White Paper

VFD Facts: Discovering the True Potential of Smart Pump Technology

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Executive Summary

Engineers know the capabilities of variable frequency drives (VFDs)—devices that regulate electrical motors to accommodate changing loads. VFDs are used to regulate speed in a wide range of machines, including cranes, escalators and pumps. They are designed to extend equipment life and lower energy costs, but they account for only 4 percent of motor energy usage, compared to a potential of 18 to 25 percent.[1]

Virtually every industry is striving to be more energy-efficient, but with VFD usage rates significantly lower than they could be, it's helpful to review some of the top benefits of VFDs and their improvements over the years. Facts show that today's VFD technology is far better than it was even in the last decade. As with the computing industry, power electronics have improved exponentially, providing a more efficient and durable VFD for a wide range of industries.

The design and reliability of VFDs have come a long way since their introduction in the 1950s. Today, several manufacturers produce reliable and robust VFDs for industrial pumps. For example, many pumping systems that use mechanical "gate" valves can replace them with VFDs to significantly boost overall system efficiency. The basic reason is that manual valve throttling doesn't change the speed of the pump. In fact, it's similar in effect to keeping your foot a car's gas pedal while pressing the brake with the other foot.

Also, upgrades in electronics technology have made VFD circuit boards resistant to nearly every threat—including heat, dust and vibration—and the industry has even found ways to protect against lightning and electrical service brownouts.

One development that makes VFDs smarter than ever is ITT PumpSmart® Controls—which work with VFDs to enable high levels of control and protection for pumping systems. PumpSmart Controls are integrated into the drive and provide a simple and cost-effective solution for organizations that want to improve pump reliability, extend pump life, save energy and lower pumping costs. An

[1] "Motor Challenge," Office of Industrial Technology, U.S. Department of Energy

intelligent pumping system—condensed into one rugged control package—provides a plant or system economic value through increased energy savings and system cost.

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For industrial processes that depend heavily on centrifugal pumps, newer technology promises ways to optimize pump performance, extend pump life and save energy. VFD-controlled pumps play a critical role in improving processes for a wide range of industries.

Pump Control and Protection

VFDs transform electrical power to usable power for a pump's electrical motor. Their purpose is to convert a static voltage—standard North American supply voltage is 460 V at 60 Hz AC—into variable voltages and frequencies, matching the speed of an equipment motor to the needs of an application. Varying the speed of a process pump is useful in any application where demands on the pump change significantly:

- In a hotel, for example, demand for water is exceptionally high in the morning, and very low in the middle of the night.

- In a power generation plant, the need for cooling water rises and falls with the demand for electricity output by the plant.
- In a paper mill, the pumps that move paper pulp must work at different speeds depending on the quality of wood pulp and type of paper being produced.

VFDs can raise and lower a pump's operating speed by adjusting the supply voltage. Power electronics used in the VFD can change the rotation rate of a shaft turning at 3,500 RPM using the standard supply voltage, to half speed simply by lowering the voltage and frequency to 230 V at 30 Hz.

As a result, the slower pump speed reduces the load on the pump and its motor, and saves energy. In the hotel example, the ability to slow the water pumps saves energy and reduces the load on the motor and pump.

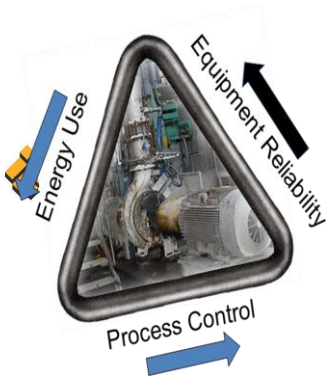
In addition to speed control, VFDs also protect pumps against spikes in voltage or current. In a scenario where a pump is binding and slowing for some reason, the VFD can shut the pump down to prevent damage.

Standard VFDs are based on power electronics, taking an input of AC current and converting it to DC and variable AC to the motor to enable basic speed control. There are many VFDs on the market, and basic models sometimes differ only by price. Common uses for VFDs include machines such as escalators, cranes and elevators.

Enhanced software and sensors—such as ITT Goulds Pumps SmartPump Controls—enable high levels of control and protection for pumps. PumpSmart Controls make VFDs more intelligent by enabling greater control and protection of rotating equipment—with key advances such as the ability to regulate flow using a control in the base drive instead of a flow transmitter, and patented algorithms that help a pump conform to changing conditions.

Fact 1: VFDs don't simply replace gate valves—they boost efficiency

For more than 150 years, pump operators have used manual valve throttling to control the flow of fluid entering and discharging from a pump. Manual or automatic valves are in wide use in industry to operate pumps at proper levels on the pump efficiency curve. Instead of changing motor speed, operators close a gate valve to reduce the load going to a pump, or the rate of discharge.



While it's easy to do, and the operator skill level required is minimal, manual valve throttling is far from the most efficient method

for changing pump flow. In simple terms, it's analogous to slowing an automobile by keeping a foot on the gas while pressing the brake with the other foot. Throttling wastes energy and reduces pump reliability, because every watt of energy that isn't needed is transformed to heat or vibration that reduces the efficiency of the pump and can ultimately damage it.

VFDs are like cruise control for pumps. By matching the power supplied to the specific demands of the application, they achieve a triple benefit—reduced energy costs, improved equipment reliability and better process efficiency.

Fact 2: Low-voltage VFDs can operate high-powered pumps

Many people assume that standard VFDs can't control pumps bigger than about 300 HP, but experience tells a different story. At the Grand Canyon recently, an ITT Goulds Pumps installation with PumpSmart Controls enabled a customer to pump water from the canyon floor to an installation near the rim. Even though the highest voltage available was 460 V, ITT was able to build the system using low-voltage VFDs, which controlled the required 800 HP pumps. Fortunately, access to medium voltage isn't necessary, because low-voltage power can be used to run VFDs for pumps up to 800 HP and even higher.

Fact 3: Reliability of VFDs has improved significantly in recent years

Some say that VFDs are electronic boxes that suffer high failure rates. This might have been true 40 years ago when VFD technology was first developed, but durability and reliability improvements to VFDs have been vast. One of the contributing factors to this myth is the "black-box mystery." VFDs contain circuit boards and other user-unserviceable parts, making some operators feel frustrated that they can't repair faulty VFDs and components with their own crews.

With today's improvements in VFDs and smart pump technology, lightning strikes may be one of the only forces likely to affect them. But the industry now has devised ways even to protect against lightning—as well as the voltage fluctuations and brownouts that happen more often in many parts of the globe. In addition, there is greater protection for VFDs in service in developing countries where grid power is less reliable.

Fact 4: Extensive piping modifications are seldom required to accommodate a VFD

Typically, there are no piping modifications required before beginning to use VFDs. In fact, VFDs work well in retrofit applications. Where the motor is the right voltage and the pump is the right size, skilled technicians can install a VFD in the existing system with little or no piping modifications.

By installing a VFD and increasing the efficiency of the pump, operators often are able to reduce the number of valves in the system as another part of saving energy, because control is maintained by the VFD, not by a control valve. In that scenario, there may be an opportunity to reduce the overall mechanical footprint of the system, but it's not normally necessary to modify piping to accommodate VFD use.

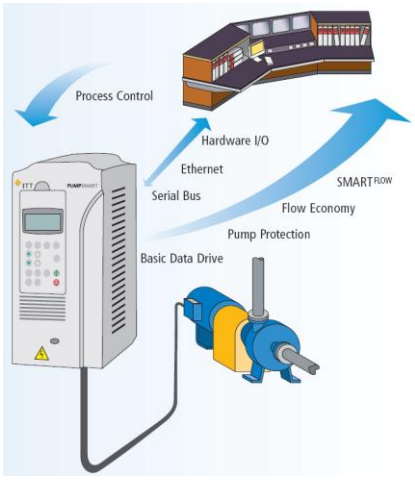
Achieving a smaller equipment footprint is a factor in many manufacturing environments. Just as consumer electronics have become smaller over the years, VFDs have decreased in size and become more efficient and more robust.

Fact 5: A full return on investment can usually be measured in months

In the early days of VFD adoption, studies suggested that a typical payback on the investment would take five to 10 years. With improved technology and rising energy prices, returns are greater.

Of course, each plant engineer may have their own goals and priorities in areas such as energy usage, control, downtime or maintenance. VFD vendors can provide calculations, based on plant load profiles and local cost of electric power, that show expected ROI rates on the VFD and its installation. Typically, VFD investments can be recouped in periods ranging from six months to two years.

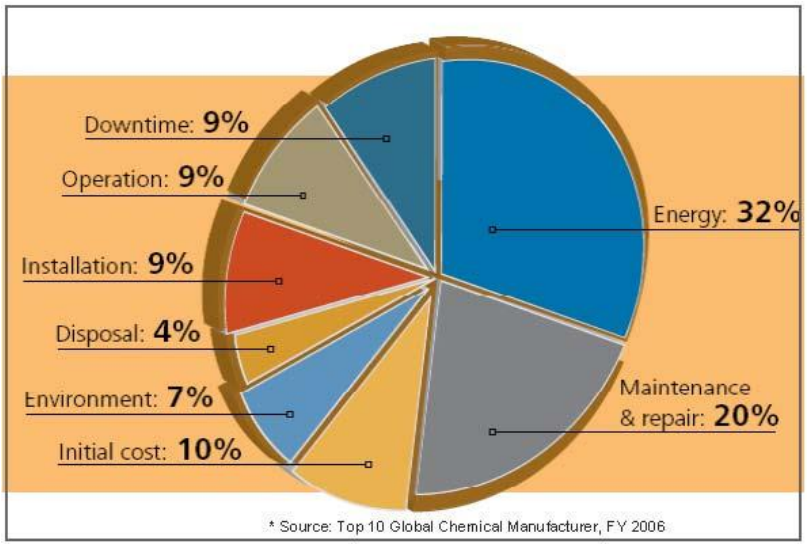
Integrating VFDs with Process Controls Improves ROI



There are further opportunities for savings and investment recovery. Unlike standard units, VFDs using ITT PumpSmart Controls protect pumps against problems with fluid dynamics, such as low flow, no flow and cavitation conditions. The ability to carefully control these conditions results in energy savings for operations that use pumps. Of the five major pump costs—acquisition, operation, electric energy usage, pump-system maintenance and downtime—acquisition is a relatively low cost, and the others can be significantly lowered through the use of PumpSmart Controls. In fact, ITT is so confident of the effectiveness of PumpSmart Controls, the company attaches a three-year warranty on the parts

of all ITT Goulds Pumps that are operated with PumpSmart. As of this writing, the company has never had to pay a claim on such a warranty.

Total Lifecycle Cost Components for Industrial Pumps



It's important to understand the benefits of variable-speed control on equipment reliability, which can have a dramatic financial impact. Some experts say that improvements in motor systems and management can yield energy savings of up to 42 percent.[2]

On an ITT project at a paper mill, for example, a single pump in a bleaching plant was having startup failures that cost the company more than $1 million annually in unplanned downtime. The solution was to replace a medium-voltage, 250 HP pump with a standard-voltage 200 HP pump controlled by a VFD. In energy savings alone, the VFD system paid for itself in 18 months. In addition, the new pump has not failed in 10 years of operation, and more than 100 plant startups—adding millions of dollars in uptime benefits to the mill's bottom line.

Fact 6: VFD systems are relatively easy to use

To the uninitiated, fully understanding VFDs and ITT PumpSmart Controls may seem challenging. In fact, VFDs simplify the systems they help run, and their interfaces have improved, just as many consumer-electronics devices have been designed for more friendly operation.

For operators, PumpSmart Controls actually make programming easier, versus programming for standard VFDs. Standard VFDs offer programs that run many other applications aside from pumps, so operators need to know exactly how to program their VFD to control a pump. Because it's designed to control only pumps, programming for PumpSmart Controls is far easier to understand and execute.

[2] Energy-Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities, American Council for an Energy-Efficient Economy

To make adjustments to the system using PumpSmart Controls, operators only need to work with a wall-mounted control unit with screen and keypad. It's a far cry from manually adjusting multiple series of valves distributed throughout the piping complex of a large production facility.

Fact 7: VFDs can operate reliably in rugged environments

VFDs contain circuit boards, and it's a fact that such electronics generally can't withstand extreme heat for long periods of time. What's more, our atmosphere is full of dirt and dust. Any of those things—and especially a combination of them—can kill electronic devices such as VFDs. However, VFDs are installed in areas specially suited to protecting electronics. They don't need to be in glass houses, but they require relatively clean and temperate conditions. In remote locations, big facilities aren't required, just a host enclosure large enough to contain a VFD, similar to the boxes that hold electrical transformers.

Older VFD controls were very large and difficult to program. Today's PumpSmart controls, left, are smaller, more durable, and easy to use.

For example, oil refineries often operate big pumps outdoors in desert environments, pumping fluids at more than 1000° F, and controlled by a VFD in a box smaller than a refrigerator.

Much like computers, the electronics and overall packaging has become much smaller and more efficient.

Today's VFDs: Reliable on their own, more intelligent with SmartPump Controls

Overall, VFDs over the years have evolved into more robust designs, and ITT PumpSmart Controls provide a significant differentiation for pump operators who seek the kind of control and protection for their pumping system that enable them to operate more efficiently, extend pump life, and save energy and money. Because ITT Goulds Pumps designs, markets and services pumps, the company is in a unique position to understand the challenges of pump operators and offer solutions to meet them. Whichever industry the pumping application is in—chemical, oil and gas, mining, or others—pumps and motors are best protected with VFDs and smart pump technology.

U.S. Department of Energy statistics show that the adoption rate of VFDs is about 4 percent, and experts believe that a reasonable goal is 20 percent. Toward that end, in the specifying and

purchasing process, today's engineers are increasingly talking about whole systems, rather than individual pumps. As a result, the industry is recognizing the value that VFDs and newer technologies, such as ITT PumpSmart Controls, can mean to the effectiveness and efficiency of their operations, and how they can gain new levels of control and protection for their pumping processes.

About ITT and ITT Goulds Pumps

ITT (NYSE: ITT) is a diversified leading manufacturer of highly engineered critical components and customized technology solutions for growing industrial end-markets in energy infrastructure, electronics, aerospace and transportation. Building on its heritage of innovation, ITT partners with its customers to deliver enduring solutions to the key industries that underpin our modern way of life. Founded in 1920, ITT is headquartered in White Plains, N.Y., with employees in more than 15 countries and sales in more than 125 countries. The company generated 2011 revenues of approximately $2 billion.

ITT Goulds Pumps is a leading manufacturer of pumps for a wide range of industrial markets—including chemical, mining, oil & gas, power generation, pulp and paper, and general industry. As the first manufacturer to make digital monitoring standard on every process pump, ITT's Goulds Pumps continues to lead the industry in both mechanical pump design and the adoption of smart technologies.