



Cold Chain in F&B Industry

Food and grocery retail needs passive temperature-controlled packaging.

The Food and Grocery (F&G) segment in India is a very critical market to focus our attention on when looking at cold chain. The Indian market for F&G is expected to reach USD 810 billion by 2020. This segment consists of a diverse portfolio of consumers, channels and unique distribution models. For instance, today the various channels in this segment are the traditional mom and pop stores, large supermarkets, online grocery retailers with the largest channel still comprising of small stores popularly known as *Kiranas*. The *Kiranas* account more 90 per cent of the total F&G segment and the newest channel in the segment - online grocery retail or e-grocery accounts for 2 per cent already within the last five years. The



Macrovector/Freepik, n.d.

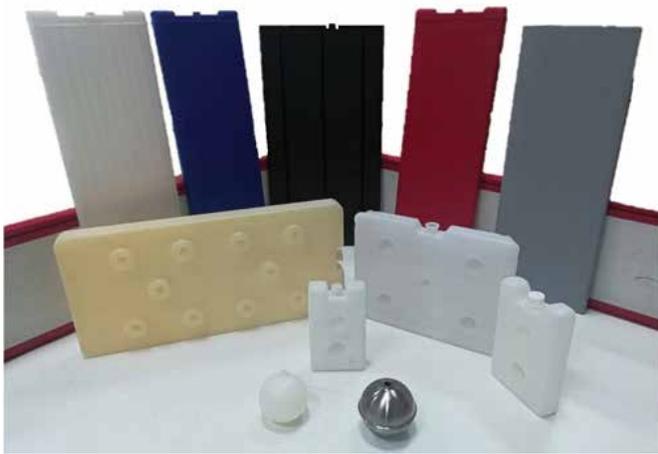


Figure 1: PCM thermal batteries

e-grocery phenomenon cannot be ignored and its adoption will only keep increasing with the increase in internet connectivity and access to smart-phones.

The shift from *Kiranas* to alternate channels such as the large supermarkets and e-grocery essentially aims at getting wide range of food products to consumers conveniently, faster and in the right condition. The most challenging aspect in the supply chain is the preserving the quality and value of perishables.

Challenges

Small part load shipments

The complexity of offering a wide portfolio of food products requiring different temperature conditions of storage further increases as one goes downstream to the last mile. In a supermarket, the last mile is taken care by the consumer, while in case of an e-grocery retail it has to plan its process until the consumer doorstep. Whether the order is for a single-family pack ice cream or a mix order of cereals, yogurts, frozen meat and fresh vegetables the amount of effort in planning and cost of resource is the same.

Pre-packaging of orders

The increasing competition for market share and high expectations of the consumer has resulted in unique business models. Large super markets have begun offering home deliveries while e-grocery companies are moving from pre-defined delivery schedules to just in time deliveries. For instance, a popular e-grocery retailer based in Gurgaon offers a unique value proposition aligned to the young millennials and one which I personally use. The offering is to ensure that any order placed latest by 11pm is delivered sharp at 7am at your doorstep. For such services the challenge is in preparing the packages of perishables and temperature sensitive products in advance which on an average is seven hours. Within the temperature-controlled food products, the chilled category (2C to 8C) of products such as fruits, vegetables, milk, yogurt, constitutes 80 per cent and the frozen category (-)15C to (-)25C constitutes 20 per cent of the order. From winters to summers the cost of rejection and complaints vary from as low as 1 per cent to 7 per cent a month.

Multi-temperature transport

Each state would have a central warehouse where the products are consolidated and further moved to the spokes which in case of e-grocery retail is known as a dark store and in case of large supermarket chain it is the outlet itself. The movement from hub to spoke is relatively simple as consolidation can be based purely on temperature category. However, the challenge is that a full truck load is not viable as refrigerated trucks have single temperature in which case moving multi-temperature commodity becomes a challenge and a high cost.

Passive cold chain Ecosystem

Difference between Active and Passive cold chain

A cold chain that uses conventional air-conditioning which is dependent on instantaneous power whether the fuel is electricity or diesel is termed as an active cold chain ecosystem. An active system such as compressor-based packaging system would be high on capital cost and maintenance cost. It does not offer flexibility in payload. While a passive cold-chain system is based on thermal energy storage (TES) technology that enables decoupling the cooling operation from the source of energy. TES technology based on Phase Change Materials (PCMs) enable storage of energy at different temperatures. These materials can be packed in plastic cartridges or pouches as shown in the figure 1. Popularly known as 'PCM packs' or 'thermal batteries' it could be customised in any shape, colour and size.

Bespoke Solutions

The temperature and number of hours of retention forms a parameter to design the insulated box and the thermal batteries. Also, understanding the customers requirement to arrive at an optimal universal packaging volume for the last mile delivery becomes critical. In many cases the customer would have already made the investment in an insulated box. In such cases the box specification should be considered to arrive at the right type and quantity of thermal battery.

The standard packaging from a solution provider is validated to perform at under various ambient conditions. The combination of the three components - PCM, the insulation quality and the volume of the packaging play an important role, hence, it is important to get the performance re-validated incase the customer wishes to take only the thermal battery.

Charging of thermal batteries

The charging of thermal batteries essentially means freezing



Figure 2: plo save® PCM charging unit

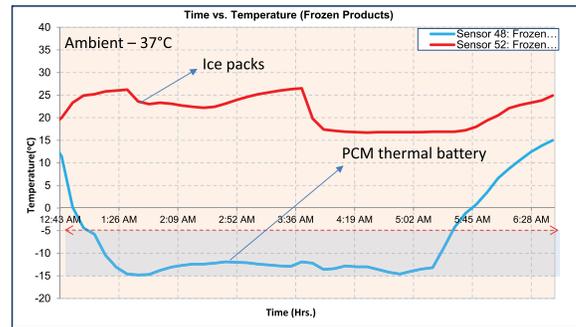
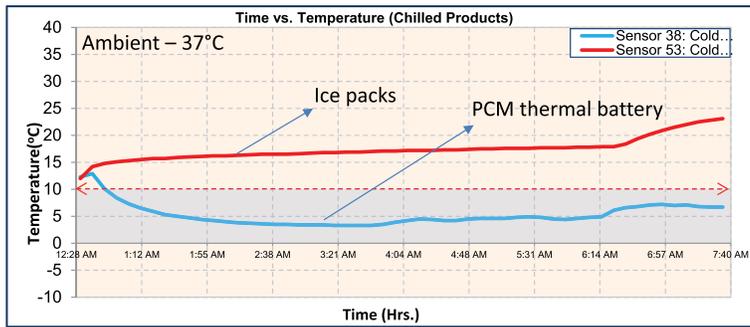


Figure 3: Thermally insulated boxes lined with PCM thermal battery of the PCM material completely. A PCM material's core utility is derived from its ability to store latent heat at the designed temperature. Latent heat is the energy absorbed or released during phase transition, for instance, if the PCM thermal battery contains a (-)26C Cell material then it needs enough cooling energy at a temperature lower than (-)26C Cell to ensure freezing. A PCM thermal battery provider hence would provide the right charging unit as shown in figure 2.

Precise, predictable and lean

PCM thermal batteries not only offer precise temperature control in virtue of its property as explained above but also eliminates any uncertainty linked to active cooling systems. In an active cooling system, a machine failure or switching of the equipment would result in temperature excursion. However, in case of passive systems one can control it but not switch it off. In retail supply chain for intercity the routes are predictable hence, with the thermal battery one can essentially quantify the amount of cooling requirement, which is stored in advance. The most critical product is ice cream in which thawing and freezing cannot be tolerated at all. PCMs are the only solution to provide for an accurate (-)18C transport for as long as 16 hours (Most requirement is below 16 hours).

The layout and arrangement of the thermal batteries as shown in figure 3 also changes depending on the temperature and retention time required.

Performance

Ice packs, glycol packs and dry ice were the commonly used passive materials which today become redundant owing to its disadvantages in terms of precise temperature control, repeatability and reusability. PCMs ensure all these key performance metrics required to ensure product integrity and lower operating cost of supply chain. The above graph indicate the performance of the product packaged with PCM battery pack vs ice packs. In absence of PCM thermal batteries, the product is exposed to a much higher temperature beyond the threshold zone (The highlighted zone).

The Indian cold chain sector provides for immense opportunity for making an impact on the social, economic and environmental conditions. With rapidly growing demand, the adoption of new technology to handle this demand is becoming mandatory. Passive cold chain packaging is just one of the many applications of PCMs and it is time companies proactively identify supply chain efficiency gaps which can be filled with simple and smart technology interventions.

Vishnu Sasidharan
 Vice President
 Pluss Advanced Technologies Pvt. Ltd.



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