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Controlling Your Energy

Today's mixing and processing machines are far more efficient and cost-effective than machines of just a few short years ago. With the introduction of Variable Frequency Drives (VFD's), as well as the advancements made in AC motor technology, coating engineers have substantially more ability to optimize the performance of their machines. VFD's allow machines to run more efficiently, with reduced operating costs, and with an attendant reduction in maintenance concerns.

Mixing and dispersing are accomplished by spinning a blade at high speed to produce a shearing effect upon the product. The machine designer's task, therefore, is transferring power from the motor to the shaft in the most efficient manner possible. Through the years, this task has been accomplished in a variety of ways.

Early machines were simple single speed designs, based on the speed of available motors. This had the unfortunate effect, however, of forcing coating engineers to match their product to the speed of their machines. Understandably, this led to frustration and often times inferior products. Designers sought a way to vary the speed of the machine to better disperse all components of the product.

With the introduction of the variable speed pulley, coating engineers now had a machine whose speed was controllable, even during the course of the mixing process. Blade speeds could be controlled even down to about forty percent of designed maximum operating speed. Speed could also be matched to the requirements of the product at any given time during the process. Consequently, product was greatly improved in quality and consistency.

Variable speed pulleys do have a downside, however. First, using a single, wide belt results in inefficient transfer of horsepower to the output shaft due to slippage. Secondly, horsepower and batch sizes are limited due to the maximum length of the wide belt. For practical purposes, 30 HP is considered about the maximum for wide belt machines. Finally, maintenance costs are increased for a variety of reasons. For example, should the machine be stopped at high speed, and then restarted at high speed, the belt will fail. This would necessitate belt replacement at a minimum, and could lead to pulley damage as well.

Designers have known for some time that multiple v-belts and sheaves are a very efficient means of power transfer from motor to output shaft. Seeking a way to minimize the drawbacks of wide belts, while utilizing the efficient power transfer of v-belts, hybrid machines were introduced. Short wide belts transferred power to a jackshaft, which then transferred power to the output shaft by way of v-belts and sheaves. This allowed for machines with larger motors, as well as increased batch sizes due to the ability to move the output shaft farther away from the motor.

With the advent of solid-state electronic technology, a Variable Frequency Drive was introduced whereby input frequency to the motor was varied to control the output speed. This technology

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necessitated motors that would maintain constant torque through all ranges of frequency input. Modern inverter duty motors were created to meet this need. Output speeds are controllable down to one-quarter of maximum output speeds while maintaining constant torque throughout this range. Some specialty motors are even equipped with a turndown range of 1000:1.

VFD's have been slow to find acceptance in the marketplace, however. Early VFD's were quite larg and costly, much like early computers. Energy costs at that time were relatively inexpensive, so very little practical advantage was apparent. The minor savings in energy expenditures were more than offset by the initial cost of the VFD, as well as the space requirement for the unit itself.

In today's world, however, energy costs are skyrocketing, processes are becoming more complicated, and quality control is a major factor in the international marketplace. VFD's driving inverter duty motors have become a major tool in controlling costs while providing efficient transfer of power to the mixing blade.

With an across-the-line motor, such as is used in a mechanical variable speed machine, electrical current at start-up spikes drastically. This spike can be many times the full load current of the motor. For example, a 50 HP motor is rated at 62 full load amps, yet it's starting current jumps to 341 amps. This spike is the measure an energy company uses to rate electrical service to a facility. Total service current must meet the demands of this spike for all machines in use. This larger service equates to higher energy costs, in spite of the fact that operating current is much lower.

An inverter duty motor driven by a VFD never has this spike in current. Power is gradually applied to the motor, in a relatively short period of time, until full power and speed are achieved. Electrical service can now be rated to the full load current of the system, instead of the much larger service required by a spike in starting current. Smaller electrical service means an immediate cost savings for plant start-up. For existing plants, a larger electrical service already in place would allow for more machines to be brought on-line, sometimes as many as 2-3 times more.

There are additional advantages to using VFD's. First, as frequency is lowered, so is current. Most processes require maximum output speeds for only a relatively short period of time. Efficient dispersion can often be accomplished at lower speeds, requiring less current, therefore less energy. A 50 HP motor draws 62 amps at full power, yet an inverter duty motor operated at 30Hz (assuming 60Hz service) would require far less current. This directly translates to measurable cost savings. An across-the-line motor requires full load amps constantly, with no way to control energy costs.

Secondly, because of the solid-state nature of VFD's, computer control is easily accomplished. The entire process can be programmed in advance for efficient dispersion speeds and times, including

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down times if necessary. VFD's can be integrated with complete control systems that govern loading, process times and temperatures, as well as unloading product to other systems. This control can also be accomplished away from the machine, which answers to issues of workforce safety. In addition, remote control stations can be incorporated on or near the machines should this option prove necessary.

An additional advantage of a VFD concerns its "soft start" capability. With product in the mix vessel, such as when it was left overnight to resume in the morning, starting an across-the-line motor can cause product to splash out of the vessel. This can happen even at low speed. This is a waste of material, as well as a safety concern. "Soft starting" the blade eliminates this waste.

Cost and size of VFD's, like those of computers, has been reduced to reflect advancements in technology. Cost, though slightly higher than a motor starter for the same horsepower and voltage, is more than offset by the reduced cost of the machine that it controls. With increasing capabilities of VFD's, this can be seen as a tremendous value-for-cost incentive. Sizes as well have been reduced drastically from the big, bulky machines of a few years ago. For example, a 50 HP VFD is now approximately the size of a desktop computer.

Productivity can only increase with the introduction of VFD controls. Full automation can be achieved in all aspects of product manufacture. All systems can be linked to ensure continual product flow, eliminating waste and operator error. Product consistency is achieved through the precise process control inherent in VFD's. Coatings engineers can fine-tune their product to achieve precise formulations required in today's competitive marketplace. More product can be produced through elimination of unnecessary handling at various stages of manufacture. This all adds up to increased production while lowering costs.

Much of the advances in VFD technology have most likely already been accomplished. From the viewpoint of mixing and process equipment end users, any further developments will probably be only incremental in nature. An investment in today's technology, therefore, will not likely be rendered obsolete by tomorrow's breakthrough. Today's technology should provide the end user with years of cost effective service and increased productivity. Inverter duty motors are here to stay and their requirements are not likely to change.

VFD technology and modern AC inverter duty motors are the answer to ever increasing energy costs, space limitations, and automated control in the process industry. They provide precise control of the dispersing process, increased productivity, and lower maintenance concerns. They are a smart choice in today's competitive world.

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