial pool systems."

Calculating Savings

Savings derived from VSD pumps and motors are based on the pump affinity law, which states that when you reduce the impeller rpm by half, you cut the power consumption, typically measured in kilowatt hours, by seven eighths.

In other words, although there's a linear relationship between rpm and flow in terms of gpm – reducing the rpm by half also halves the flow – the reduction in power consumption is cubed. In effect, when the rpm and resulting flow are reduced, the turnover will naturally be slowed by the same rate, which means the system will generally need to run double the time. But even with the system running twice as long, the affinity law indicates that you'll still achieve a 75 percent reduction in energy use.

Advocates of the technology are quick to point out, however, that actual savings and the return on investment for the motors vary dramatically depending on a range of factors. Explains Osborne, "If you take a pool in the Midwest, where energy prices are relatively low, and the pool operates only a few months each year, the payback in savings is going to be slower when compared to the same pool in California, Arizona or Florida, where the energy costs are much higher and pools run year round. In the latter scenario, you could be looking at a payback within less than a season.

"It's fair and reasonable to say that up to 80 percent savings and potentially greater can be achieved simply by changing the motor. But not to mislead," he adds, "this is attainable, but it also depends on a variety of other factors."

Gockel is quick to point out that while those levels of savings are commonly achieved, the rest of the pool system plays a role, including the efficiency of the plumbing scheme, resistance from suction and return fittings as well as the type and condition of the filter and how dirty the filter might be at a given time.

"There are several factors that need to be determined when upgrading a pool to be more energy efficient," he explains. "Primary are gallons of the pool and secondary, the flow rate. While there are several ways to establish what the flow rate is, I like to include a flow meter on each pool upgrade, which I use to determine what the existing conditions are and then again when setting up the system. Knowing the pool gallons and dividing by the flow (set at about 30 gpm) equals the daily minutes of pump operation. This results in a normally acceptable pool turnover of once per day for a residential pool at the lowest cost to the client."

(He adds that flow meters are a great way to gauge when it's time to clean or backwash the filter.)

To verify energy savings possible in a VSD replacement upgrade, Century partnered with the Foundation for Pool and Spa Industry Education (FPSIE), to provide data for the organization's training and to present demonstrations of the technology as an energy conservation measure to utility companies, including Pacific Gas and Electric and the Sacramento Municipal Utility District.

The findings of the study, indeed, verify dramatic energy savings: In one example, a system running with a standard induction motor 5 to 6 hours per day, 1,983 hours per year, used a total of 2,895 kWhrs at a cost of $868.55. Under the same conditions, using the Century V Green motor, the system used only 953 kWhrs costing $285.55, a savings of $585.60.

Note: The Independent Pool and Spa Service Association also conducted a recent study of multi-speed pumps and motors, which revealed similar levels of savings associated with reduction in motor speed.

Multiple Benefits

Underlying those measurable savings, replacement VSD motors offer other basic advantages:

Replacing just a motor instead of the entire pump/motor combination generally results in less work and aggravation at the equipment pad because nothing needs to be re-plumbed. In terms of installation time and effort, switching out a standard motor for a VSD model is not much different than replacement with a standard motor, save the need to adjust the motor speeds, set the motor and set the time clock.

Currently, the VSD motors like the VSD pumps only come in 230-volt models, meaning that some rewiring of the electrical service may be required. And, you do have to select either a C- or square-flange motor mount to match the existing pump. Manufacturers are offering motors designed to work with pumps ranging from ¾ horsepower to 3 horsepower (2.7 in the case of the Century V Green motors).

In addition, variable speed pumps and now VSD motors usually are quieter.

The upshot: The technology can now be used with a vast majority of residential pools as well as commercial vessels that use National Sanitation Foundation- approved residential-grade equipment. According to Gockel, the health departments he's worked with do not usually object to the use of the VSD motors. "After introducing the product to them, they basically see it as a maintenance issue," he says. "So long as you're achieving the six-hour turnover or better, aren't altering the hydraulic system (the existing impeller is used), and have keypad lock-out, they don't seem to be concerned with the motor technology."

Another benefit comes in the ability to precisely adjust flow rate to maximize performance of other system elements. If, for example, homeowners or pool operators are looking for a faster turnover rate to improve overall cleanliness, they can simply turn up the rpm. "You can fine tune the system and not only achieve significant savings in energy costs," explains Osborne, "you can also maximize system performance in terms of water quality."

Yet another plus that might come as a surprise to some: VSD systems can offer a huge assist when setting up waterfalls or fountain elements. "Typically you'd use valves to throttle down the flow for a waterfall," explains Gockel. "In that scenario you've essentially got your foot on the all the way down on the gas and you're using the brake at the same time. With this technology you can now adjust the flow at the motor, achieving the exact flow you want without wasting all that energy."

With all of those advantages in mind, it's likely that the future of VSD technology will include increasing use of the variable speed motor/controller only option in addition to the continued growth of factory motor/pump combinations.

Installation and Service Recommendations

The service life of VSD motors and their controllers are impacted by a number of practical considerations which also apply to standard motors. Failing to observe these basic measures can (and often will) greatly reduce the life of any motor, be it single-speed, dual or variable.

- Install the equipment on a secure and level platform or base such as a concrete pad.
- Protect against heat: Shade the motor/control from the sun, provide ample cross ventilation and protect the motor/control from lint or anything that can clog the ventilation openings.

- Protect against dirt: Keep the motor/control and surrounding area clean, avoid sweeping or stirring dust near the motor/control while it's running and avoid storing or spilling dry chemicals near the motor/control.
- Protect against moisture: Provide protection from rain, snow, etc.
- Do not wrap the motor/control with plastic or other air-tight materials.
- Locate the motor/control on a slight elevation so water will not run or puddle nearby.
- Avoid splashing water on or near the motor/control.
- Repair leaky pipe joints or pump seals promptly.

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