RP1015

GROUND COUPLED PHOTOVOLTAIC THERMAL (PV/T) DESICCANT COOLING

Research Question (50 words)

As cooling loads generally peak with solar irradiation, solar cooling would be a better alternative than conventional vapour compression cooling. In particular, using PV/T collectors could be a lower cost approach than other solar technologies. This research focuses on how to utilise recovered heat from flat plate PV/T collectors for ground coupled desiccant cooling.

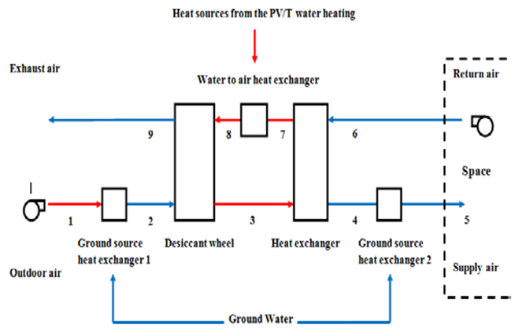

Figure 1: Schematic of the ground coupled PV/T desiccant cooling system

Methodology (75 words)

To evaluate the overall performance of a ground coupled PV/T desiccant cooling application, TRNSYS software is used to model all components in Figure 1. Once each component is calibrated with product specifications, the system is simulated under a temperate climate for its supply air temperature at a set humidity ratio of 8g/kg. The outputs would approximate a physical cooling unit and assess its performance under different climate conditions. This research is still in the progress to optimise heat utilisation from PV/T collectors for sufficient desiccant regeneration.

Results (225 words)

High temperature heat source requirement presents one of the main challenges to utilise the recovered heat from PV/T collectors to sufficiently recharge desiccants. Pre-cooling of the inlet air to the desiccant wheel could effectively allow desiccants to be regenerated at a lower temperature as shown in Figure 2.

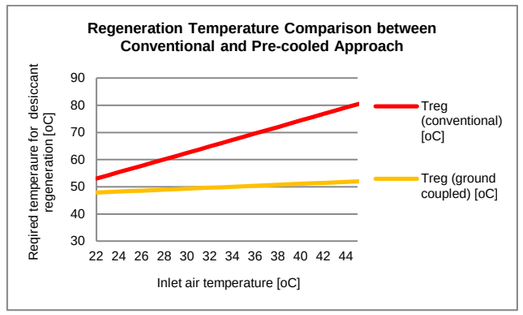

Figure 2: Regeneration temperature comparison between conventional and pre-cooled desiccant dehumidification approach under various inlet air temperature

The pre-cooling of the inlet air could be provided by the ground water via a water to air heat exchanger. In comparison to the conventional desiccant dehumidification, pre-cooled dehumidification could have lower regeneration temperatures. In addition, the regeneration temperature would be less affected by the ambient conditions.

From the TRNSYS simulation, Figure 3 shows that the ground coupled desiccant cooling process could supply air temperature between 21^{o}C and 23^{o}C at fixed humidity ratio of 8g/kg with daily average ambient air temperatures between 19^{o}C to 29^{o}C in January under Sydney climate. This allows the air moisture to be removed adiabatically.

The supply air temperature is limited by the inlet ground water temperature of 20^{o}C. Thus when a cooler supply air temperature is required, an additional sensible cooling method could be easily integrated.

In addition, Figure 3 shows that in some days in January, the daily average temperature is below the supply air temperature. Therefore, appropriate control strategies could be implemented, to operate the system under a ventilation heat recovery mode to achieve indoor human comfort.

Conclusions (50 words)

Ground coupled PV/T desiccant air cooling process could supply air with temperature below 25^{o}C with a set humidity ratio of 8 g/kg under the Sydney climate in the month of January.

In comparison to the conventional desiccant cooling, ground coupled PV/T desiccant cooling with pre-cooling could operate a lower heat source temperature under various inlet air conditions.

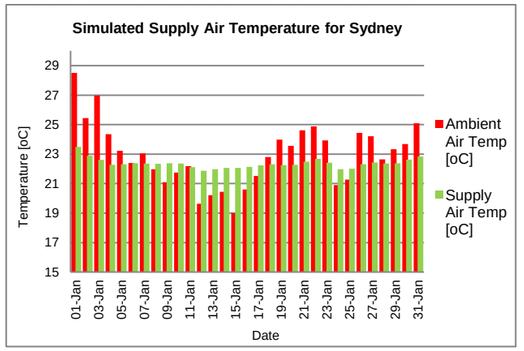

Figure 3: Simulated daily supply air from ground coupled PV/T desiccant cooling in January under Sydney climate

Anticipated impacts (50 words)

The ground coupled PV/T desiccant cooling could be used to effectively control indoor temperature and humidity ratio. It could be implemented in both residential and commercial sector. The utilisation of the solar energy would reduce the peak power demand from the utility. It is also environmentally friendly where no chemical would be used in the process.

Key statement about the research project to go into this space (what is the key message?).

Solar cooling could be a more sustainable and energy efficient solution to current vapour compression system. Utilising recovered heat from PV/T for desiccant cooling with ground cooling presents a good opportunity to provide space cooling.

Further information

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