

## VARIABLE-FREQUENCY DRIVE

A viable-frequency drive is an electronic controller that adjusts the speed of an electric motor by modulating the power being delivered. Variable-frequency drives provide continuous control, matching motor speed to the specific demands of the work being performed.

Variable-frequency drives are an excellent choice for adjustable-speed drive users because they allow operators to fine-tune processes while reducing costs for energy and equipment maintenance.

### USE IN THE WATER/WASTEWATER TREATMENT PROCESS

Variable-frequency drives are enjoying rapidly increasing popularity at water and waste-water facilities, where the greatest energy draw comes from pumping and aeration—two applications particularly suited to variable-frequency drives.

For applications where flow requirements vary, mechanical devices such as flow-restricting valves or moveable air vanes are often used to control flow, which is akin to driving a car at full throttle while using the brake to control speed. This process uses excessive energy and may create punishing conditions for the mechanical equipment involved. Variable-frequency drives enable pumps to accommodate fluctuating demand, running pumps at lower speeds and drawing less energy while still meeting pumping needs. Figure 1 illustrates the reduced energy consumption of variable-frequency drives over valve control systems.

Variable-frequency drives work with most three-phase electric motors, so existing pumps and blowers that use throttling devices can be retrofit with these controls. Variable-frequency drives can also be specified for new equipment.

### BENEFITS

Single-speed drives start motors abruptly, subjecting the motor to high torque and current surges up to 10 times the full-load current. In contrast, variable-frequency drives offer a "soft start" capability, gradually ramping up a motor to operating speed. This lessens mechanical and electrical stress on the motor system and can reduce maintenance and repair costs and extend motor life.

Variable-frequency drives allow more precise control of processes such as water distribution, aeration and chemical feed. Pressure in water distribution systems can be maintained to closer tolerances. Wastewater treatment plants can consistently maintain desired dissolved oxygen concentrations over a wide range of flow and biological loading conditions by using automated controls to link dissolved oxygen sensors to variable-frequency drives on the aeration blowers.

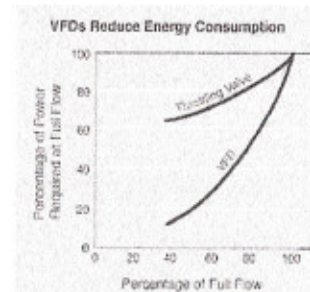


Figure 1. Energy consumption of VFDs and throttling valves.



VFDs offer improved performance, tighter control, and a quick payback.

Energy savings from variable-frequency drives can be significant. Affinity laws for centrifugal pumps suggest that even a small reduction in motor speed will highly leverage your energy savings. Variable-frequency drives can reduce a pump's energy use by as much as 50%. A variable-frequency drive controlling a pump motor that usually runs less than full speed can substantially reduce energy consumption over a motor running at constant speed for the same period. For a 25 horsepower motor running 23 hours per day (2 hours at 100% speed; 8 hours at 75%; 8 hours at 67%; and 5 hours at 50%) a variable-frequency drives can reduce energy use by 45%. At \$0.10 per kilowatt hour, this saves \$5,374 annually. Because this benefit varies depending on system variables such as pump size, load profile, amount of static head, and friction, it is important to calculate benefits for each application before specifying a variable-frequency drive.

## PERFORMANCE HISTORY

Variable-frequency drives are reliable, easy to operate, increase the degree of flow control, and reduce pump noise.

Because of the nature of this technology, variable-frequency drives can produce harmonic distortion—adversely affecting power quality, and subsequently, other electrical machinery. However, manufacturers have developed many solutions to correct this problem. For example, installing an isolation transformer in conjunction with the variable-frequency drive can reduce distortion to an inconsequential level.

## COST CONSIDERATIONS

First costs for variable-frequency drives are relatively expensive. Installed drives range from about \$3,000 for a 5 horsepower motor to almost \$45,000 for a custom-engineered 300 horsepower motor, and more for larger versions. Variable-frequency drive installation can take from 10 to over 70 labor-hours, depending on system size and complexity. However, payback period for these drives can range from just a few months to less than three years for 25- to 250-horsepower models. Because each variable-frequency drive can drive more than one motor, some costs can be consolidated. In addition, savings from reduced maintenance and longer equipment life contribute significantly to achieving a rapid payback and long-term savings. Many electric utilities offer financial incentives that can reduce the installed costs of variable-frequency drive.

## DEMONSTRATED SUCCESS

Variable-frequency drives have a proven track record of success in water and wastewater facilities throughout California. The [Moulton Niguel Water District](#) saves money by using variable-frequency drives instead of cycling their pumps on and off. San Diego Gas & Electric supported this energy-saving measure by providing financial incentives to the District for installing variable-frequency drives.