

## **ENERGY SAVINGS USING VARIABLE FREQUENCY DRIVES ON CENTRIFUGAL PUMPING APPLICATIONS**

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### Modern Electric Motor Starting Means

There are three primary methods used to start and operate induction AC motors: Full voltage direct across the line starters, reduced voltage soft starts, and Variable frequency drives (VFD's). The three methods all have distinctly different effects on both the mechanical system but also the power distribution networks.

Both the full voltage and reduced voltage starting means are only capable of running AC motors at the motor's synchronous speed of 60Hz. Full voltage cross the line starters allows the utility's full wave form to start the motor. This method will see a 600% to 800% of full load current in-rush during the starting of the motor. Many utility providers have begun to limit this starting means to only smaller motor loads due to the effects of the high in-rush current required to start the motor. Reduced Voltage soft starts will allow for more control of starting ramp rates of the system, but will have a typical in-rush current during starting of 350% to 450% of the motor's full load current and not allow for speed control. Both of these starting means do not allow for power factor correction within an induction AC motor system.

However, a variable frequency drive allows an induction AC motor to have virtually no in-rush current and is capable of reduced operating speeds of the motor. As a mode of operation, a variable frequency drive rectifies the incoming AC power to a DC bus first. It then switches the DC bus power to create a modified AC waveform to the motor. This technology allows for smoother starts, infinite control of a pump's flow, and significant avoidance of water hammer. A variable speed drive is also capable bringing an oversized system closer to unity power factor as well.

## Affinity's Law Effects on Power consumption

Affinity's law is the phenomena that a centrifugal pump typically follows as the system's speed is reduced to control flow rather than throttling. A cubed root relationship allows for significant reductions in energy consumption as the system's speed is lowers. Typically a reduction in speed by 10% can net an energy saving of 27%. These savings often justifies the additional cost of the more sophisticated variable frequency drives.

## Comparing the Cost to Traditional Engines

The three popular power sources for irrigation today are Natural Gas fired internal combustion engines, Diesel cycle engines, and Electric AC induction motors. The more traditional methods of power are far less energy efficient than an AC motor. These typically run at 50% or less efficient. Their efficiency will dramatically decrease as their operating speeds are reduced which can negate the benefit of running a system at slower speeds. However, an AC motor with an applied variable frequency drive system is capable of reducing its energy consumption at slower speeds while maintaining the system's efficiency in excess of 90%.

During this session we will cover the basic calculations for power consumption, speed's effects on a centrifugal pumping system, and a look at the total cost of ownership comparing traditional power means versus AC motors applying variable frequency technology.