Review on Thermal Energy Storing Phase Change Material-Polymer Composites in Packaging Applications

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Introduction

- A Phase Change Material (PCM) absorbs or releases large amount of **latent heat** when it melts or crystallizes in a material-specific temperature range

- PCMs are characterized by
  - Phase change temperature range
  - Latent heat storage capacity

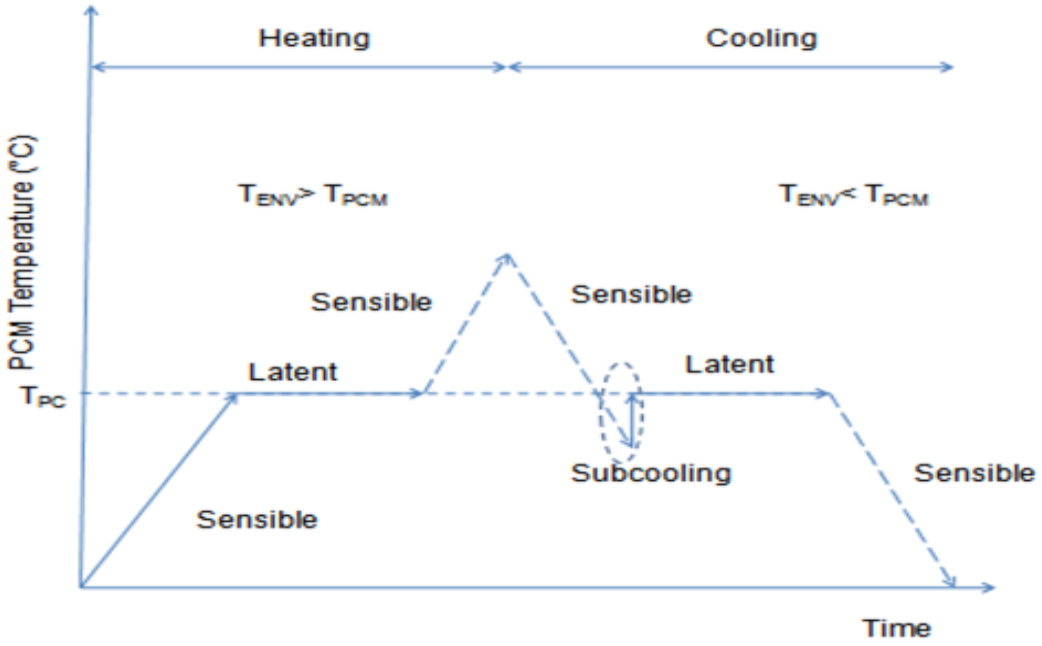
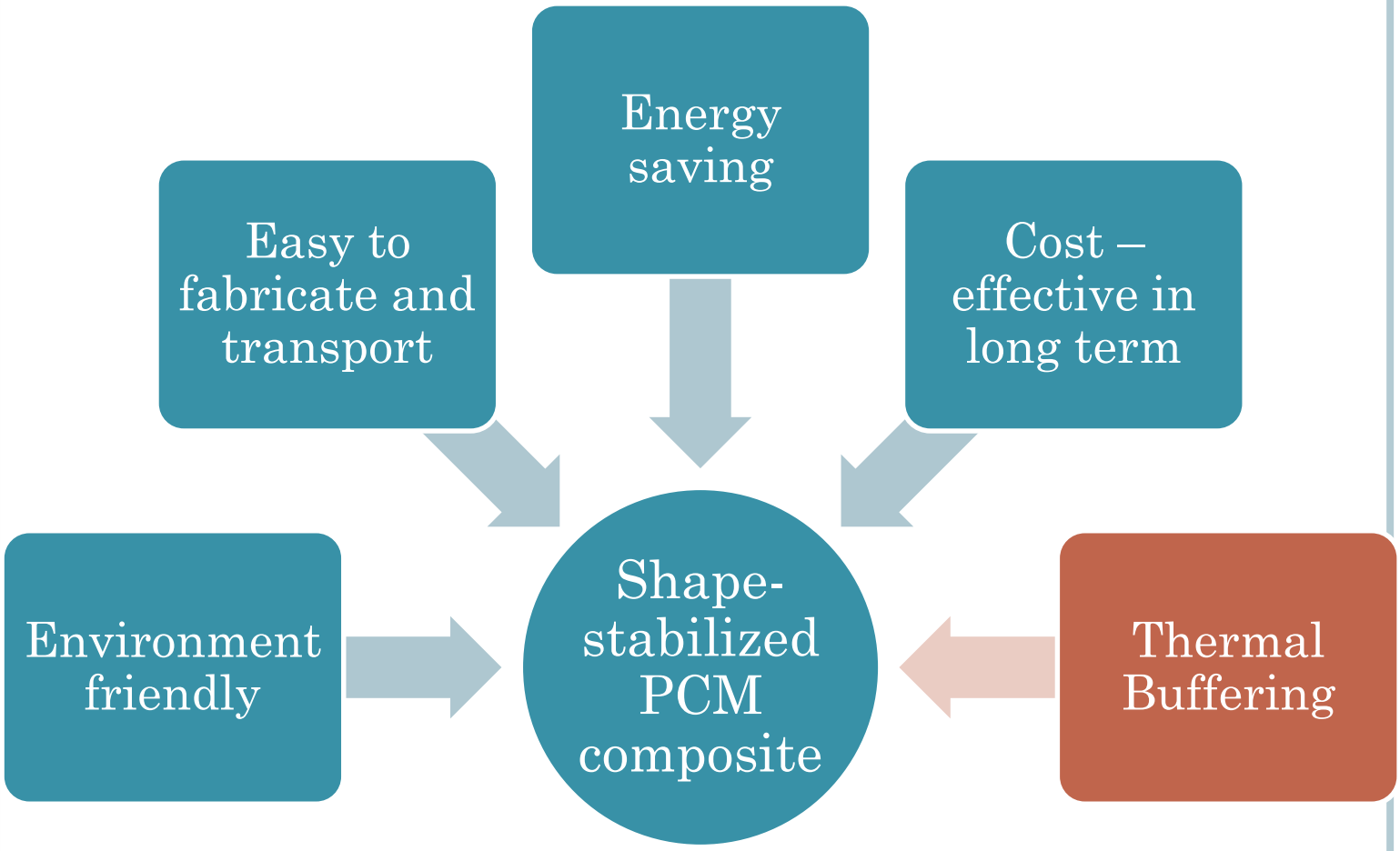


Figure 1: Working principle of PCM

Need of PCM in packaging

- Temperature sensitive food items should be served and transported at particular temperature
- Biopharma products such as vaccines and biologics loose their effectivity with temperature excursion
- Dearth of electricity and fuel in remote location is bottleneck in supply of food and life saving pharma product requiring active temperature regulation transportation

Solution



Methods of PCM incorporation

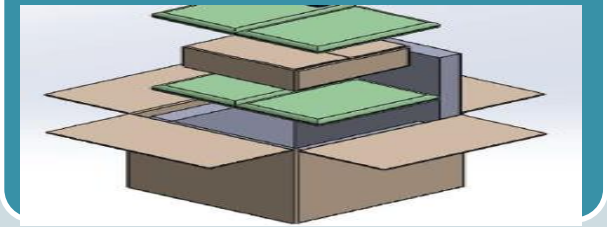
Large container shipment

In wall-
Affect thermal gradient between inner and outer wall

In refrigeration-
Affect function of compressor

Small container packages

PCM & insulation-



Only PCM

Literature

PCM	Method	Phase transition properties	Reference
RT 35HC RT 5HC	Macroencapsulated in wall Macroencapsulated near compressor	Delay in peak temperature by 4.3 hrs Compressor cycle reduced to 6 from 13	1
RT 35HC	Macroencapsulated in wall with PU foam	Peak heat load and total energy reduction of 20% & 4.7% respectively	2
RT 5	Macroencapsulated in wall as cold plate	Maintained temperature below 12 ^{o}C for 14 long hours	3
RT 18HC	Macroencapsulated in aluminium container in refrigeration system	Outlet air can be stabilized around 18^{o}C for 1 hour	4

Literature

PCM	Method	Phase transition properties	Reference
RT 18HC	Macroencapsulated in refrigeration system	Reduced fluctuation to 2.56°C from 4.3 °C	5
Lauryl alcohol-octanoic acid Sodium formate aq. solution	Macroencapsulated in wall in two different chambers	Maintained phase change temperature without external power supply for 9.2 hours and 6.2 hours respectively	6
E-26 E-29 E-32	Macroencapsulated in wall as cold plate	E26 gave melting time of 17200 sec for moving truck	7
Eutectic PCM	Macroencapsulated in wall as cold plate in stainless steel container	Maintained phase change temperature without external power supply	8

Literature

PCM	Method	Phase transition properties	Reference
RT 6	Impregnation in Ca silicate with 6 layer bubble wrap insulation	174J/g at 8ºC, 4-9 hours	9
Sodium chloride hydrate and additive	Macroencapsulated in plastic brick without insulation	PCM and insulation show fluctuation of 1ºC and 4ºC separately	10
Octanoic acid	Microencapsulated PS shell in aluminium bag without insulation	42.9J/g at 14.7ºC, 6-8.8 hours	11
Paraffin	microencapsulated in aerogel with insulation	Temperature maintenance increased with PCM layer of 5ºC	12

Literature

PCM	Method	Phase transition properties	Reference
Na_2SO_4. $10H_2O$ and additives	Macroencapsulated in aluminium sheets	Maintained temperature for 9.63 hours	13
Tetradecane	Microencapsulation in PS shell without insulation	30 min	14
OP5E aq. solution	Macroencapsulaed with insulation	Maintain temperature for more than 72 hours in the range of 2-8ºC in ambient temperature range from -20ºC to 35ºC	15
PCM with suitable phase change temperature	Macroencapsulated in container wall	Maintain temperature of beverage for longer time	16

Conclusion

- PCM consumption seems to be an emerging trend in various fields such as e-commerce packaging, food packaging and pharma packaging
- This presentation provides information about different packaging systems utilizing PCMs for transporting temperature sensitive products

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THANK YOU !