Refrigeration:
Reducing energy costs in dairy parlours

Factsheet
Milk cooling systems account for about 20% of energy used in dairy parlours. Farmers have a few options to improve the efficiency of their refrigeration process. Pre-plate coolers, variable milk pump control, refrigeration heat recovery units and insulated bulk milk tanks can help reduce cooling costs whilst maintaining or even improving the quality of milk.

Unpacking the milk cooling process

Milk inside a cow’s udder has a temperature of about 37°C and drops to about 35°C once it passes through the collector container and piping. It must be cooled quickly to prevent bacteria from affecting its quality. To get milk to the right temperature of 5°C as fast as possible, the cooling equipment includes a pre-cooler and a refrigeration system, which is a bulk milk tank using either a direct expansion refrigeration cycle (Type B tank) or an ice bank (Type A tank). The lower the temperature of the milk when it leaves the pre-cooler, the lower the electricity usage in the refrigeration unit.

The energy efficiency of the milk cooling process can be improved in a number of ways.
Advantages of a plate pre-cooler

Plate pre-coolers, also known as plate heat exchangers, use water to lower the temperature of milk as it flows from the milking system to the bulk milk tanks.

Bulk milk tanks are divided into two classes:

1. ED-class is a tank whose content is emptied on a daily basis – according to SANS 708-2007 the tank must be able to cool its content from 19 to 5°C in 2.5 hours.
2. AD-Class is a tank whose content is emptied every alternative day. According to SANS 708-2007 the tank must be able to cool its content from 12 to 5°C in 2.5 hours.

Using cold water from a tap or borehole as a heat exchanging medium to remove heat from the warm milk as it exits a cow’s udder, the plate pre-cooler helps to reduce the temperature of the milk before it reaches the bulk milk tank.

Increasing the surface area of the heat exchanger by installing additional plates can also help improve the milk’s cooling rate and reduce energy usage by the refrigeration unit as the temperature of milk entering the unit will be lower. It is important that plate coolers are properly cleaned and – in accordance with HACCP regulations – maintained in a hygienic environment to provide efficient cooling and prevent milk from becoming contaminated.

With plate pre-coolers, the refrigeration running time can be reduced by 40%.

On a farm producing 15,000 litres of milk per day and using an energy-efficient refrigeration unit, each 1°C reduction in the temperature of milk leaving the pre-cooler will save about 860kWh per year.

Using a milk pump speed control

The pre-cooling process can be improved by installing a Variable Speed Drive (VSD) on the milk pump used to pump milk from the receiving tank inside the parlour to the pre-cooler or bulk milk tanks.
A limit switch inside the receiver tank activates the milk pump when the receiver tank reaches its maximum level and switches the milk pump off when empty — this is a continuous process during the milking time.

The speed of the milk pump can be reduced, thereby saving energy. During the wash cycle the milk pump will, however, need to run at full speed.

**VSDs can also be used on the vacuum pump to maintain a constant vacuum and can also be added to the milk refrigeration system to reduce demand during peak times by maintaining the milk’s temperature without reducing it.**

### Keeping refrigeration units running efficiently

During the milk cooling process, the main electricity user is the bulk milk tank refrigeration unit. Direct expansion is the simplest and most energy-efficient way to cool milk to the required storage temperature. It is a feature of the mechanical refrigeration cycle that heat energy removed from the milk exceeds the electricity required to run the refrigeration unit.

The ratio of the energy extracted from the system to the energy used to run the unit is known as the ‘Coefficient Of Performance’ (COP). The higher the COP, the more energy-efficient the refrigeration system. When running as designed (COP ranging from 2.7 to 2.9), the unit is operating efficiently. If a unit has a lower COP, it is considered inefficient.

Possible causes of poor performance include poor installation of refrigerant lines to the bulk milk tank or a faulty refrigeration unit. If the milk cooling time is getting longer and the bulk milk tank refrigeration unit is suspected of poor performance, call a refrigeration serviceman to check the unit.

Improvement of the refrigeration system does not require new technology — it requires maintenance or improved installation of the current technology. The cooler the condenser and compressor units are running, the better the cooling effect and the lower the energy use. This can be achieved by installing the condenser and compressor units on the southern side of buildings to ensure sufficient ventilation, removal of heat and protection from direct sunlight.
If you are purchasing a new bulk tank or replacing a failed reciprocating compressor, specify that the compressors should be of a scroll type. Scroll compressors are 15 to 20% more efficient than traditional reciprocation compressors, yet they have fewer moving parts and are only slightly more expensive. Scroll or screw compressors can also be fitted with VSDs.

Consider using a refrigeration heat recovery unit

A refrigeration heat recovery unit transfers excess heat from the condenser of a bulk milk tank to preheat water for use in milking parlours; it can generate approximately one litre of preheated water for every litre of milk cooled.

Adding a refrigeration heat recovery unit will help increase refrigeration system efficiency because of the increased capacity to dissipate heat, whilst at the same time capturing heat in water to reduce water heating costs. This is beneficial because water heating can be one of the larger energy uses in a dairy parlour.

It is important to note that a pre-cooler will reduce refrigeration needs but also the amount of heat available for preheating water in a refrigeration heat recovery unit. Because of the lower efficiency of water heaters (50 to 85%), it is usually more economical to displace water heating before reducing refrigeration needs with a pre-cooler. In dairies with less than 100 cows, it is usually not economical to use both a pre-cooler and a refrigeration heat recovery unit.

Typically, a refrigeration heat recovery unit will provide greater energy and cost savings than a pre-cooler. Dairies with more than 150 cows could benefit from using both technologies.

Make maintenance a priority

Well maintained refrigeration systems almost always use significantly less energy. Dirty coils or low refrigerant pressures will reduce efficiency and increase operating costs. Make sure you regularly service your refrigeration units, as well as check that condensers are kept clean and fans are working correctly.

Dairies could save over 10% of their refrigeration energy costs by implementing some low and no-cost measures including installing good insulation, operating the unit efficiently and implementing an appropriate maintenance schedule.
Conduct an energy assessment

Farmers should invest in an energy assessment to determine whether an investment in more energy-efficient refrigeration equipment or other energy-saving technologies offers an acceptable economic payback.

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

Eskom’s national Advisory Service offers information on manufacturers and suppliers of energy-efficient electro-technologies. 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 can 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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