# Eskom
## Variable speed drives
## Saving energy in the industrial sector

**Brochure**

Eskom

## 1 Sustainable use of electricity is a necessity

In common with most other countries in both the developed and the developing world, South Africa needs more generation capacity. The extent to which Eskom is able to supply the country's demand for electric power has a direct impact on economic growth.

By establishing energy efficiency policies, implementing process optimisation and plant efficiency, companies can reduce input costs and thereby increase their return on investment. As an added benefit, reduced energy consumption means reduced environmental impact, an important part of the "triple bottom line."

This information brochure aims to assist industrial and commercial users of electricity to improve the energy efficiency of motor drives. It explains the benefits of optimising the energy efficiency of drives, types of drive control and common problems affecting drive efficiency before describing a number of measures to improve operating efficiency and thereby reducing electricity usage and costs. It concludes with details of free energy advisory services available from Eskom.

The graphs show which applications or processes lend themselves more towards variable speed drives. In figure 1, the majority of the required flow is well below 100% capacity and is well suited for VSD's. Whereas in Figure 2 the flow required is above 80% capacity which is not necessarily suited for VSD's.

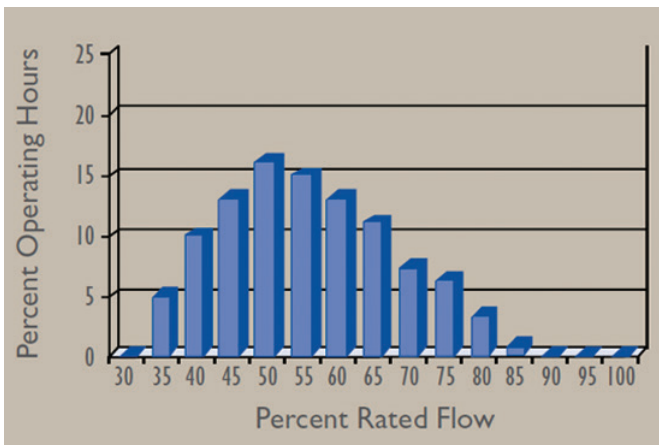


Figure 1: Example of an Excellent Variable Speed Drive Candidate

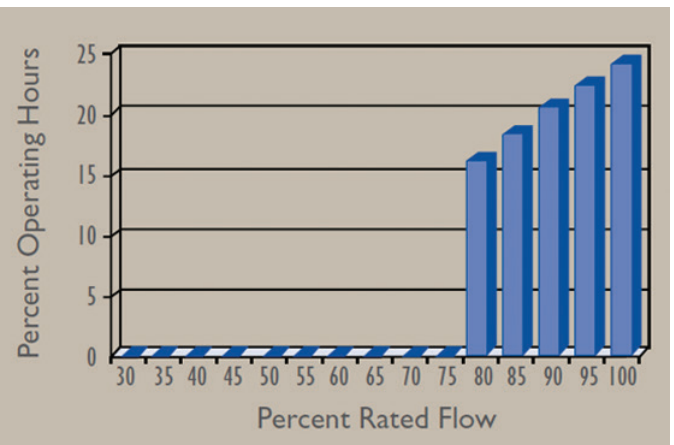


Figure 2: Example of a Poor Variable Speed Drive Candidate

## 2 Background on adjustable drivers

When Henry Ford devised a mechanical assembly line for his motor vehicles in the early 20th century, it soon became apparent that controlling the speed of the process was of fundamental importance. If the line was too slow, production targets would not be met; if it moved too fast, mistakes happened and quality suffered.

Early methods of controlling the speed of various processes were inefficient and energy wasteful. Fans, pumps and conveyors were equipped with sufficient power to meet maximum demand and then "throttled back" to achieve the desired output by means of baffles, shields, valves and brakes.

As processes became increasingly automated, it was imperative to find more efficient methods of speed control. Different methods of speed control were developed dependent on the application, namely:

- Mechanical
- Hydraulic
- Electronic

### *Mechanical adjustable drives*

A mechanical drive is a transmission system or mechanical controller used to control the speed of the electric motor.

There are various types of mechanical drives:

- Variable pitch drives
- Traction drives
- Variable speed gearboxes
- Fluid couplings
- Magnetic couplings
- Steel shot couplings.

### *Hydraulic speed control*

A hydraulic drive is a transmission system or mechanical controller used to control the speed of a hydraulic motor that uses pressurised hydraulic fluid to power hydraulic machinery

Types of hydraulic drives include:

- Hydrostatic drives
- Hydrodynamic drives
- Hydro-viscous drives.

Both mechanical and hydraulic drives have been used for many years. Although in certain applications they are irreplaceable, they do not have the efficiency, flexibility or the responsiveness of new-generation electronic devices. They also do not have the same control when it comes to speed control, the ability to run at lower speeds, also the ability to be fine-tuned for maximum efficiency of the motor.

### *Electrical (electronic) speed control*

There are various types of electrical (electronic) drives:

- Direct current drives
- Eddy current drives
- Soft starters
- Variable speed drives.

## Energy efficiency benefits of variable speed drives (VSDs)

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Variable Speed Drives (VSD) are typically used for process control and, lately, more specifically for energy conservation. VSDs are becoming the most commonly used method for speed control in industry. They control the speed of the induction alternating current (AC) motor to which they are connected, and are the most energy efficient means of controlling the speed of a motor. VSDs have the ability to vary the voltage (V) and frequency (Hz) simultaneously.

## Applications and examples of the benefits of VSD control

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### *Fans*

The performance of centrifugal fans is controlled by a set of rules known as the affinity laws, which state that:

- Flow is proportional to speed.
- Pressure is proportional to the square of the speed.
- Power is proportional to the cube of the speed.

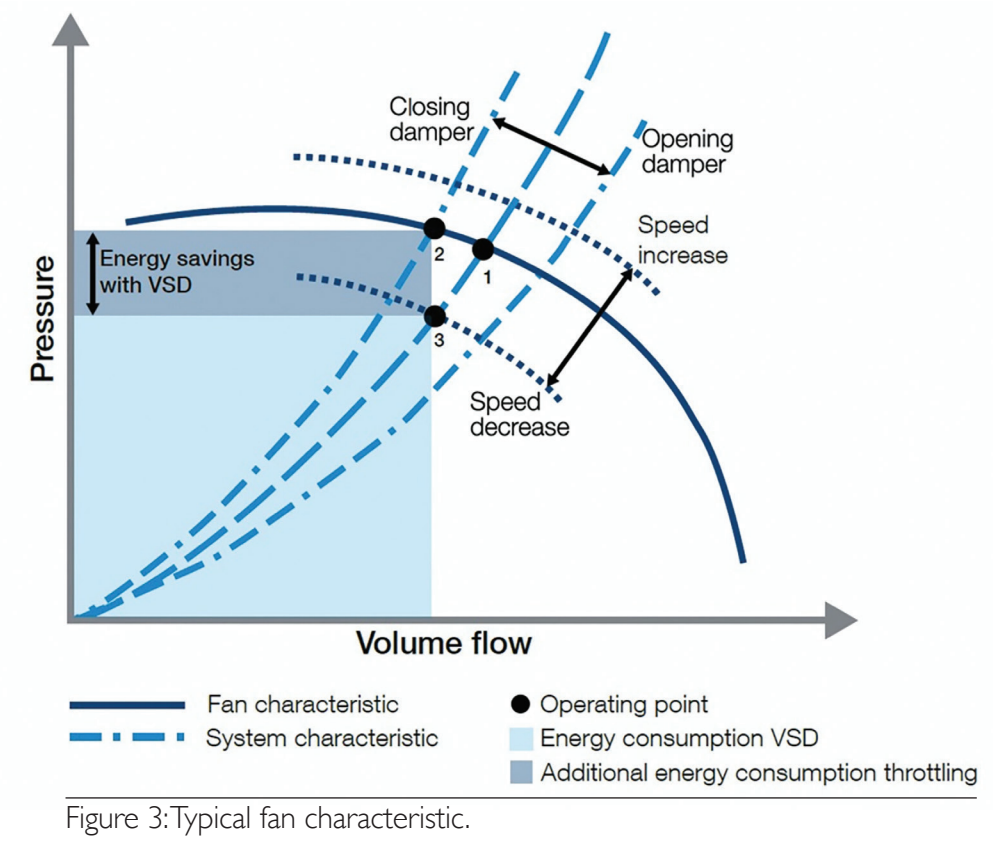


Figure 3: Typical fan characteristic.

Shown in figure 3 above is a typical fan characteristic, which is a function of volume flow and pressure. Also shown is a typical system characteristic. The operating point of the application is at the intersection of these two curves. If the required volume of air deviates from this point, the fan and/or system characteristic must be changed.

Traditionally, the most common way of changing the operating point is by means of a damper which alters the system characteristic (operating point moves from position 1 to 2, increasing the system losses).

However, increasing or decreasing the fan speed with a VSD will change the fan characteristic itself (point of operation moves from position 1 to 3, without adding additional losses). The energy consumption can be reduced significantly because lower pressure is needed for the same air flow.

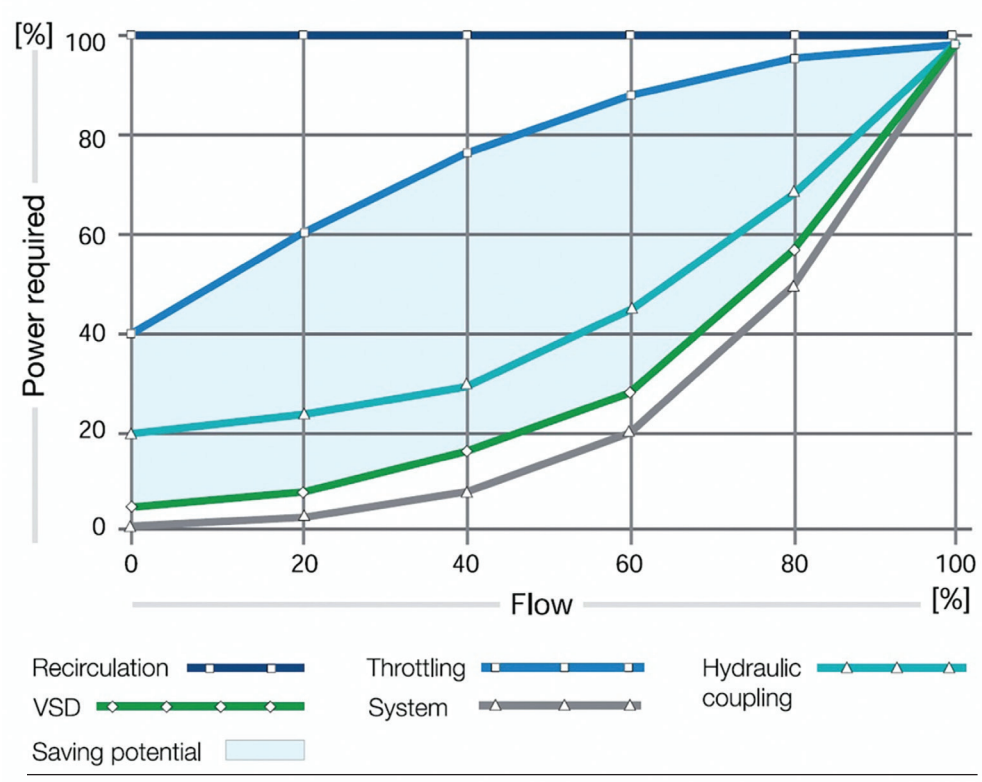


Figure 4: Power consumption for various pump control methods.

## *Pumps*

Energy consumption is the most critical factor of a pump's total life-cycle costs. About 20% of a mine's total energy consumption is used by pumps.

### *Flow and pressure control*

The flow and pressure of pumps must be controlled due to fluctuations in process demand and system parameters. The flow and pressure can be adjusted electrically with VSDs, or mechanically, with fixed-speed solutions such as throttling valves, hydraulic couplings or recirculation. As the affinity laws also apply to centrifugal pumps, controlling the pump motor speed with a VSD brings substantial energy savings compared to on/off control, throttling or any other control method. The pumps will be operated at the Best Efficiency Point (BEP) under all operating conditions, saving energy, decreasing carbon emissions and minimising total operating costs. Soft starting, another benefit offered by VSDs, eliminates pressure peaks in pipelines.

## *Slurry pumps*

Pumping slurry is one of the most demanding applications for a pump. Parts wear out quickly due to high-density, abrasive and corrosive substances, and maintenance and energy costs are high. The operating speed of a centrifugal slurry pump is one of the most important factors determining the lifespan of the pump.

Operating them at full speed increases impeller wear and reduces the pump's lifetime. With a VSD, the pump speed can be adjusted to match fluctuations in system parameters such as flow rate, static head and settling velocity. Should a pipe start to block due to changes in concentration or particle size, the VSD can adjust the pump speed so that the flow is above the critical velocity, preventing blockages and avoiding a shut-down of the plant. With VSDs, slurry pumps are operated at the most efficient rate, reducing energy and maintenance costs considerably.

## *Mills*

Mills usually have to operate continuously to sustain production. Reliable and precise control has a high impact on production throughput and operating costs. Controlling them with variable speed drives results in the following benefits:

### *Optimised plant production*

By controlling mills with VSDs, the system can easily react to changes in ore characteristics and throughput. There is no need to change mechanical components if ore characteristics change. Also, the speed of the mill can be tuned for optimal grinding and maximum throughput, resulting in more efficient use of the grinding power. If upstream and downstream processes require lower grinding throughput, the mill can be operated at partial load without having to stop the process. VSDs can adjust the speed according to the fill level of the mill.

### *Smooth ramp-up*

Torque pulsations and peak torques generated by mill equipment during the starting phase create high stresses on network and mechanical equipment. VSDs provide a smooth ramp-up of the mill. They deliver high starting torque for the current drawn from the power system and have a programmed upper limit to reduce peak torque during the start of the mill.

The low starting currents and high starting torque enable a smooth start-up for the mill, even when fully loaded.

### *Energy savings*

Mills are one of the biggest energy users in mines. Controlling electrical energy usage with VSDs will lead to significant energy savings.

## *Conveyors*

Conveyors are used in various industrial processes. The environment is demanding and there is always the risk of damaging the belt by overstretching, slipping or breaking. It is important to extend belt lifetime and availability to reduce operational costs.

### *Extended lifetime, increased availability*

VSDs provide accurate torque and speed control for conveyors. This reduces the stress on mechanical equipment such as gearboxes, pulleys and belts, especially during start-up and stopping, but also during operation and maintenance.

With VSDs, it is possible to control the speed of the conveyor to match the production capacity and, as such, reduce wear and save energy. The conveyor can be run at low speed for maintenance inspection, belt changes, repairs or avoidance of ice build-up.

### *Regenerative braking saves energy*

Downhill conveyors require continuous braking to minimise conveyor wear. This varies depending on the amount of raw material transported. VSDs provide the precise speed and torque control to meet the braking demand. With regenerative VSDs, the braking energy can be fed back into the plant's electrical network, thereby not only saving, but also generating energy.

## *Hoists*

The uninterrupted operation of mine hoists is most important to safety and production. They provide access to the mine, allow the movement of miners and material, and serve as evacuation routes in case of emergency.

### *Greater equipment control*

VSDs enable soft starting and stopping of the equipment, as well as smooth and fast acceleration and deceleration. This allows for greater equipment control and prevents motors from over heating.

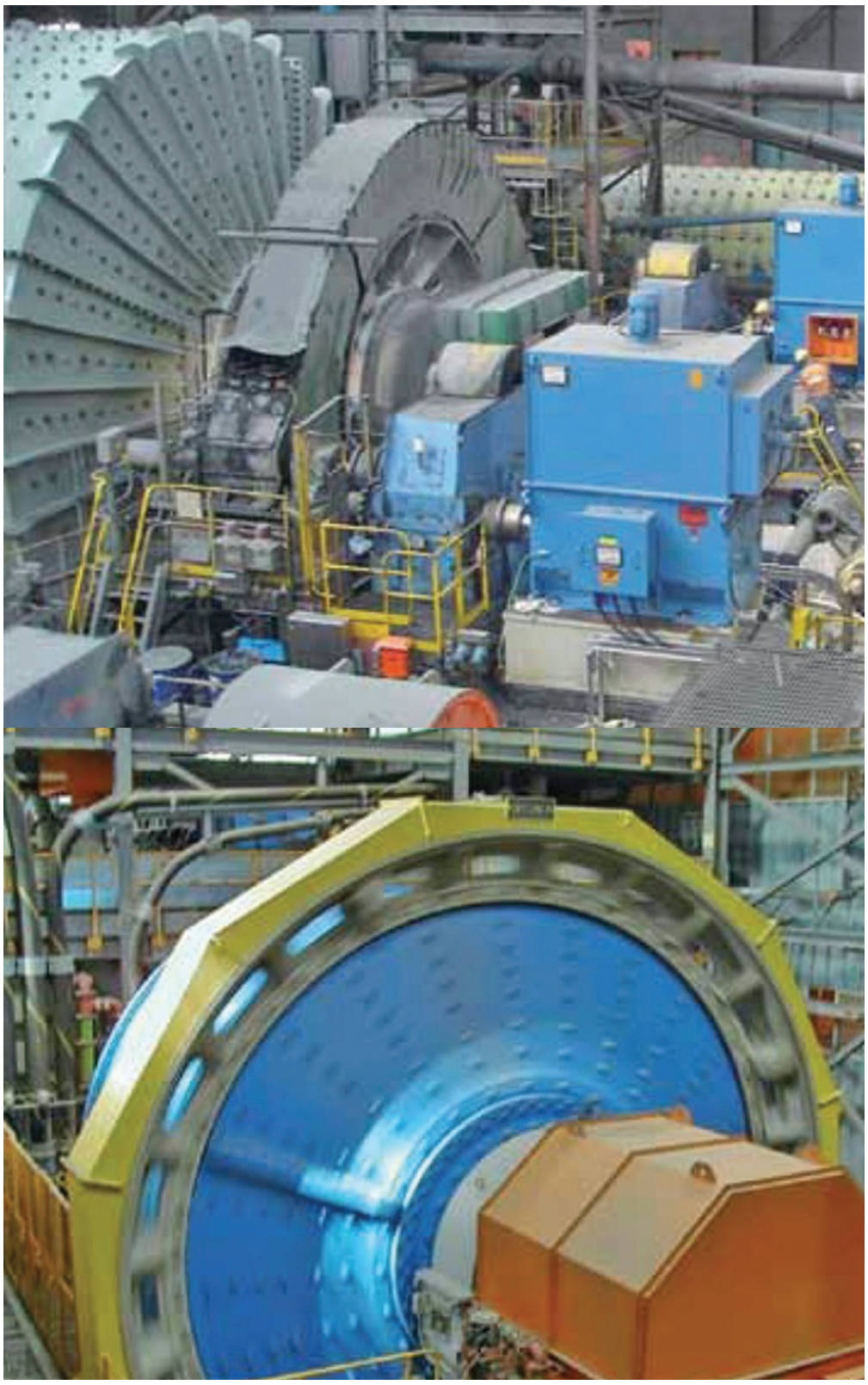

Fig. 3: Drives in action.

### *Remote monitoring and diagnostics*

Monitoring mine hoist equipment allows operators and maintenance personnel to schedule preventive maintenance tasks, thereby increasing the safety and reliability of the operations..

### *Half-speed, full load redundancy*

VSDs can be designed with redundancy to allow for continued hoist operation at half-speed and under full-load if required by the process. This function ensures the safety of the hoist system, continued production and reduced maintenance time and cost.

## *Turning obstacle into advantages*

The usual obstacle to installing a VSD is the initial cost. However the benefits outweigh the cost:

- A VSD installed for the correct application saves energy and decreases maintenance; thereby, saving on the energy bill – the VSD pays for itself
- As the electricity tariff increases, the payback period reduces
- The VSD allows the plants Maximum Demand (MD) to be managed, thereby avoiding NMD penalties.
- A VSD can run more than one motor at a time so the number of drives can be reduced

## Energy Advisory Service

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Eskom's role is to aid the client with basic information in the decision making process. Thereafter the Eskom Advisor will fulfil the role of energy advisor as part of the team that the business selects.

Eskom's Energy Advisors, in regions across South Africa, offer advice to business customers on how to optimise their energy use by:

- Understanding their energy needs
- Understanding their electrical systems and processes
- Investigating the latest technology and process developments.
- Analysing how to reduce energy investment costs
- Optimising energy use patterns in order to grow businesses and industries

## Things to consider before implementing VSDs

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- Conduct a proper feasibility study before investing in VSDs to ensure that they are the most appropriate solution for optimising your process.
- Consider the age of your equipment - the working condition of existing motors, pumps and fans can influence potential energy savings, particularly in older technologies.
- VSDs can increase harmonics in the electricity supply, which distort the AC supply sine wave and cause motors to run warmer than they were 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 the VSD to filter out the harmonics and protect your equipment.
- Full energy-saving gains will be achieved when harmonic filter protection 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 who can backup their product.
- Once installed, VSDs must be correctly programmed - 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 VSDs are kept in optimal condition.

Important note: VSD's should be installed by qualified personnel, and that includes the necessary measures for obtaining optimal power factor correction.

## Contact us

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Call **08600 37566 (ESKOM),** leave your name and number and request that an Energy Advisor in your region contacts you. Alternatively, e-mail an enquiry to advisoryservice@eskom.co.za. Visit www.eskom.co.za/advisoryservice for more information.

Eskom_SA

eskomsouthafrica

eskom_hld_soc_ltd/

or call **08600 37566 (ESKOM)**

## References

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2. Audit Procedures Manual - SADCC


**Together we can make a difference**


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