Automatic Energy Saving Control

VFDs Automatically Optimize Motor Efficiency on Conveyor Applications

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In the present economy, consumers are caught up on how and where they can save on energy. One such way is to utilize a Variable Frequency Drive. A Variable Frequency Drive (VFD) is a reliable electronic device that efficiently operates a three-phase electric motor. These drives or inverters, as they are also called, are used to control motors in building automation, industrial, pumping, agricultural, irrigation, and water/wastewater applications. The energy saving benefits of utilizing VFD's in fan and pump applications have been well established and documented. The costs of a VFD and its installation for various pump and fan systems can usually be paid back in energy savings within a few years. However, not every application can benefit in the same manner as can those with variable torque loads.

Consequently, consumers continue to search for new avenues of reducing their energy consumption. In line with that concept, some inverters now have the ability to automatically save energy by optimizing motor efficiency. With time and patience, any drive can be fine tuned to optimize motor efficiency. However, many VFD's are usually capable of only optimizing a motor's efficiency at one specific load condition. On the other hand, some VFD's now have an energy savings control feature designed to automatically optimize motor efficiency at any given load point.

With a drive's automatic energy savings control, industrial applications can now begin to benefit from energy savings. Not all industrial applications run their motors at rated load. Those applications that do run at rated load generally do not do so on a full time basis. One such application that can benefit from energy savings control is a conveyer.

Conveyors are used in a broad range of industries to move packaged goods, assemblies, process byproducts, or any material from one place to another. Airports, mines, cement plants, distribution facilities, assembly, and food processing plants all utilize conveyors. Conveyors are typically constant torque loads, meaning the required torque to drive a conveyor is independent of speed.

When sizing drives and motors for conveyors, the heaviest load needs to be considered. Quite often, speed, load, and Acceleration/Deceleration testing is performed to determine the proper drive and motor size. Hence, conveyers are generally oversized to accommodate its peak load requirements. As a result, conveyers may experience periods of time where the load placed on the conveyer is not at its maximum capability. There may even be periods of time where the conveyer runs lightly loaded or completely unloaded. Unloaded operation may occur with conveyers because it is sometimes unjustifiable to continuously start and stop a conveyer. In some cases, such as in large mining conveyers, a long painstaking process would be required to restart a conveyer. In addition to the timing aspects, starting and stopping these conveyers could stress the coupling and joints holding the conveyer belt sections together. Likewise, the belt's rubber could undergo thermal stress as it cycles from a warm running state to cold state when it is stopped, which could eventually snap or tear the belt. It is in these cases where a drive's automatic energy savings control can be utilized.

Conveyers typically run continuously at a fixed speed, where the only change is the load itself. A fixed amount of torque is always required to overcome the frictional portion (machine drag) of the total load.

Therefore, the motor will never be in a no-load state, but the conveyer may run for long periods with very light loads.

A VFD's energy savings feature is designed to be utilized during these lightly loaded conditions. A motor is typically designed for maximum efficiency at rated slip. However, less slip will be required to generate torque at lower load demands. Therefore, slip will decrease as the load placed on the motor is reduced. As slip decreases further and further away from rated slip, the motor becomes less and less efficient.

By design, VFD's operate motors by applying varying frequency to vary motor speed. The applied frequency is such that the motor generally operates within its normal full load slip value. However, VFD's are designed to apply rated slip only at rated load. Therefore, a drive will only run the motor near its optimum efficiency while running at rated load. Energy savings control regulates the drive's output such that the motor always runs at rated slip to continuously optimize motor efficiently regardless of the load condition.

A drive with its energy savings function enabled optimizes slip by first determining the amount of power being supplied to the motor. Then, the drive will calculate the amount of power that should be supplied to the motor based on the frequency range, tuned motor parameters, and power measurements. Once the drive has calculated the right amount of slip to run the motor at its maximum theoretical efficiency, the output voltage is adjusted until the calculated amount of slip is achieved. Therefore, energy savings control improves motor efficiency by regulating the amount of slip through adjustments in the output voltage.

As previously stated, conveyer applications must continuously accommodate for the friction required to move the conveyer. Therefore, a conveyer could feasibly run at 20% of motor rated load without any actual load placed onto the conveyer. The actual percentage of motor rated load will impact the amount of energy savings. Energy savings will have its largest impact on motor efficiency at no-load.

Figures 1 and 2 show the power required to run the same load with and without energy savings control. The series in blue (V/f) designates a drive running a given load with a default constant torque volts-per-hertz pattern. The red series (V/f + ES) has the drive's energy savings function enabled. The v/f pattern using energy saving has its voltage continuously adjusted away from the default pattern to optimize slip.

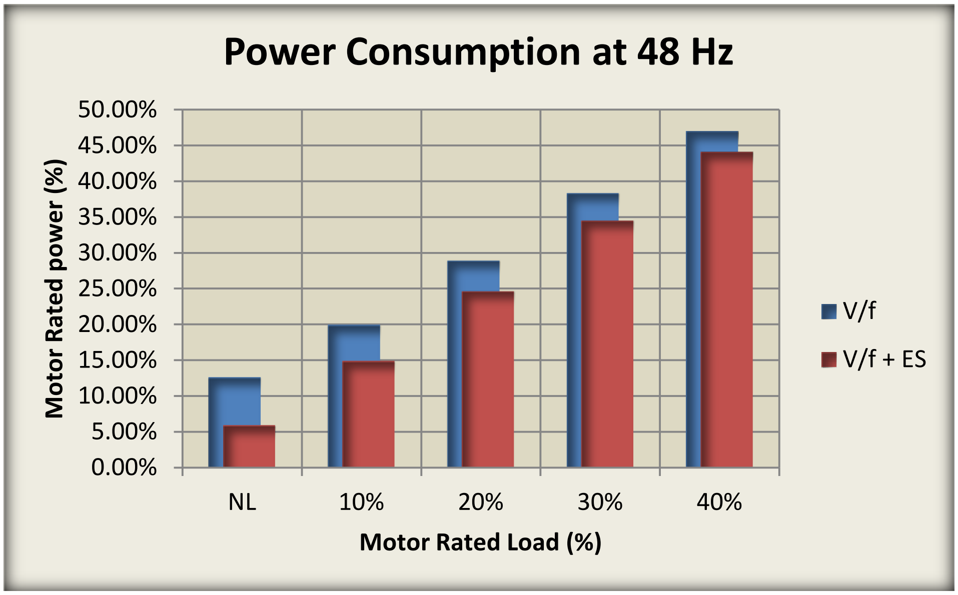

Figure 1: Power Consumption at 48 Hz

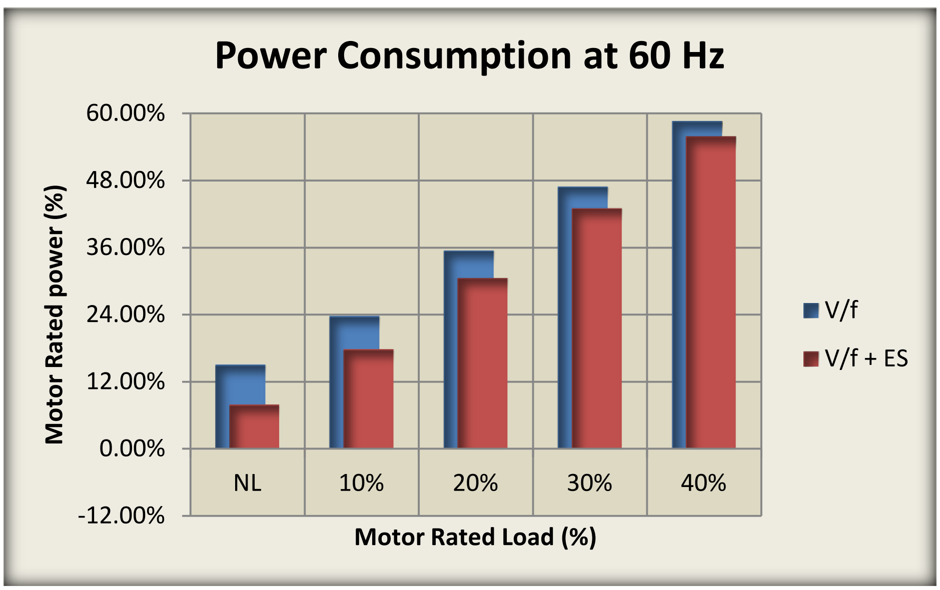

Figure 2: Power Consumption at 60 Hz

As figures 1 and 2 show, less power is required to run the same load when energy savings is utilized. The reduction in energy consumption is approximately the same at each load condition regardless of the operating frequency. In the case of our conveyer example, energy savings can be quite significant even at a 20% load. At 20% load, the drive will reduce energy consumption by greater than 10 % at both 48 Hz and 60 Hz.

Again, the energy saving function will provide a larger reduction in power consumption the lighter the load becomes. On the other hand, as we draw nearer and nearer to rated load, the motor will run closer and closer to rated slip. Energy savings control will have its least effect as the motor runs near or at rated slip, as the motor will already be running near optimum efficiency.

Additionally, energy savings control allows for real time adjustments. By making real time power measurements, the drive can accommodate for motor parameter changes that may have been effected due to motor temperature changes. Therefore, any unexpected load or motor characteristic changes will be automatically compensated for by the drive.

Energy savings control is a feature that may already be imbedded into your drive. The drive's energy savings control is simple to setup and use. The feature is generally initiated by enabling a parameter setting during the drive's installation. Then a simple one-time auto-tune with the load uncoupled from the motor must be performed. The tune allows the drive to ascertain key motor information for its energy savings calculations. With a drive's capability to auto-tune motor data, the type of motor becomes irrelevant.

The benefits described using a drive's energy savings control is not limited to conveyer applications. Other application to consider using a drive's energy savings control include, but are not limited to, spindles and band saws. Essentially, most any application where there are long periods of light loading can benefit from a drive's energy savings control.