



Recycled Tetra Pak-based PCMs for enhanced photo-

thermal conversion and thermal energy storage



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What are Phase Change Materials?

Why are they used ?

Why recycled plastics (Tetra Pak waste) can be employed ?

Phase Change Materials

A phase-change material (PCM) is a substance

- a high latent heat of fusion
- able of **storing** and **releasing** large amounts of energy during phase transition at constant temperature



Paraffin waxes

- Broad melting range
- ✤ Heat of fusion up to 200 kJ/kg
- Environmentally harmless
- Available / cheap



number of carbon atoms in the molecule

Phase Change Materials

Polymer: Fixation of active component Immiscibility of components , but good compatibility. To keep a material in a compact shape even after melting of wax.







Paraffin wax: High heat of fusion. Melting point according to application **Filler:** Enhancement of thermal conductivity of mixture at minimal concentration of filler.

Shape Stabilized PCM



Applications

- Temperature Management in Rooms / Buildings
- Thermo Regulating Textiles
- Thermal Comfort in Vehicles
- Thermal Protection of Electronic Devices
- Thermal protection of Food



• Cooling / energy management of engines (electric, combustion)

PCM designed from Tetra Pak waste



<u>Tetra Pak[®] :</u> 190 milliard packages sold and net sales of 11.5 milliard € in 2019. 50 milliard of the cartons were recycled (Tetra Pak, 2020).

Composition: Paper-75 wt%, polyethylene -20 wt %, and aluminum - 5 wt %

PE/AI= 80/ 20wt.%

Matrix for preparation of PCM composites (plus paraffin and graphite)



Thermal energy storage of PCM



Transient guarded hot plate technique (TGHPT)

Heat flux and temperature evolution from solid to liquid state

Photo-thermal conversion a heat release



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Conclusions

Recycling potential of polyethylene-based packaging

The main problems:

- A low interest of plastics convertors
- Limited marketability of products based on recyclate
- Enhanced costs for sorting and cleaning
- Lower quality, deteriorated mechanical properties
- Limited number of recycling cycles
- Lower aesthetical performance

The main challenges:

- A specific application does not require
- a high mechanical performance
- Material has some special functionality
- Extended life cycle

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