Smart submersibles: The new generation of constant pressure systems

BY JOHN VASTYAN,
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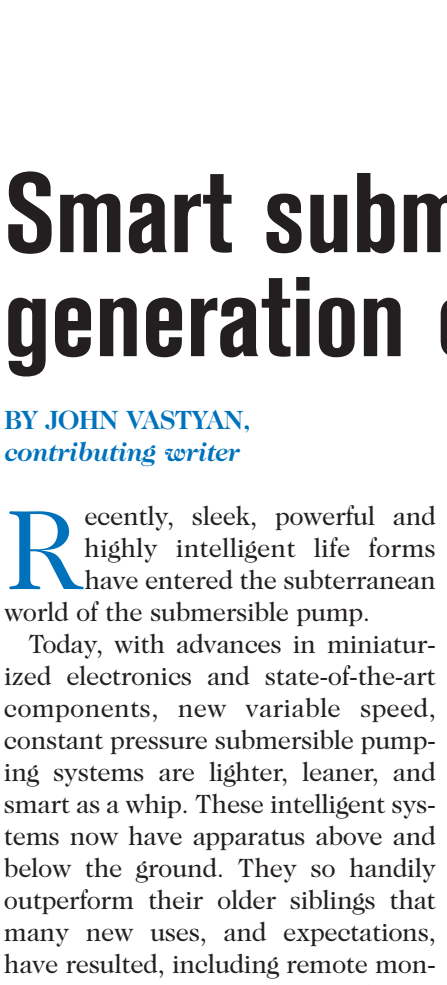
Recently, sleek, powerful and highly intelligent life forms have entered the subterranean world of the submersible pump.

Today, with advances in miniaturized electronics and state-of-the-art components, new variable speed, constant pressure submersible pumping systems are lighter, leaner, and smart as a whip. These intelligent systems now have apparatus above and below the ground. They so handily outperform their older siblings that many new uses, and expectations, have resulted, including remote monitoring, control and diagnostics from a PC within a home or facility, or 5,000 miles away.

Though, with new technology in the driver's seat, broader use of these systems is spurred by a simpler need. It's called consumer demand. No doubt all of us have seen and been affected by some facet of the astounding push for bigger, better homes with amenities like radiant heat, granite counter tops and spacious walk-in showers with water-guzzling plumbing fixtures.



The new, low horsepower constant pressure systems come with most of the components you will need.

The pressure transducer maintains constant pressure by giving the controller a pressure signal that's used to increase or decrease the speed of the pump to sustain a constant, preset pressure in the 3,000 to 10,700 rpm range for gradual build-up or slowing-down of the motor for continuous maintenance of a desired pressure.

Though admitting they still install plenty of the traditional, single-speed submersible pumps, Chris Myers, Myers Brothers Drilling, based in Salunga, Pa., said that, just a few years ago, he had to be in a "sales mode" to move a homeowner or builder toward constant pressure, variable speed, or "VFD" (variable frequency drive) technology. That's changed. More frequently today, the need is asked for, or simply required by the nature of a home's or commercial system's call for higher volumes of water, or the need for steady water pressure.

"As installers, our needs are pretty simple," said Myers. "We want highly reliable systems and the ability to install them quickly. Over the past decade, the pace of our business — in response to the building industry boom, and the need to provide new or improved well systems at existing homes and businesses — has been running at full tilt. None of us like the late night or New Year's Eve 'no-water' call. That's why we developed a recipe that works, with components that will last a long time."

These new, 1/3- to 1 1/2-hp submersible pump systems — such as the SQE system by Grundfos, the pump of choice for Myers Brothers — are designed to provide constant pressure by varying the speed of the pump motor. When there's a demand for more water, the pump's control operates it at a higher speed. When the demand for water lessens, RPMs are reduced. The technology isn't new; VFDs have been used for years for a broad range of industrial applications.

All torqued up?

In the water well business, a key advantage to variable speed systems is the reduced wear and tear on the electric motor. Gone is the furious, high-revolution starting-operation-stop cycle. The traditional well pump, still sold in great quantities today, bears the brunt of that punishment day in and day out, jumping from zero to 3,500 RPMs in a flash. The motor is hit with a start-up torque demand, stressing every component in the impeller assembly.

With variable speed pumps, that brutal cycle is replaced with a gentler, soft start, slower-to-higher RPM rhythm that ramps-up smoothly, and winds-down just as gently when the need for water is satisfied. Mechanical torque and in-rush currents are eliminated. Yet the Grundfos SQE has a high starting torque, even at low voltages. You get the best of both worlds.

VFDs use only the amount of power that's needed. This also adds to the life expectancy of the pump. Typically, traditional pumps tend to last five to 10 years or more. A variable speed system should last substantially longer. And because these systems are rarely running full-tilt, meeting the demand at slower speeds, there are considerable energy savings for the home or building owner, a benefit that shouldn't be ignored.

With the variable speed, 3" SQE pumps, you can set limits of 10,700 RPM at the high end and 3,000 RPM at the low end. For higher demand applications, you can set them up in parallel format to operate in a lead-lag fashion. This way, if a single pump meets the desired pressure, that's the way it'll go. But if the demand increases, pushing the need beyond the first pump's ability, the second pump jumps in to run at whatever RPM is needed to hold the pressure within the system.

Another advantage to the new, low horsepower constant pressure systems is exactly that: they're systems. Meaning that they come with many more of the components you need to get the job done. For those of you who learned how to do these jobs piece by piece — and naturally have some pride in knowing what to choose, and how best to assemble them — this might take a little getting used to.

"We found it pretty easy to let go of the old way of doing it," added Myers. "Before, we'd have to assemble and connect low water and voltage spike protection devices. That's now included in these pumps. There are also many other safety devices built in as well, such as dry run and under-voltage protection."

But according to Dave Heikes of Pompton Plaines, N.J.-based Morris Industries, Inc., one of the largest privately held suppliers of water well equipment and environmental products — a supplier whose job security rests on his familiarity with well water, drilling and environmental monitoring technology — one of the best devices, part of these new systems, is the pressure transducer. "Gone is the old, stupid, on-or-off pressure switch," he said with a chuckle (see photo).

"The pressure transducer assures that constant pressure is maintained," added Heikes. It does this by giving the controller a pressure signal that's used to increase or decrease the speed of the pump to sustain the constant, preset pressure. "It operates the pump in its range of 3,000 to 10,700 rpm, permitting gradual build-up or slowing-down of the motor for continuous maintenance of, say, 60 or 70 psi, plus or minus 3 psi. This is one of the reasons Myers doesn't have to go into his 'selling mode' quite so often. Homeowners are usually pretty happy about not having the wild

swings in pressure you can get with basic well pump systems.

"The motor accomplishes the soft start because it's permanently magnetized," continued Heikes. "This is a huge benefit because there isn't a big amp draw to kick-start the motor. This type of operation replaces the old, 40- or 50-pound system with a differential of 20 pounds that ramped up fast to add volume into a much larger holding tank . . . then died . . . to start the cycle all over again."

Heikes referred to another advantage of the constant pressure systems. At one of the Pennsylvania homes, they replaced an old, single-speed pump with one of the new variable speed systems. A free-standing, 20-gallon storage tank was replaced by a much smaller, two-gallon tank that was hung on the wall. This was quite a space saver in the basement mechanical room.

Eliminating the much larger pressure tank also translates to a substantial cost savings on the front end, certainly helping to offset the higher cost of the more sophisticated constant pressure system.

Another change made at the home where an old, single-phase pump was removed was the need to shorten the depth of the pump. The well was 450' deep, and the pump rested at 425'. Myers explained that he could have lowered the new, 1 1/2 hp SQE to the same depth, but to avoid a voltage drop that would have required a heavier gauge power cable, bumping-up the romex to a #8 wire, something he and the homeowner chose not to do. Because the well source was quite strong, delivering 21 gallons per minute, with a stream that entered the well at about the 430' mark, there was no concern about raising the pump 50', conceivably reducing the amount of water that could be pumped from the well.

Myers also took into consideration the 80' distance between the well head and the basement. The water and electric lines were trenched, about five feet deep, straight to the house, entering the basement wall where they mounted the new control box and manifold.

At the new home in Lancaster, Pa., about 20 miles away, the homeowners had a list of home system prerequisites "a mile long," according to Myers. "They'd been researching all aspects of their new home for years," he said. "And there on the list was a section labeled 'Domestic water system.' Under that were a few items having to do with the well, including the name of our firm. That felt good. Also on the list, they had 'steady water pressure for six bathrooms, Jacuzzi and garden watering.'

"Fortunately, the home's well, which we dug to 350', hit a pretty good supply of water," added Chris Myers. "The 5,000-square-foot home would have three active bathrooms immediately, and three more were planned for the basement that they planned to finish in a few years. The SQE was a perfect match for their need, and they didn't flinch at the cost difference between a standard pump, and the constant pressure system. It met their needs exactly."

Big power, small package: The Grundfos SQE submersible pump with VFD technology provides all the water the homeowners need for their 5,000-sq.-ft. home that eventually will feature six bathrooms.

"Kathleen and I have been in the house now for a few months," said Douglas DeAngelis of the new home he and his wife moved into shortly after Myers and his crews finished the well, and pump installation. "We're very impressed with the system. I really appreciate the level of control we have, but what we enjoy most of all is the steady flow of water, and the incredible pressure it delivers. We know we made the right decision to have it installed."

As a retired aircraft mechanic, DeAngelis is no stranger to technology. He asked many questions about the well water system that Myers Bros. recommended.

"I was amazed at how quickly he was up to speed on it," said Myers. "He understood everything almost immediately, and when we were done talking about it, he was completely satisfied with our explanations, and the system we recommended."

DeAngelis was there the day Myers Bros. drilled the well, and then later when they installed the Grundfos system. "We have a structured wiring system within the home," explained the homeowner. "That becomes the backbone for a complete home automation system. It will connect the fire, security, home computing, HVAC, music and video systems. And now, once we've got it all set up, we can add the well water system to it. We'll be able to monitor and control all of the home's connected systems from the main PC at home, or even from a laptop in my hotel room if I'm away."

Though home automation hasn't yet become mainstream, constant pressure well water systems are quickly moving in that direction. There's some truly brilliant engineering in this technology, much of it tailored to the needs of professional installers. Additional protection and application features are designed-in by some manufacturers, offering installers the flexibility to adapt the pump to many different applications. The small horsepower Grundfos FVD line, for instance, includes two pump system models: the standard SQ for traditional pressure switch operation and the more advanced, constant pressure SQE. Both models offer five flow sizes from 5 to 30 gpm and a horsepower range of 1/3 to 1 1/2 hp.

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How unique are the SQ or SQE systems?

I MUST ADMIT to being impressed by the Grundfos VFD technology. So I poked around, asking: "How unique is it, really?" Currently, there is no competition for the SQ systems at the lower horsepower motors most commonly used for residential purposes. The SQE provides constant pressure systems from 1/3 to 1 1/2 hp.

The technology closest in capability the Franklin Electric SubDrive system, but these drive either a 1 1/2 or 3-hp motor. And, all other VFDs worldwide are of the non-integrated type, meaning that the VFD electronics reside in a separate enclosure located at the well head, in a mechanical room area or basement, and drive a conventional motor. Thus far, Grundfos is the only company to squeeze down the VFD electronics, integrating them within the motor enclosure.

This offers some key advantages. By their nature, VFDs generate heat. Non-integrated systems contain cooling fans and substantial heat fins, tasked with the need to dissipate the heat, and heat destroys motor components and spells death to submersibles. So, components must be fabricated and sized to handle the high temperatures.

The stroke of genius by Grundfos, with its integrated SQE, is that the system is constantly bathed in cool ground water. In this cool, continuously refreshed aqueous environment, they could eliminate the cooling fan, greatly reduce the size of the heat fins, and use smaller, more efficient electronics. And, by installing the VFD in the motor, other possibilities open up that can't be had with non-integrated system.

Unlike induction motors, the SQE's soft start permanent magnets aren't at all affected by the number of start/stop cycles. They're oblivious to it. The maximum inrush current is the same as the full load current. The whole issue of inrush current dissolves with this motor design. And in almost all water well pumping scenarios, energy consumption by VFD systems equal that of the more traditional CPVs. And, with the integrated VFD design, there's less opportunity for RFI, or radio frequency interference.

Essentially, the VFD circuitry is classified as a computer. Grundfos puts the power to use by equipping the motor with sensors that detect and prevent damaging operating conditions. This extends the life of the pump and motor. Also, sophisticated diagnostics are built in, allowing levels of troubleshooting and interaction that simply aren't possible with non-integrated systems.

There are five sizes in the SQ/SQE line, all at 3" diameter; with discharge sizes of 1", 1 1/4" or 1 1/2"; and flow rates of 5 gpm to 30 gpm.

— *John Vastyan*

Submersibles with intelligence provide steady water flow

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Both the SQ and SQE incorporate the following common features: dry-run protection, protection against up-thrust, soft-start, over-voltage and under-voltage protection, overload protection, over-temperature protection, and high starting torque, comparable with three-wire motors. Additional benefits of SQE pumps include constant pressure control, variable speed regulation and electronic control and communication.

The "smart" motor communicates through the power leads into the CU300 microprocessor-based status box. (Noting that it's not necessary to run any additional wires down the well.) Through its communication with the pump, you achieve constant pressure control and the ability to change and monitor pump performance.

And, referred to earlier by Heikes, another of the key advantages to this new technology is an electronically controlled permanent-magnet motor. This state-of-the-art technology allows the pump to start-up without drawing high amps, unlike a conventional induction motor. And the pumps use single-phase power and a simple two-wire design, while providing starting torques comparable to 3-phase motors.

Yet, the "higher life form" comes with a few caveats:

1. One of them is the need to be sure that an above-ground, non-integrated VFD, sold by some manufacturers, isn't located too near existing (or later) electronics. The unit's drive components do create electrical noise. Some sensitive electronic equipment — such as high-speed modems, or internet system servers — shouldn't be within five or six feet of them.

Certainly, that's one of the strengths of the Grundfos system. The harmonics issue — electrical noise — virtually disappears when the VFD is put down in the well with the motor. Radio frequency interference is for all practical purposes eliminated.

2. Remote, non-integrated VFDs can be at risk in harsh environments such as the factory floor, or in an unfinished basement. To protect them, there may be the need for costly air conditioning or air filtration systems.

Grundfos solved this, too. Because their VFD is integrated into the submersible motor, it is beyond the reach of dust and heat, both known VFD predators. In the well, the integrated VFD is cool, wet and dust-free.

3. And, because these more sophisticated systems rely on computer electronics, they keep an electrical charge — possibly up to several hundred volts stored in capacitors. So, when servicing them, it pays to be cautious. It states clearly in the instructions: wait at least 15 minutes after powering-down before opening the unit to do repairs or diagnostic work. The SQE is sealed, so it won't be affected by this.

4. And, finally, because the system is more expensive (about a 40% increase over a conventional installation), installers are encouraged to add lightning/surge protection. Sounds like a good investment to me.

Pumps with one 1-hp motors, or less, often have this protection built-in. But this should be verified with the supplier. Even with that, installing redundant lightning/surge suppression on any pump is not a bad thing. And, in some instances, a lightning arrestor may be required to protect the pump. The arrestor should be wired to the line conductor and back to the electrical grounding system with No. 6 AWG copper wire, or a heavier wire or cable (but nothing lighter than that). In some power supply circumstances, the electrical grounding is connected to steel well casing. It wouldn't be a bad idea to check with an electrical inspector on that one.

At the home where Myers installed the replacement pump system, an electrician was on hand to complete the job. He installed a small (3"×4") SyCom 120/240 single phase, 150,000 amp surge current suppressor on the line side of the well pump control, protecting the pump and control unit from common, everyday voltage variations.

A free-standing, 20-gallon storage tank was removed in favor of a much smaller, two-gallon tank that was hung on the wall (blue tank in background), saving space in the basement mechanical room and saving costs on the front end.

This was also a good idea because the homeowner had installed an LP gas fired, 15 KW whole-house, backup generator. Though its output was said to be smooth, it increased the chance of electrical spikes. With the SyCom unit in place, the well water system was safeguarded, and only a direct lightning strike at the well would overwhelm it. And we all know there's not much we can do about that one.

But what you can do is offer the very best expertise, advice and equipment to your customers. "The SQE is a definite win-win for us," concluded Myers. "We've put them to the test, and watched them perform for years. We're confident that it's the best system out there. And no late night wake-up calls." ■

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The future is here

When checking operation of a well water system, what you need is information. And the sooner the better. Today's technology — thought to be futuristic just a few years ago — can make that happen, whether you're on location, or thousands of miles away. I've looked everywhere to include news about all of these high tech problem-solvers and, amazingly, find that (again) Grundfos is the leader in offering sophisticated electronic data monitoring and configuration features.

For their SQE pumps, Grundfos offers both the CU300, and the more advanced CU300 control units. The CU301 was developed for control and operation of the SQE submersible pump via user-selected external sensors.

Two analog sensor inputs and one digital input are provided for controlling pump operation based on signals from external 4-20mA, 0-10vdc or dry contact sensors. Some typical applications are constant water level maintenance, float switch control or PLC control. The CU300 is supported by optional software tools designed to provide local or remote computer access to the CU300, displaying pump performance and offering control and configuration capabilities.

With the electronic control unit, even when the needs change, it's easy to make adjustments. A simple push of the button will start, adjust, re-set or stop the pump. And, with sensors installed, the water table and cost per pumped volume of water can also be monitored.

And, there's also the R100 infrared remote. Dave Heikes had one of these with him at the Lebanon, Pa. home (retrofit) where Chris Myers was swapping-out the old for the new. This handheld, wireless troubleshooting tool permits the installer to communicate with the CU300 or CU301 to interact with and retrieve important pump and performance data and diagnostics, as well as to change both field-set and factory-set system parameters.

Because it communicates with the control unit via infrared light, it must have visual contact with status control box.

Here are examples of some menu screens you can access with the R100 infrared remote: