

Ammonia as a refrigeration

The 'Watts in Your Business' project has completed energy audits of 30 packhouses and orchards Australia-wide. This fact sheet shows how Radevski Coolstores has upgraded their refrigeration system at two sites to save thousands.

Radevski Coolstores is a family owned and operated business, and a major Goulburn Valley supplier of apples and pears to Coles. As experienced growers, the family is involved in every aspect of the business from marketing, orchard and packhouse management, to quality control and dispatch. Radevski Coolstores has grown from one orchard in 1959 to its present 182 hectares of apple and pear orchards, in the productive heartland of Goulburn Valley's Shepparton East district. Its turnover is around 10,000 tonnes of fruit per year.

Site savings opportunities:

- Use ammonia as refrigeration for cool store systems.
- Implement condenser fan speed control using variable speed drives.
- One site recorded a massive 60% reduction in its maximum electrical demand

Energy savings activities

Radevski Coolstores has undertaken a \$1.15m refrigeration on upgrade of two cool store systems – their Swainston Road site and their Benalla Road site.

The upgrades were designed by refrigeration on specialists Minus 40 Pty Ltd and constructed by Shepparton-based refrigeration on contractors Leamon Refrigeration on. Both involve upgrading the plant to operate on ammonia as the refrigeration and the implementation of condenser fan speed control using variable speed drives, to further improve the system's energy efficiency and performance.



Reasons for changing

'We were driven by a number of factors,' said Peter Radevski, General Manager. 'Firstly we knew that the phase-out of the HCFC R22 was coming and changes would have to be made.'

With the help of refrigeration specialists, Radevski's expect the upgrades to their cool store systems will cut energy costs by 25%.

Saving energy

'Secondly, the price of R22 itself is extremely high. To keep the R22 units properly charged is not cheap. Thirdly, we knew that energy was one of our biggest costs and that electricity prices would rise over the next few years. Finally, we want the fruit coming out of the cool store to be the best quality possible – and a move to ammonia is a step in the right direction in that regard.'

The Benalla Road site uses an ammonia refrigeration system which cools a secondary refrigeration brine – Alcool LF – which is pump-circulated to the cool rooms. From October 2012 to September 2013 this facility consumed over 1.6m kWh of electricity at a cost of over \$300,000

The Swainston Road site utilises ammonium as the sole refrigeration throughout the plant. It is of similar size to the Benalla Road site.

The Radevski's have been very conscious of energy savings and improving the refrigeration on plant efficiency. The Benalla Road facility has already implemented the following energy saving opportunities:

- compressor staging and capacity control: Both screw compressors are controlled by variable speeds drives (VSD).
- variable head pressure control: The fans of both evaporative condensers and cooling towers are controlled by variable speed drives through plant discharge pressure set-point which is calculated based on ambient conditions and plant load.
- Primary brine pump variable speed drive control.
- Evaporator fan variable speed drive control (Implemented when the plant was first built).

Details of the major refrigeration equipment at Benalla Rd.

Refrigeration System Components	Make	Model	Motor size (kW)	Comments/Remarks
Compressors	2 x Mycom	200 VMD	185	Both VSD controlled
Compressors	Grasso	810	90	So started
Evaporative Condensers			15kW fan; 2.2 kW pump	New condensers installed in Dec 2013; VSD controlled fans
Cooling towers	2 x Superchill	EWK-D 450 – 3.0	11kW	VSD controlled fans
Cooling water pumps	2 x Regent	DIN 80-260	9.2kW	Fixed speed; (Duty/Standby)
Primary brine circulation pumps	2 x Regent	NP 100-195-T21A	37kW	VSD controlled; (Duty/Standby)
Warm brine (Defrost)	2 x	50-146-	7.5	Fixed speed;
Evaporators N4E	32 x Luve	HILW 2430	kW per evaporator	Two evaporator units per Cool room; 3 fans per unit; All VSD controlled
Secondary brine	16 x	NP 65-50-	3	Fixed

The audit showed other energy-saving opportunities at Radevski Coolstores (Benalla Rd)

	Annual Electricity savings (kWh p.a.)	Annual Electricity cost savings	Capital Cost \$	Simple Payback period (yrs)	% electricity use
Optimising condenser/cooling tower fan control logic	27,500	\$3025	\$6000	2.0	1.8%
Compressor leak maintenance	2076	\$228	\$750	3.3	0.1%
LED replacement for Pack House High Bay lighting (200W)	17,280	\$2246	\$14,000	6.2	1.1%
Cool room door automation upon 1-electronic sliding doors	7500	\$975	\$6250	6.4	0.5%
T5 type replacement for T8 type lighting for the Office	1296	\$168	\$1100	6.5	0.1%
Voltage Power Optimisation	140,593	\$15,465	\$125,000	8.1	9.0%
99 kW Solar photovoltaic (PV) system	130,086	\$16,911	\$175,000	10.3	8.3%
Total	326,331	\$39,018	\$328,100	8.4	20.9%

How it was done

At Benalla Road, Radevski Coolstores engaged Minus 40 to deliver a package of services that commenced with a review of the existing cool room configuration, refrigeration employed and energy usage. From that a design for the new plant was developed and tendered. Leamon Refrigeration on was contracted to install the new equipment and also completed the Swainston Road upgrade.

Benefits

The expectations from the upgrades to both plants were energy savings of the order of 25%.

A stunning outcome of the upgrade to the Swainston Road site was a massive 60% reduction in the site's maximum electrical demand. Maximum demand dropped from 250kW under the old system to 114kW for the upgraded system. This will allow renegotiation of cheaper tariffs for this site.

Part of the reason for the substantial reduction is that the old plant was not operating efficiently. To fully charge the system required 1500kg of R22 valued at around \$350,000. All R22 plants leak refrigeration and continual need recharging, which can be costly. When around 30% of refrigeration is lost there is a significant reduction in refrigeration on efficiency and a big increase in running costs.

Rob Leamon from Leamon Refrigeration on notes that this situation is common in the Goulburn Valley region.

'Because of the high cost of recharging R22 plants, growers are reluctant to recharge them regularly, leading to the R22 plant operating inefficiently and with much higher power consumption,' Rob said.

A second reason for the extraordinary efficiency of the all-ammonia Swainston Road plant is the use of ammonia as the sole refrigeration.

'For a glycol-brine plant, as at Benalla Road, a 45kw pump is required for brine circulation to the cool rooms,' said Rob. 'In comparison, for the Swainston Road plant, the pump that recirculates ammonia to the cool rooms, is a much smaller 4.5kw unit.'

'While the comparison between the two plants isn't exactly fair due to capacity differences between the sites, plants that utilise ammonia as the sole refrigeration are 12% to 13% more efficient than ammonia plants that recirculate a glycol refrigeration.'

Further, prices for equipment to handle ammonia refrigeration have come down in price (in relative terms) compared to 20 years ago.

'Plants that utilise ammonia as the sole refrigeration are cheaper to buy, cheaper to install and cheaper to operate than ammonia/glycol plants,' said Rob.

Ammonia is not user-friendly, is toxic at high levels and is corrosive. But, it can be smelt (at levels of around 50ppm) if there is a problem and it breaks down relatively quickly to its components (nitrogen and hydrogen). For controlled atmosphere (CA) rooms that need to remain locked up for long periods, specialist ammonia sensing detectors can be used that detect ammonia at levels of around 3ppm – well below the threshold for any fruit damage.



Radevski's have installed Evapco condensers at the Benalla Rd plant that use variable speed drive-controlled fans to reduce energy use.

Advice for others

The advice that Radevski Coolstore has for others considering cool store refrigeration on upgrades is:

- Work with a specialist to assist in the design of the new plant
- Install a well-designed, modern plant with efficient equipment (e.g. variable speed drives on the fan motors) throughout.
- The plant should utilise ammonia as the sole refrigeration.