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Inspire the Next

A good time to upgrade irrigation systems

Variable frequency drives save energy, time, and money

On December 20, 2018, the US government announced it would help farmers implement more efficient irrigation systems with financial and technical support. As part of the latest Farm Bill, the Environmental Quality Incentives Program, or EQIP, is intended to improve water and air quality, conserve ground and surface water, reduce soil erosion, improve wildlife habitat, and protect against drought. EQIP is projected to spend $19.3 billion over an 11-year period.

Efficient irrigation is sought

Irrigation is estimated to use 118 billion gallons of water per day by the United States Geological Survey, second only to water used for thermoelectric power supply. Efficient crop irrigation is more than an engineering challenge, it is an economic challenge, too – the demand for water is beginning to exceed supply. Up to half of the water used for irrigation is lost to evaporation or in transit, by a leaking pipe. Government policy supports the building of modern, sustainable water supply systems to improve crop production, conserve water and maximize the population's overall investment in agriculture.

Farmers are under pressure to increase crop production while balancing more efficient use of energy and water resources. The EQIP initiative provides financial assistance to help plan and implement practices that address these resource concerns — including more efficient irrigation systems.

An estimated $670 Million will be spent in North America alone for Variable Frequency Drives (VFDs) in pumping applications. There has never been stronger demand for the technology that enables efficient irrigation solutions. For many farmers, now may be the best time to upgrade from traditional fixed speed systems to a VFD controlled system.

Many farmers know that traditional water supply systems are either turned on or off. VFDs are electric controllers that vary the speed of the traditional irrigation pump, allowing it to respond smoothly and efficiently to fluctuations in demand. A properly installed VFD eliminates the need for throttling or restrictive devices, and minimizes use of valves, outlet dampers, inlet vanes and diffusers that can waste energy.

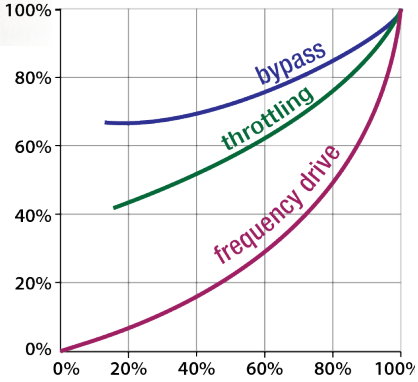
With so much riding on irrigation, farmers are naturally looking for systems that help them maximize their output, deliver consistently optimized irrigation levels to crops, and are automated and simple to operate.

A system curve displays centrifugal pump efficiency

The best way to see the difference between a system with a fixed speed pump and a VFD is to compare the pump system curves of both methods. Pump engineers use a pump system curve to determine a pump system's ability to describe what flow will occur at a certain pressure.

A pump curve is a graph showing a pump's ability to provide flow against head, or head pressure. Flow, or the rate of water volume delivered, is measured on the horizontal (x) axis of a pump curve. Head, which is pressure or resistance, is indicated by the vertical y axis and measured in distance (e.g., feet) or pressure (e.g., pounds per square inch, PSI). Pressure head includes static head, which is the vertical distance between the water source and the delivery outlet, and friction head, which is the resistance to flow caused by pipe, valves, bends and any other device or obstacle in the piping. Pump manufacturers recommend the proper pump system configuration for a particular job taking into account impeller size and necessary pump drive output.

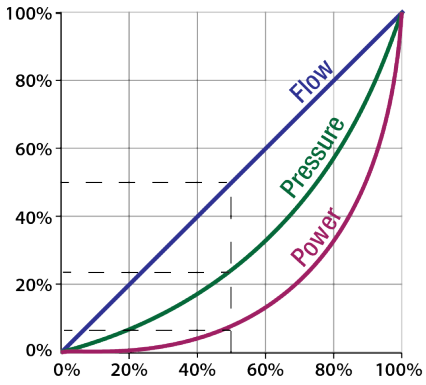
Here is an example comparing a centrifugal pump powered by a 2-horsepower pump motor with a 7½" impeller. One system has a fixed speed drive and the other has a variable frequency drive.



On the **system curve 1A** (shown above), a single performance curve shows the pump performing at a fixed speed. Fixed speed pumps draw nearly full horsepower consuming maximum energy full time, regardless of demand. When water is turned off using a valve, only the flow is blocked, the power is continuously on full speed. Flow is blocked and the system runs dry, until the valve is opened, and flow is provided again.

The effect of the speed of rotation and size of impeller may be described by the Affinity Laws, a set of formulas that predict the potential load requirements and energy output for a specific application:

1. **Reduced speed reduces flow or volume proportionally. Since flow varies linearly with speed, a 50% decrease in speed means a 50% decrease in flow.**
2. **Pressure or head varies as the square of speed. At 50 % speed, there is 50% flow, but only 25% pressure.**
3. **Power requirements vary as the cube of speed. At 50% speed, there is 50% flow and 25% pressure, but only 12.5% power.**



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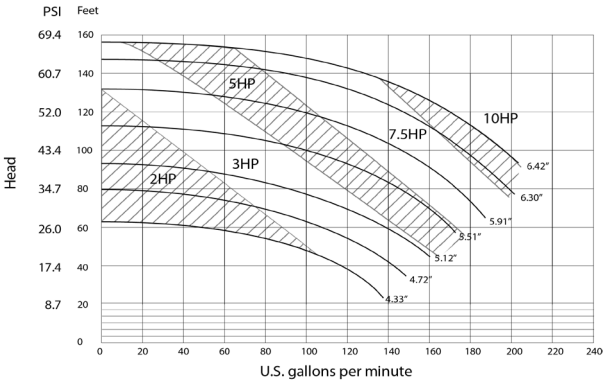

On **systems curve 1B** (shown above), there are a range of performance curves relating to the different speeds that are achieved with variable frequency drive. The difference here is that the variable frequency drive varies the pump speed to control the flow rate.

Varying the speed with a VFD has the same effect as installing a different-size impeller on the pump while requiring reduced power. It essentially displays a new pump curve.

Many farmers use a center pivot system of pump, piping, and water distribution components to irrigate their fields. Implementation of a VFD to control pump motors in these systems offers precise control of irrigation flow rates, while controlling these conditions as well:

- **Pipe damage that results from over pressure and water hammer in long pipe runs, potentially flooding fields and ruining crops**
- **Undetected loss of prime that results in continuously running pumps and premature motor burnout**
- **Undetected leaks in pump motor seals leading to pump failure**
- **Changing crop conditions that dictate flow/pressure setpoint changes**

Addressing these common irrigation-specific challenges make it easier for farmers to operate the irrigation system.

Losses in a valve-controlled system occur in the valve and in the additional piping required to bring the valve to a location where it can be adjusted. With the VFD, there is no valve or valve losses. With no pipe bends required for the valve, the piping losses are also reduced. With the elimination of the pipe and valve losses, a smaller pump can often be used. Users can achieve the same results—flow rates and pressure—with a lower horsepower pump. Significant savings are realized, providing additional economic justification for using a VFD.

Today's VFDs are responsive to signals from flow sensors, programmable controllers, and other control systems offering a new level of control and simplicity to farmers. When properly configured, VFDs provides users with options that can provide short- and long-term productivity and profitability improvements.

Addressing Cost

Many VFDs are built to handle a wide variety of pumping applications with capabilities beyond irrigation needs and are available at typically 20% less cost than pump specific VFD. These controllers can be controlled with specialized irrigation software that eliminates the need for extra control devices like timing relays, PLCs, etc.. With software-delivered capabilities, farmers only pay for the control panel functions they need.

Addressing Flexibility

As irrigation requirements change over time or new capabilities like Variable Rate Irrigation (VRI) are desired, a simple software update can easily incorporate new features into the control panel. No additional hardware is required in the panel and the useful life of the farmers' original investment is extended. Using software, contractors can offer increasingly sophisticated pump controls without having to buy new equipment.

Addressing Simplicity

Specialty pumps with extra hardware components add complexity that can lead to operator error resulting in wasting water and energy, and even decreasing pump motor life due to overuse. Many VFDs have a dizzying array of parameters for control that confuse the farmer making setup and operation difficult, and irrigation results unreliable. Software designed for irrigation applications can continuously monitor for seal leaks, pipe breaks, loss of prime etc. — even execute a line fill cycle that eliminates water hammer. For the farmer this means virtual push-button simplicity, lower maintenance costs and consistently optimized irrigation.

Today's farmer has many choices, along with many questions. Achieving efficient and economic farm operation is possible. With careful research, growers can optimize many tasks, and the US government is offering financial and technical support in several areas. Irrigation pumps are undergoing innovations that increase their usefulness. Among the features pump users should investigate are:

Pump Functionality — Features are specifically designed for pumping applications that minimize start-up time and provide a smooth interface for operators.

Application Support — Application engineering support is an essential resource for users before, during, and after the installation.

Using a VFD in a pumping system provides additional savings because many elements required in a valve-controlled system are eliminated or reduced without affecting the function. Further, software controlled VFDs can perform functions previously handled by programmable controllers, improving process flexibility, and further eliminating components and cost.

Selection should depend on flexibility, options, service and support critical to the business and operational success of the control system. The importance of choosing a supplier with the appropriate technical capabilities and expertise in applying VFDs solutions cannot be overemphasized.

The goal of building a modern, sustainable water supply system for improving crop production, conserving water and qualifying for EQIP support is achievable.

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