# Eskom

# **Electric pumps:** Energy efficiency of electric pumps

## Fact Sheet

## Introduction

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As is the case in many other developed and developing countries in the world, South Africa needs electricity 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 optimising processes and plant efficiency, companies can reduce input costs and thereby increase their return on investment. Reducing energy consumption will also have a reduced impact on the environment. As such all sectors of the economy can reap benefits from implementing energy efficiency policies.

This brochure aims to guide industrial and commercial users of electricity on how to improve the energy efficiency of electric-driven pumps. It explains the benefits of energy efficiency of pumps, types of pumps and common problems affecting pump efficiency before describing a number of measures to improve operating efficiency and thereby reduce electricity usage and costs.

## Optimising the energy efficiency of industrial pumps

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Pumps frequently operate at efficiency levels significantly below their optimum design levels. This can cause excessive wear, downtime and the wasteful use of electricity. In view of this there are opportunities for meaningful reductions in power consumption by deploying more efficient pumping systems which accurately meet the pumping requirements of the customer.

In simple terms, just by implementing an informed maintenance regime, operations managers can significantly improve pump performance and efficiency, thereby improving reliability and longevity.

In an effort to ensure improved energy productivity of its industrial and commercial customers, Eskom helps to identify opportunities where electricity savings can be realised together with the added benefit of more reliable, longer-lasting equipment. Efficient pumps are one of the focus points given the pump loads contribution to total electricity demand.

## Pump types

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Pumps are grouped into two main categories: centrifugal (dynamic) and positive displacement. Centrifugal pumps impart kinetic energy, or energy of motion, to a liquid by the spinning motion of an impeller. The simplified radial flow centrifugal pump shown in Figure 1 has rotation vanes that move the liquid outward from the centre of the impeller into the scrolled casing.

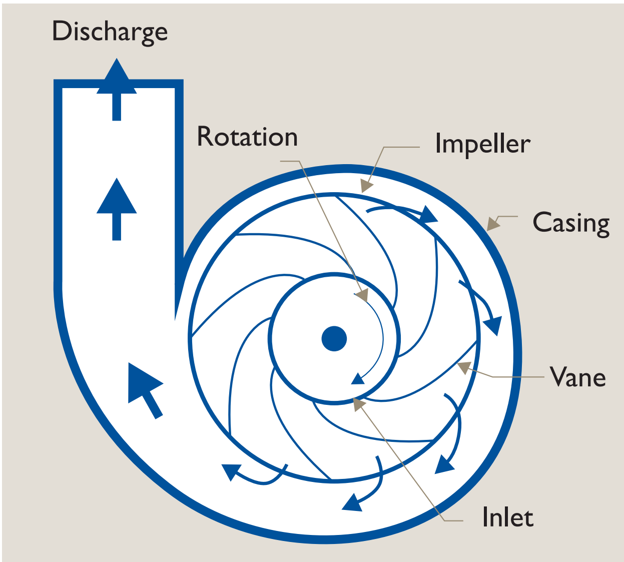


*Figure 1: Radial-flow centrifugal pump*

An axial flow centrifugal pump imparts energy to the liquid by the lifting of propeller shaped vanes, resulting in an axial discharge. In a mixed flow pump, the energy of the liquid is increased by a combination of radial forces and a lifting action.

Positive-displacement pumps operate by trapping liquid in pump cavities and displacing it to a pump discharge. They provide a constant volumetric rate of flow for a particular pump speed, independent of pressure difference and liquid characteristics. A typical gear-type positive displacement pump is shown in Figure 2.

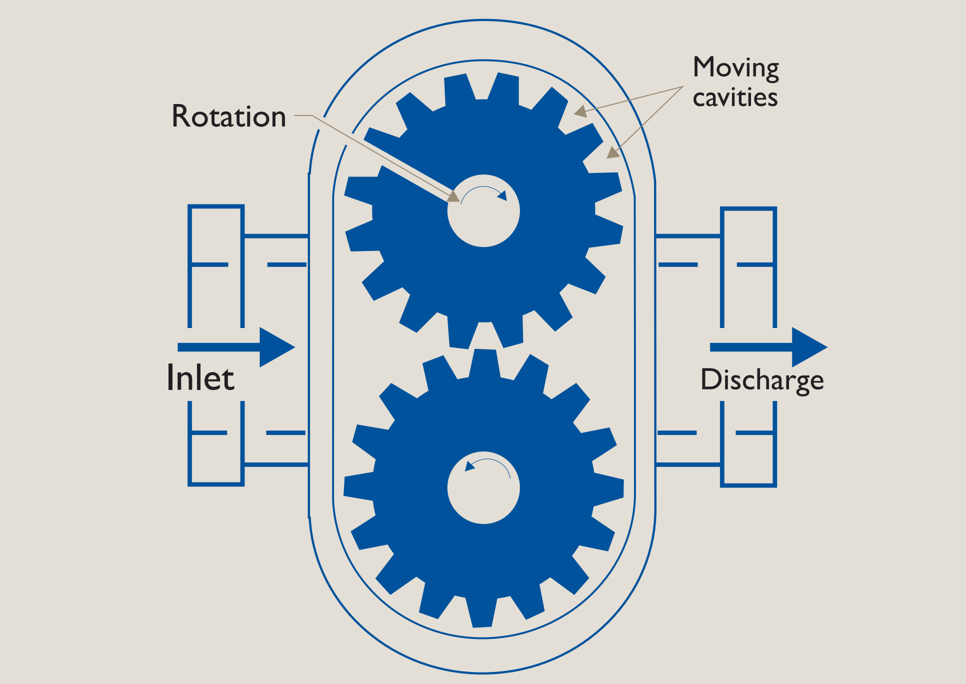


*Figure 2: Positive-displacement pump*

## Common problems affecting pump efficiency

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### Cavitation

Cavitation is a damaging condition that erodes the pump impellers, shortening the operating life and accelerating the wear rate of bearings and seals in the process. Cavitation is an indication of poor system performance.

In simple terms this means that vapour (bubbles) forms within the liquid. When they collapse against the impeller they create pressure variances which cause noise, vibration and erode the impeller. The larger the pump the greater the noise and vibration. The noise and vibration can also cause bearing failure, shaft breakage and other fatigue failures in the pump.

The other major impact of cavitation is a reduction in the efficiency of the pump. In general, cavitation indicates that the pump has insufficient supply of the fluid to be transported, causing it to 'churn'. If the system cannot be adjusted to eliminate cavitation, it may be necessary to install a more suitable pump.

### Belt drive losses

Pumps that are driven by belt drives are susceptible to inefficiency, which results from a slipping or poorly adjusted belt drive.

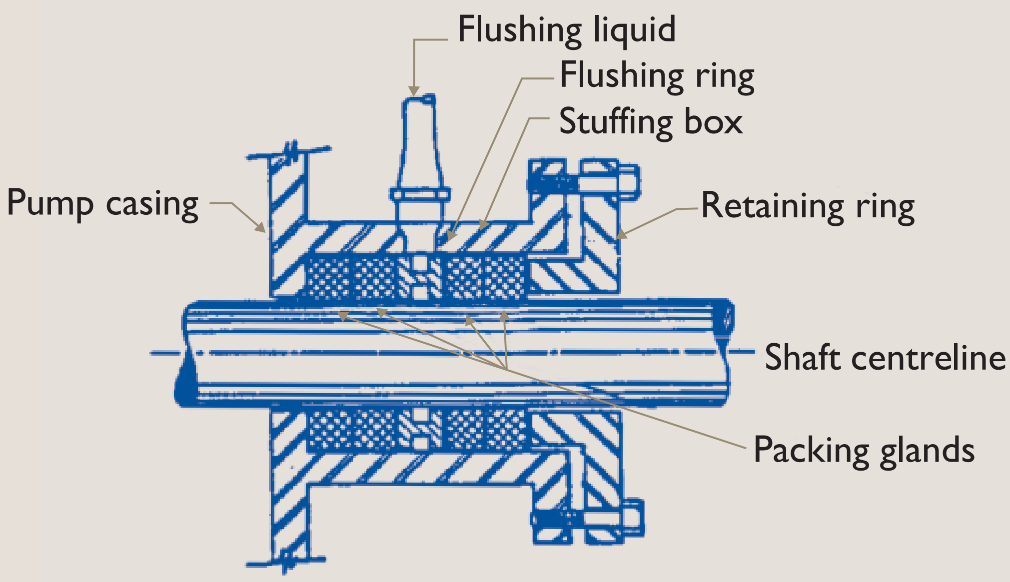
### Causes of inefficiency of belt drives

Hysteresis **losses** as a **belt** is bent on and off a pulley and sliding **losses** as a **belt** is wedged into and pulled out of its groove at entry to and exit from a pulley.

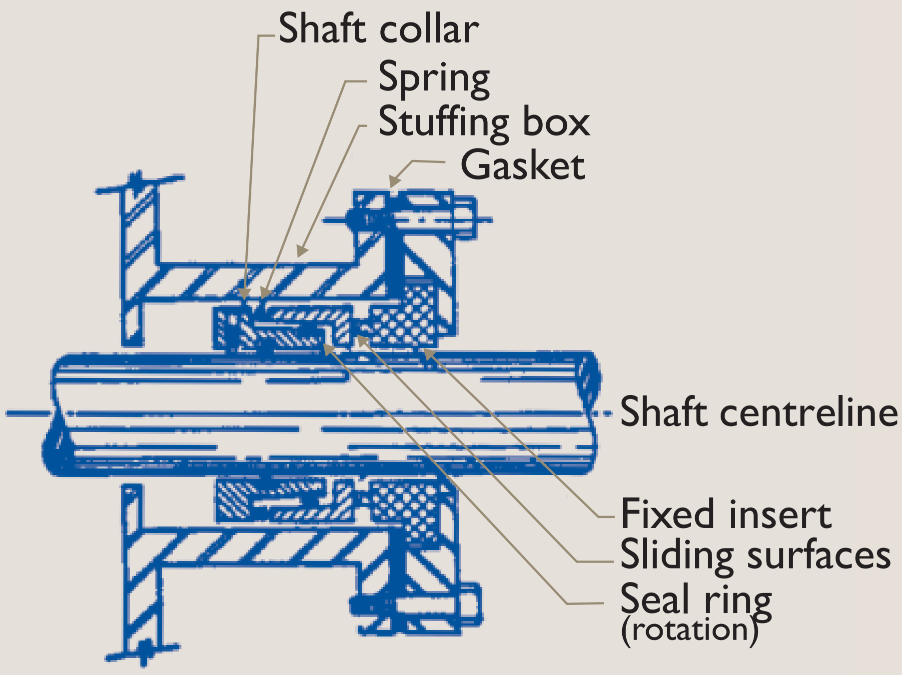
### Inefficient or leaking seals

The type of shaft seals used on centrifugal pumps, and the quality of maintenance performed can have a significant impact on the overall pump efficiency. Friction at the shaft seal uses a portion of the shaft input power and the leakage past the seal represents a loss of pumped liquid, further compromising efficiency.

The most common types are packing gland and mechanical seals (Figure 3).




Packing gland seal




Mechanical seal

*Figure 3: Typical pump seals*

Packing gland seals consist of multiple rings of flexible, low friction packing material compressed to achieve close contact with the casings of the shaft and pump. Lubrication is usually provided between the shaft and the packing rings. As a rule of thumb, the power losses by packing glands is about six times greater than that of mechanical seals.

Mechanical seals consist of spring-loaded rings of rigid, low friction material sliding against finely finished matching surfaces. The seal rings may be made of a self-lubricating material or the seal surfaces may be lubricated through a slight leakage of the pumped liquid. These types of seals are relatively expensive but their power losses are much lower than packing gland seals, resulting in significant operating cost savings. Special types of mechanical seals can be retrofitted on existing pumps that have packing glands.

## Energy management opportunities

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Effective housekeeping would be to implement relatively simple maintenance actions on a regular basis that minimises energy losses as per supplier specifications or at minimum on an annual basis. These activities are directly related to the issues that cause energy loss and reduced efficiency. Such energy management activities are listed below:

### 5.1 Check packing glands

Pump packing glands should be checked periodically for correct adjustment and tightness. Monitor the rate of dripping from the packing in order to determine the optimal tightening of the packing. Pump and packing material manufacturers can provide guidance on packing tightness for specific applications. With a few exceptions, packing must leak slightly for lubrication, otherwise excessive energy will be used and mechanical damage could occur to the shaft.

### 5.2 Check critical tolerances

The efficiency of a pump is affected by the amount of leakage past the impeller from the suction to the discharge ports. Some pumps have replaceable wear rings with small clearances between moving surfaces to minimise leakage and maintain serviceability. Mechanical seals are used with critical tolerances to stop leakage and to stop air from being drawn into the liquid flow. These tolerances can be affected by erosion of the impeller and wear rings when pumping liquids that contain abrasive particles. The clearances and surfaces must be checked and maintained periodically to keep the pump efficiency high.

### 5.3 Check and adjust drives

Open drives, such as belts and flexible couplings, need to be serviced as per the servicing schedules.

The following actions should be carried out regularly:

- Maintain the alignment of pulleys and couplings.
- Check the tension of belts.
- Lubricate the bearings.
- Replace and/or repair damaged belts, pulleys, clutches, drive keys and couplings.

Proper tensioning for various types of belts is usually described in handbooks and catalogues available from component manufacturers.

### 5.4 Clean pump impeller

Pumps – particularly those moving dirty liquids – should be regularly cleaned to maintain the efficiency of the pump. Refuse that collects on the impeller and the housing of the pump causes higher dynamic pressure losses in the pump itself, reducing its efficiency.

### 5.5 Shut down the pump when not required

Savings in both energy and maintenance costs can be achieved by shutting down pumps when the liquid flow is not required in the system.

### 5.6 Establish and follow a maintenance programme

A maintenance programme should follow the manufacturer's recommendations, and be tailored to the specific needs of the facility. The programme should include the following actions:

- Daily: monitor the pump sound, bearing temperature, mechanical seal leakage, and also check flow rate.
- Semi-annually: check free movement of the stuffing box glands, inspect the packing, check the pump and driver shaft alignment, drain and refill oil lubricated bearings, check quantity and consistency of the grease in grease lubricated bearings and lubricate the gland bolts.
- Annually: clean, inspect and lubricate the bearings and their seals; examine the packing and the shaft sleeve; recalibrate all associated instrumentation, and check pump performance against the design ratings. Replace worn components when tests indicate a loss of performance. Adjust impeller clearance on pumps to match power requirements when tests indicate a loss of performance, and keep repair records on each pump. Maintenance personnel must have the capability and experience to service, repair and trouble shoot the pumps and distribution systems.
- Rewinding motors is not always the best alternative. It can reduce the motor efficiency to such a level that it can become cost efficient to replace the pump motor.

## Retrofit opportunities

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Many of the retrofit opportunities may require a detailed process analysis, which should be carried out by specialists.

The following are typical examples in the retrofit category:

- Installing a variable speed controller on pumps to match liquid flow demand better.
- Replace outdated pumping equipment with new units sized for optimum efficiency.
- Replace oversized motors.
- Install an energy management control system.

## Reduce energy consumption while maintaining productivity

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By having a better understanding of how pumps and pumping systems in industry work, it is possible for industrial clients to reduce their power consumption and improve the performance and duty cycles of essential equipment. It is important to note that energy efficient operations provide the ability to maintain output while limiting the risk of increased operating costs.

## Energy efficiency checklist

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Good housekeeping and regular maintenance of electric pumps makes perfect energy sense, saving your business downtime and money. Below is the checklist of relatively simple actions you can take for optimal effiency of your pump usage:

- Check and adjust drives.
- Check packing glands.
- Check critical tolerances.
- Clean pump impellers.
- Shut down pumps when not required.
- Establish and follow a regular maintenance programme.
- When fitting new pumps, make sure that your specialist supplier conducts a proper needs analysis, replaces oversized motors and ensures new units are sized for optimal efficiency. Install variable speed drives where appropriate, to get your pumping job done more efficiently.

**Case Study**

Eskom, together with the University of Potchefstroom conducted an irrigation pilot project using variable speed drives on electrically driven pumps.

The study revealed the following findings:

- The average saving was about 25% overall.
- From the electricity cost savings, most variable speed drives had a simple payback period of four to eight months.
- Variable speed drives are not plug-and-play. Use a reputable supplier to commission them.
- Variable speed drives do not always save energy; it depends on the system and process.

The study revealed further spin-off benefits.

- Re-winding costs reduced significantly as variable speed drives protect themselves and the motor from common line faults like spikes, dips and single phasing.
- Variable speed drives are highly compatible with automation; it is easy to operate them remotely and incorporate them into precision practice.
- Variable speed drives collect data and send alarm when something happens. This data can guide the operations manager on usage trends, assist in diagnostics, and enable them to better manage the system.
- Motors, pumps and fans last longer because the variable speed drive keeps them operating on their optimum performance point.

## 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.

**Optimise your energy use**

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, including electric infrared heating and drying systems.
- Analysing how to reduce energy investment costs.
- Optimising energy use patterns in order to grow businesses and industries.

**Call 08600 37566**, 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**.

## References

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- Eskom commissioned research.





Issued by Energy Advisory Service May 2020
Eskom Holdings SOC Ltd Reg No 2002/015527/30
Job 3558