Variable Speed Drives: Reducing the energy costs of commercial refrigeration systems
Refrigeration accounts for a considerable portion of energy consumed in supermarkets and cold store warehouses. Variable Speed Drives (VSDs) have become a viable and cost-effective tool to optimise refrigeration systems and, help save energy and reduce operating costs whilst ensuring produce is kept at the required temperature according to health and safety standards.

VSDs provide constant load matching capacity and prevent refrigeration systems from operating at full motor capacity, which is not always necessary. Variable speed operation can, therefore, result in substantial operating cost savings, reduced maintenance and longer lifespans for compressors, fans and motors.

What is a VSD?

A VSD, also known as a Variable Frequency Drive or Adjustable Speed Drive, is a device that can adjust electricity supply, regulates and adapts motor speed to match the actual demand required by the system or application it is driving, resulting in a reduction in energy consumption.

VSDs offer a high degree of motor control, accurately varying motor speed according to demand whilst adjusting torque accordingly – all within the specifications of a particular manufacturer.

A basic VSD can be used for simple applications – such as to control a pump or a fan – where variable loads are required. It can also be interfaced with a transducer, such as a pressure or flow rate sensor, and programmed to maintain a particular setting. More advanced VSDs can be used for precise speed and torque control in complex applications like materials forming and can be interfaced with a computing system to provide real time operating data on the status and performance of a motor.
VSDs come in different sizes to suit a variety of applications, and can vary from as small as 0.18 kilowatts (kW) to several megawatts (MW), depending on the size of the motor. Typically, they are available as stand-alone devices connected to the electricity supply of the motor. They can, however, also be built onto a motor as an integrated motor drive product for small motors under 15kW.

VSDs are between 92 and 98% efficient with marginal losses resulting from additional heat dissipation caused by the high frequency electrical switching.

**Slowing down a pump or fan from a 100 to 80% can reduce a motor’s energy usage by up to 50%.

**Smart control for varying load conditions**

Most standard refrigeration systems operate at reduced capacity because the refrigeration motors that drive the compressors, pumps and fans are designed to operate at maximum load conditions and a fixed speed.

Although maximum load conditions — high ambient temperature, high humidity and fully loaded store fixtures and storage boxes — occur with as little as 4% of running time, refrigeration systems are designed to cope with these conditions.

Most of the time a refrigeration system is operating, the cold storage load is not at a maximum but is rather average. In these average conditions, motors in systems not equipped with a VSD are either constantly running at a higher speed than necessary or are frequently cycling on/off.

Producing more capacity than is needed wastes electricity whilst frequent on/off cycling causes wear and tear, shortens the life of motors and associated components. A VSD can help save energy by matching the system’s output with the actual load requirement and, importantly, also improve the products’ cold storage environment.
The use of VSDs in refrigeration applications provides dramatic energy savings – a refrigerator equipped with a VSD runs at only the capacity needed and can deliver a cost saving of up to 30% and – in some cases – 50% in reduced energy consumption.

Applying VSDs in cold storage environments

The compressors and condenser motors used in supermarkets and other large commercial cold storage applications are three-phase Alternating Current (AC) synchronous induction motors. A VSD will output AC voltage at a low frequency to the controlled motor. This low speed start and corresponding low voltage prevents the high start-up current of systems that cycle at full speed.

A motor starter is not required for compressors or fans controlled by VSDs. VSDs take over the function of electric motor starters and therefore motors equipped with VSDs do not require any additional starters.

VSDs allow refrigeration systems to operate on a wide range of speeds. When used to vary the speed of a refrigeration compressor and networked to an appropriate controller, a VSD offers a range of capacities. From a low initial current frequency, motor speed is slowly increased to supply the required capacity. As load changes, motor speed is varied constantly according to the required capacity. This means that rack capacity can be controlled to match the load on the refrigeration system with considerably less on/off cycling of compressors.

Without the use of a VSD, the only way to vary a rack’s capacity is to turn on compressors in different combinations. However, each time a compressor is started, a considerable amount of energy is used to overcome inertia and bring the motor up to speed. With the proper rack size and a VSD on one of the rack’s compressors, the speed variation on that compressor will provide all the capacity change necessary to meet 90% of load variations. There is least cycling and considerable energy savings whilst wear and tear on compressors are also reduced, extending their useful life and reducing service calls.

VSDs cannot be used on hermetic compressors, which are mostly used in smaller applications – newer screw compressors are already equipped with VSDs.

Using VSDs for condenser fan control

VSDs applied to condenser fans lower speed, provide energy savings and capacity control whilst reducing start-up noise. The whine produced as fans also start and climb rapidly to full speed is reduced because fans are gradually ramped up to the required speed.
Additional benefits of using VSDs in refrigeration systems:

- Uses a smaller compressor with the same system capacity demand
- Reduces noise through reduced starts and stops
- Decreases stress on critical valves and pipes due to lower pressure differences
- Allows soft starting, which can reduce stress on motors and bearings
- Reduces service maintenance call outs
- Helps to improve the power factor
- Delivers meaningful intelligence on the status and performance of motors when interfaced with computers or wider process control systems.

Putting VSDs to work

- Conduct a proper feasibility study before investing in a VSD to ensure that it is the most appropriate solution for your particular system.
- Spend a bit more on quality – VSDs are high tech; mixing low quality with high tech is not recommended.
- Full energy-saving gains will be achieved when harmonic filter protections and components are properly installed and tested.
- Since VSDs are dust sensitive, an appropriate dust filter needs to be installed when operating in dusty conditions – they also need to operate within specified temperature and humidity parameters.
- VSDs must be installed by qualified installers that can backup their product.
• Once installed, the VSD must be correctly programmed as setting incorrect parameters will result in poor control and energy wastage.
• Regular maintenance on VSDs – and associated motors – is essential to maintain energy savings - preventive maintenance is always less expensive than correcting faults and having unanticipated breakdowns.
• Opt for a maintenance contract with your supplier to ensure that the VSD is maintained optimally.

Important note: If you have a power factor correction capacitor installed, remove it before installing a VSD.

VSDs can increase harmonics in the electricity supply, which disturb the sine curve of the Alternating Current and cause motors to run warmer than they are designed for, reducing their life expectancy. Harmonics can also decrease the life expectancy of computers and negatively influence the operation and accuracy of electronic measuring devices. The appropriate harmonic filters and chokes must, therefore, be installed along with a VSD to filter out the harmonics and protect your equipment.

Eskom’s Energy Advisors are on standby to assist you.

Eskom’s national Advisory Service offers information on manufacturers and suppliers of VSDs. The team can also advise businesses on:
• Reducing energy usage
• Doing walk-through energy assessments to identify energy usage patterns, energy needs, areas of energy wastage and energy-saving opportunities
• Improving the energy efficiency of operations and electrical systems and processes
• Prioritising maintenance as an important contributor to reducing energy usage
• Finding SANAS approved energy savings Measurement & Verification Authorities.

Advisors also provide information on funding opportunities for energy efficiency projects.

Call 08600 37566, leave your name and number and an Eskom Energy Advisor will contact you, alternatively, ask for a specific advisor to contact you.

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