



***Glaciem's Thermcold Thermal battery in place at 'The Bend'.
This device contains award winning Phase Change Materials***
condenser inlet temperature.

dramatically reducing peak power consumption. The cloud-based forecasting algorithm can restart the charging cycle if there is excess PV available thus maximising the onsite PV.

The total storage capacity of the PCM is 100kWh over a 10hr period.

The TES system uses a newly developed PCM, the new PCM freezers & melts at -6°C enabling cooling of between 0°C to 2°C . The new coil design and dynamic melt system incorporated in the TES tank increases the thermal efficiency of the PCM, allowing $>85\%$ of the latent heat stored to be extracted. The charging of the PCM is controlled by a cloud-based forecasting algorithm that uses a set of variables taken from the internet of things.

R744 only system has been integrated with indirect cooling technology, this integration is the result of extensive R&D carried out by Glaciem in conjunction with the Barbara Hardy Institute at UniSA. This integration allows the R744 system to operate subcritical with high efficiencies in ambient temperatures of 45°C . The R&D carried out has led to an adaptive control algorithm that defines whether the indirect cooling is required or not based on dry bulb temperature and humidity ratio the condensing temperature is continuously adjusted depending on

Our Partners

Glaciem cooling was extremely fortunate to work with extremely professional partners in this project.

The Peregrine Corporation is largest privately owned company in SA, generating over 2 billion dollars of revenue, part of the group is over 135 OTR convenience store/ petrol stations.

As a group Peregrine consume a large amount of electricity and are also left exposed to the HFC phase down/out. Glaciem approached Peregrine in 2016 to discuss an alternative platform for the OTR sites. The brief was to dramatically reduce the onsite electricity consumption, future proof against changes relating to the use of synthetic refrigerant and offer redundancy in the event of a power outage.

The new TBMS project presented a perfect opportunity for a new type of platform, the project was carried out by Glaciem as an EPC for the Peregrine Corporation.

The project was partly funded by a Tech In SA South Australian Early Commercialisation grant. UniSA Ventures have funded the data analysis for the project and a graphical user interface (GUI) to display the data. Glaciem would like to acknowledge the help and support from the Barbara Hardy Institute, Dr Frank Bruno & Dr Martin Belusko.

Challenges Overcome

The major challenges faced during the project can be categorised as follows;

Efficiency ; Finding a cost effective refrigerant with high efficiency to charge the PCM store proved a challenge.

Synthetic refrigerants were not considered due to their environmental impact & long term sustainability performance. This left natural refrigerants and in particular R744 as it is non toxic and non flammable. However R744 only systems have low efficiencies in ambient conditions above 25°C .

The solution to this was to integrate indirect cooling technology with the system allowing it to operate efficiently in high ambient conditions. To achieve this the incoming air is indirectly cooled close to the dew point temperature of the air. Tests show that with ambient dry bulb air temperatures >40°C, condenser air inlet temperatures of <20°C could be achieved allowing the R744 to condense at 25°C.

PCM's; Water in the form of ice has been used in the HVAC sector for many years to provide chilled water at 6°C, however as ice melts at 0°C its use in refrigeration applications is limited. Various research has taken place in

chloride based salt solutions for refrigeration applications, due to corrosive nature of chlorides, the PCM is usually encapsulated in balls, this encapsulation has several prohibitive aspects namely cost & poor heat transfers characteristics.

The -6°C PCM developed by UniSA is a low cost non chloride based salt solution that enables ice to be built up on directly coils eliminating the need for encapsulation thus reducing the overall cost of the TES tank. The new coil and dynamic melt design increases the efficiency of the TES system allowing more of the latent heat to be extracted thus reducing the installed footprint.

Summary

To summarise The Integrated Cooling Solution installed at 'The Bend' Motorsport Park in South Australia has the following key points of difference compared to traditional refrigeration systems;

- DP-CO₂ Refrigeration – Natural, CO₂ Only Refrigeration: The integration of indirect evaporative cooling with a R744 system enables high operational efficiency at ambient conditions >40°C, the advanced floating condenser temperature control also allows high efficiency in low ambient temperatures.
- Fully Integrated TES: a cost effective 'thermal battery', enables the end user to store renewable energy, or cheaper off-peak grid energy, as thermal energy highly efficiently, for seamless use in the cooling system when required. This newly developed -6°C enables TES to be used efficiently in refrigeration applications
- Forecasting algorithm providing 'Intelligent Energy Management: the cloud-based software collects data from multiple sources, from the internet; National Energy Market pricing forecast, solar radiance forecast, weather data, from site; state of TES charge, current electrical demand, refrigeration load. This information allows the software to continually adjust the onsite control system enabling the onsite system to operate at its highest efficiency point. This optimises the onsite generation of renewable energy & also offers a technical hedge to users that are exposed to spot market electricity pricing fluctuations.

Each of the above on their own represent a significant technical advancement for the industry and coupled together are well placed to leave a measurable long-lasting legacy as they de-risks end users of refrigeration from the two key issues facing the industry.

Overall the project has been a resounding success and offers The Peregrine Corporation with a future proofed platform for their OTR convenience store/ petrol stations that is in line with their sustainability strategy.

The project has also attracted interest significant from a large South Australian IGA supermarket group and a large national hotel chain with new projects expected in 2019.



A happy leader—Julian Hudson with the 2018 AIRAH 'Excellence in Refrigeration' Award