RP1029

INTEGRATION OF PHASE CHANGE STORAGE AS PASSIVE AND ACTIVE SYSTEM INTO BUILDINGS AND AIR-CONDITIONING SYSTEM

Research Question

"How does PCM thermal storage system integrated into 'buildings and A/C systems' contribute to energy efficiency of conventional buildings?

- ✓ The reduction of energy and peak demand with economic benefit?
- ✓ Optimised heat exchanger design of PCM TES?
- ✓ The most suitable PCM for building application considering local climate?

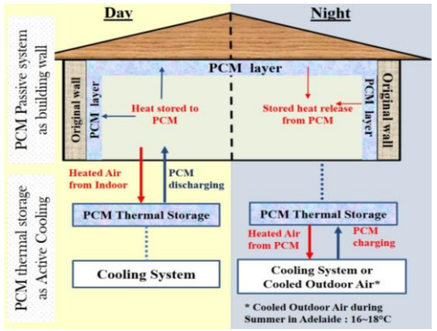


Figure 1: PCM Application in building as passive and active system

Methodology

Task 1: The selection candidate PCMs and incorporation process into building material (Current Task)

- ✓ Thermos-physical properties (PCT, Latent Heat of Fusion, Sub-cooling), safety of PCM and local climate.
- ✓ Thermal cycling test with nucleating and thickening agents.
- ✓ Various geometrical shapes of container.

Task 2: Design optimisation through modelling (Next Task)

Task 3: Experimental Investigation and cost analysis (Next Task)

Results of Task 1

1. Analysis local climate for decision of PCT of candidate PCM.

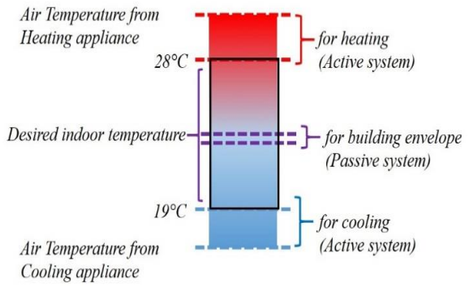


Figure 2: Thermal comfort range and PCT for candidate PCMs.

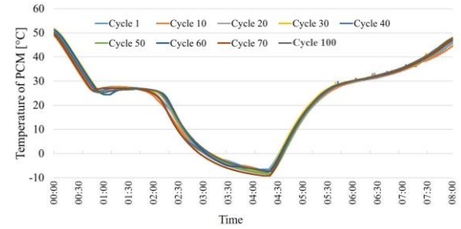
- ✓ Desired mean indoor air Temp or conditioned annual average indoor air Temp (Passive application of PCM)
- ✓ Higher than indoor thermal comfort temperature (Active Heating)
- ✓ Lower than indoor thermal comfort temperature (Active Cooling)

Name	Tm (°C)	Latent Heat (kJ/Kg)	Target
Calcium Chloride Hexahydrate + additives	**30.6**	**192**	Heating
Sodium Sulphate Decahydrate	32	140	
Sodium Carbonate Decahydrate + Sodium Dihydrogen Phosphate Dodecahydrate	**18~23**	**192~196**	Cladding (Passive)
Calcium Chloride Hexahydrate + Magnesium Chloride Hexahydrate	22~23	114	
Sodium Carbonate Decahydrate + Sodium Dihydrogen Phosphate Dodecahydrate	**18~23**	**192~196**	Cooling
Sodium Chloride(1/2)/ Sodium Sulphate Decahydrate	18	<100	
Potassium Dihydrogen Phosphate Tetrahydrate	Not detected	Not detected	

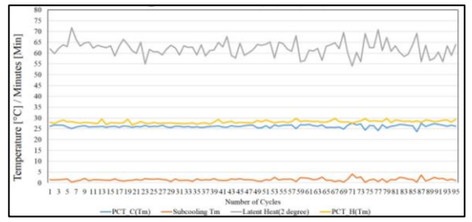
Figure 3: Candidate PCMs

2. Selection of a candidate PCM for active heating (Tm: 28°C) and the result of thermal cycling test.

- ✓ 2wt% BrCl2.2H2O(nucleator) and a 0.5wt% hydroxyethyl cellulose (thickening agent)



(a) Heating and Cooling cycle



(b) Thermal Stability

Figure 4: The result of 100 thermal cycling test for a candidate for active heating (PCT: 28°C)

3. Development of new Candidate PCM for passive and active cooling

- ✓ CaCl2·6H2O+MgCl2·6H2O for passive application but low LH
- ✓ Na2HPO4·12H2O+Na2CO3.10H2O for passive and active cooling
- ✓ Lack of candidate PCMs for passive and active cooling with low latent heat and high level of sub-cooling and phase separation → Develop Eutectic PCMs.

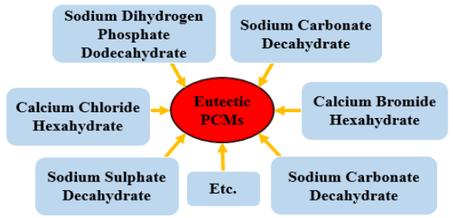


Figure 5: Candidate Eutectic PCMs for passive and active cooling.

Conclusions (Task 1)

- ✓ Low heating rate reduces sub-cooling rate during cooling cycling because of crystals that are not fully melted and working as nucleator, but causes low latent heat of the storage system.
- ✓ Relevant thickening agents can prevent phase separation but the density of the agent should be similar to that of PCMs.
- ✓ Various combination of two different PCMs needs further examination as potential Eutectic PCMs.

Anticipated impacts

- ✓ Develop innovative thermally stable PCMs with low sub-cooling, high LH and no phase separation
- ✓ Find the most suitable integration of PCM thermal energy storage as passive and active system; technically easy and economically efficient to improve the thermal performance of conventional buildings.

Key statement

- ✓ *Contribute to increase the energy efficiency of conventional building by reducing H/C load and peak load shifting*

Further information

http://www.lowcarbonlivingcrc.com.au/research/program-1-integrated-building-systems(Program 1: Integrated Building Systems)

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