Evaporative cooling and air conditioner cooling: maintenance, improvements and data collection

Back-to-office report prepared by Marcelo Precoppe

Introduction

In 2016 a sweetpotato storage unit, using evaporative cooling, was built at Organi, a processing centre located in Ringa, a village 50 km south of Kisumu, Kenya. As the target storage temperature could not be reached using this cooling method, in May 2017, the construction of a new storage unit started in Kisumu. This unit was designed to use air conditioner cooling instead. In June, the unit that was build using a 20 feet freight container, was transported to Organi. In July its construction was concluded and in August the unit was loaded with sweetpotatoes (white variety), for its first test. On October a new trial was set, using orange fleshed varieties. In December the electrical system was reported damaged, problems were identified in the solar power system and in the control panel. The unit cooled by the evaporative system was also reported inoperative. The aim of this back-to-office report is to describe the repairs, improvements and measurements performed during 13 January 2018 and 10 February 2018.

Evaporative cooling

The evaporative cooling unit uses 12 V DC, 24 V DC and 240 V AC. The control panel is complex, using several fuses and relays. No electrical wiring diagram was present, and no local electrician participated in the assembly of the system. Therefore, there was no one familiar with the setup. A lengthy system-diagnosis was performed, and it was noticed that numerous fuses were burn and some relays were damaged. While replacement fuses were easily available, suitable relays were more difficult to find. The diagnoses also identified that the water pump of the cooling system was broken. This 12 V DC water pump that this system employs is not available in Kenya and needs to be imported from UK. The pump is not designed for continuous use, but the evaporative cooling requires uninterrupted operation, and for this reason the pump lasts, on average, two months, before burning. The system was repaired using a replacement pump brought from UK. In addition, locally available alternatives for pump replacement was investigated.

A discussion with Organi staff revealed that they had difficulties on maintaining the water level of the evaporative cooling. They explained that it required to be filled two times per day and that the processing of refilling is cumbersome, mainly because of the height where it is installed. To improve usability and safety, an automatic water refilling system was installed using a float valve.

After repairs and improvements were concluded, sensors (HC2A-S, Rotronic; Bassersdorf, Germany) were placed to record temperature and relative humidity inside and outside the storage unit. Figure 1 shows the sensor placed inside the unit at the point where the cooled air enters the store. Data was collected for 2.5 weeks and can be used to determine the system efficiency and guide improvements.

Figure 1 Measurement of temperature and humidity of the air cooled by evaporative system.

Air conditioner cooling

The storage unit using air conditioner cooling was built using locally available equipment. Local technicians participated on its construction and can perform maintenance and repairs. However, the electrician who built the control panel had recently passed away.

Rats have damaged the solar power system and the control panel. The inverter (responsible for converting the DC voltage to AC) suffered a short circuit cause by the rodent faeces and urine. The electrician responsible for the solar power system was contacted, the inverter was taken to Nairobi for repair, and spare parts were imported from Victron Energy headquarter in The Netherlands. The repair was made under the warranty.

In the control panel, rodents have also chewed cables, and contactors were damaged by their faeces and urine. Given that the electrician who have built the system had passed away, it was decided to use the services from the same electrician who installed the solar power system. The control panel was rewired, in a simpler and more robust way, plus damaged components were replaced (Figure 2).

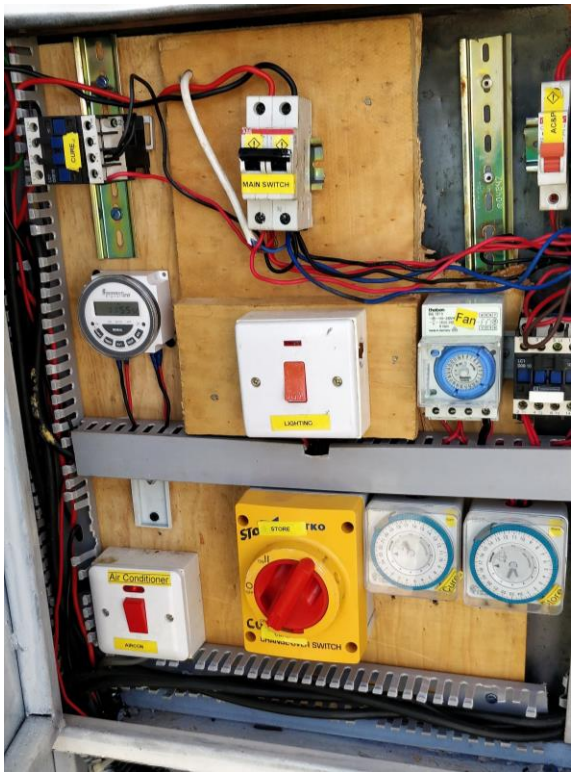

Figure 2 Control panel repaired and improved, after been damaged by rats.

To avoid future damage with rodents, all the electrical components were protected by a fine wire mash (Figure 3). In addition, ultrasonic rat repellents were installed, as well as glue traps.

Figure 3 Installation of physical barriers, repellent and traps to protect electrical installation.

While the air conditioner was not damaged by the rats, a LG authorized technician performed the recommended periodic maintenance, assuring reliable and efficient operation.

The humidification system of the storage unit consists of a water sprinkler and a water pump controlled by a timer. The sprinkler originally installed had its spray too concentrated in the centre of the container. It was then, replaced by another model that sprays the water more broadly, spreading it over the cover, as shown in Figure 4. In addition, the timer that controls the water pump was replaced by a digital one, allowing more fine control over the pump operation.

Figure 4 Water sprinkler was substituted to spread the water more uniformly over the cover.

After repairs and improvements were concluded, the store was loaded with approximately 4000 kg of sweetpotatoes (white variety). Twenty temperature-relative humidity sensors (HC2A-S, Rotronic), each connected to wireless data logger (HL-RC-B, Rotronic), were placed within the roots at various locations of the storage unit (Figure 5).

Figure 5 Storage unit loaded with 4000 kg of sweetpotatoes and sensors placed within the roots.

For curing, temperature was set at 28 °C and the data collected allowed to map its distribution inside the unit (Figure 6).

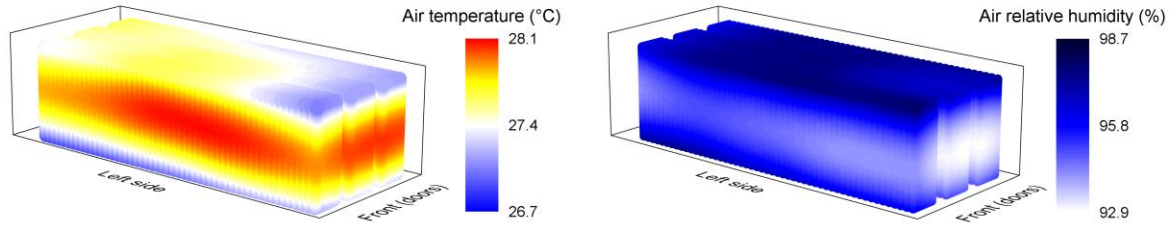

Figure 6 Temperature and relative humidity distribution inside the unit during curing.

For storing, temperature was set at 15 °C and the data collected allowed to visualize its uniformity inside the unit (Figure 7).

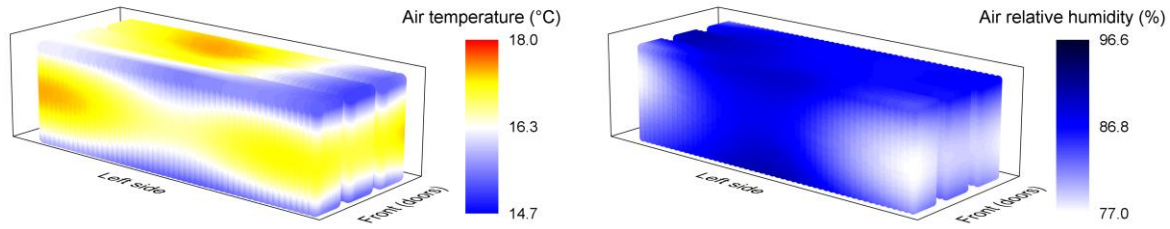

Figure 7 Temperature and relative humidity distribution inside the unit during storage.

The temperature and humidity maps were used to guide modifications aiming to improve uniformity. An air deflector on both sides of the chamber was installed (Figure 8) and a better distribution of temperature and humidity was achieved as shown in figure 9.

Figure 8 Deflectors installed to improve air temperature and relative humidity uniformity.

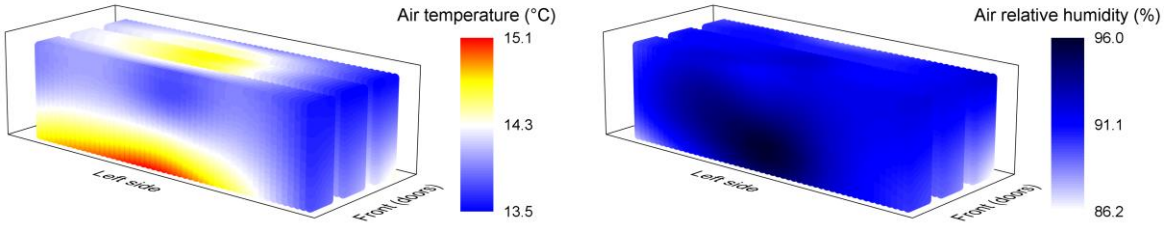

Figure 9 Temperature and humidity distribution during storage, after installation of air deflectors.

Follow-up activities

A technical report, analysing the data collected on the evaporative cooling system, determining its efficiency and guiding modifications to improve performance, will be written. Likewise, another technical report, analysing the temperature and relative humidity data collected in the unit using air conditioner cooling, will be prepare. The report will describe the modifications made to improve uniformity, provide uniformity index for the different setups and guide possible modifications for further improvement. Preparation of those reports is awaiting allocation of commissioning on NRI's Projects Information Database (PID).