Bananas light the way

Perfect ripening and storage are all about channeling the right amount of energy to the right equipment at the right time. Bananas are helping to shed light on these energy issues.

WHY EFFICIENCY MATTERS

Cooling facilities that are more energy efficient are good news for the industry because of:

- Reduced energy costs.
- Reduced operation and maintenance costs.
- Improved system resiliency.
- Improved safety.
- Increased productivity.
- Better matching of refrigeration load and equipment capacity.
- A better working environment.

THE BANANA RIPENING CENTRE at the Tshwane Market is an energy-intensive operation. Fifty-five cold rooms, each around 200 m³ in size and equipped with four fans, operate around the clock, every day of the year, to store or ripen tons of bananas.

The fruit arrives completely green from the Mpumalanga and Limpopo provinces’ subtropical fruit growing areas. Depending on their export schedule, the unripe bananas are either cooled down and stored in the growing areas. Depending on their export schedule, the unripe bananas are either cooled down and stored

Temperature control is both a science and an art, with VSDs. Two VSD modes were tested, namely constant and variable.

Based on the results of the audit, Mr Mulobe built and verified a numerical simulation computer code to simulate the refrigeration system. This allowed him to test, in theory, the impact it would have to run the motors of the evaporative coil fans in the cool rooms with VSDs. Two VSD modes were tested, namely constant and variable.

Mr Mulobe’s computer modelling also investigated how airflow patterns and stacking methods influence energy consumption. Staff members at the Banana Ripening Centre already know that the two-way pallets, which are open on two sides to allow easy forklift access, is better for airflow than the four-way pallets. Two-way pallets.

Cool bananas! By reducing the speed of an electrical motor by just 10%, its energy use can be cut by 20%.

Each cold room has four of these electrical fans that circulate cold air. They enable the required cooling and ripening processes, but consume a considerable amount of energy.

Given its combined energy use for cooling, storage and ripening and the demands that this places on temperature control, the Banana Ripening Centre was the ideal testing ground for a study into the options available to reduce the energy consumption in the fruit export cold chain by introducing energy efficient techniques.

Experience in other markets has shown that the energy use of cold rooms can be cut by 20-30% by adopting measures such as reducing the heat load, introducing variable speed drives (VSDs), optimising airflow patterns, improving operating and maintenance practices and implementing automatic controls.

An appreciation of the value that more energy efficient practices can add to the fresh fruit industry, prompted the Post-Harvest Innovation Programme to collaborate with the Tshwane University of Technology (TUT) in Pretoria in a project to identify energy conservation measures that can be applied in cooling facilities in the fruit cold chain.

The study was done by Master’s degree student, Jean-Claude Mulobe, under the supervision of Prof. Zhongjie Huan from the TUT Department of Mechanical Engineering.

PROJECT DESIGN AND RESULTS

The study involved the experimental and/or theoretical investigation of energy saving technologies that can be implemented in cooling facilities that have both cooling (temperature dropping) and cold storage (temperature maintaining) functions.

The project started with an energy audit of the Banana Ripening Centre at the Tshwane Market. The facility consumes just more than 648 MWh of electricity in a year.

The energy audit mapped the centre’s overall energy consumption, isolated the energy consumption of the refrigeration system and recommended energy conservation measures.

Energy sufficiency in the supply chain

The entire fresh fruit industry

Energy sufficiency in the supply chain

The Post-Harvest Innovation Programme (PHI-2) contributed R260 000.

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pallets’ two open sides can be closed with metal strips to ‘trap’ the circulating air. This allows the air to circulate more evenly and efficiently between the boxes stacked on the pallet. Four-way pallets, that are open to the floor on all four sides, cannot be closed off as easily, making it more difficult to achieve sufficient airflow between the boxes. The computer modelling, airflow and stacking practices are elevated from anecdotal evidence and trial-and-error to verified science.

The VSD and airflow studies were also put to the test in real life. In a small experimental cold room on the TUT campus, pallets of bananas were subjected to different experiments with VSDs and ways to optimise airflow to determine the impacts on both energy consumption and fruit quality. The variable VSD was proposed and verified as an effective way to save energy and maintain fruit quality. The experiments concluded that VSDs, combined with airflow optimisation, have the potential to reduce energy usage in the cold rooms at the Banana Ripening Centre by up to 18%.

WIDER APPLICATION
Although this energy efficiency project used the Banana Ripening Centre as its laboratory, its results and insights are directly relevant to the broader fruit cold chain, since its scope covered technologies that are applicable to all types of fruit that need a low-temperature environment.

WHAT IS A VSD?
A variable speed drive (VSD) is a piece of equipment that regulates the speed and rotational force, or torque output, of an electric motor. There are millions of motors in use in industry and offices around the world. They operate pumps, milking machines and sky lifts, paper machines and power-plant fans, sawmill conveyors and hospital ventilation systems, to name just a few examples.

In fact, more than 65% of industrial electrical energy is consumed by motors. In many cases, motors are controlled by means of a valve that regulates the flow of fuel, or a valve that controls the airflow, while the speed of the motor itself remains unchanged. These and other methods, such as using two-speed motors or controlling motors by switching them on or off, is inefficient from an energy point of view.

One of the main reasons why drives save energy is because they can change the speed of an electrical motor by controlling the power that is fed into the machine. Reducing the speed of an electrical motor by just 10% can reduce its energy usage by 20%.

Source: www.abb.com