TEMPAID™
COLD CHAIN PACKAGING

White Paper

The Case for PCMs Over Water-Based Gels for Control Room Temperature Applications

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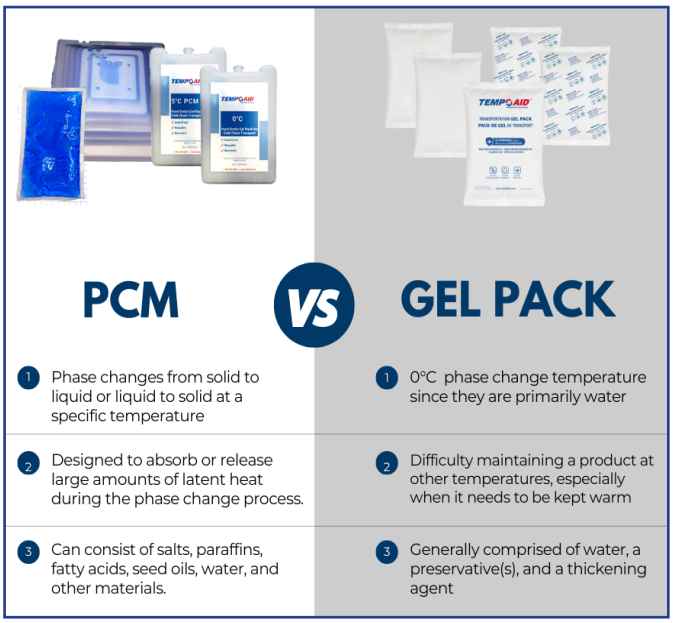
Executive Summary

Phase Change Materials (PCMs) are not typically associated with low-cost cold chain solutions, as they compete with water-based solutions that have been used for decades. When controlling temperatures near 0°C, water is your best option regarding cost and performance. However, when the temperature requirement is at room temperature, a properly formulated and utilized PCM can far outperform water. This results in smaller, lighter, more efficient packaging with significantly reduced storage space and shipping costs. It also has a major environmental impact related to both manufacturing and disposal.

This case study will demonstrate how properly tested PCMs, in a mat format, can be used with the International Safe Transit Association's (ISTA) temperature profiles to create a lighter, more cost-effective solution for Controlled Room Temperature (CRT) applications.

What is The Difference Between a PCM and a Gel Pack Regarding Composition, Use, and Cost?

PCM and gel packs are commonly used in cold chain packaging to maintain a consistent temperature while transporting temperature-sensitive products. However, they differ in terms of their composition and how they work.



A PCM undergoes a phase change from solid to liquid or liquid to solid at a specific temperature. They are commonly used in cold chain packaging due to their ability to absorb or release large amounts of energy in the form of latent heat during the phase change process, making them effective in maintaining a consistent temperature within a specific range. A PCM can be made from various materials, including salts, paraffins, fatty acids, seed oils, water, and more.

Standard water-based gel packs are pre-formed plastic pouches filled with a gel-like substance with a phase change temperature of 0°C since they are primarily water. The composition of gel packs can vary depending on the product and manufacturer but are generally comprised of a combination of water, a preservative(s), and a thickening agent. Water is ideal for keeping things cold with its 0°C phase change but has little energy available to maintain a product at other temperatures, especially when it needs to be kept warm.

PCMs hold temperatures longer than gel packs within their phase change temperature range. PCMs have a high latent heat of fusion, which means they can absorb and release a large amount of thermal energy during a phase change without the temperature changing significantly. This makes them ideal for cold chain packaging applications where temperature control is critical.

Gel packs tend to be lower cost than PCMs; however, a larger volume and weight of gel packs are needed to maintain a product at room temperature compared to PCMs. Therefore, gel pack shipments weigh more and have a lower product payload volume than those with PCMs. Since the gel packs take up more space than PCMs, shipments with gel packs require a larger cooler. These weight and size factors can increase shipping costs based on the carrier.

In summary, PCMs and gel packs effectively maintain a consistent room temperature during transportation but work differently. PCMs undergo a phase change to absorb or release heat energy, while gel packs do not experience a phase change within the range of temperatures for controlled room temperature requirements. The choice of which to use will depend on the specific requirements of the cold chain packaging and the temperature range that needs to be maintained.

Test Cases for Using PCMs Versus Gel Packs

In 2022, TempAid began testing configurations that included comparing soft pouch PCM mats to water-based gel pack configurations.

The testing started with the goal of maintaining 15 – 25°C against the ISTA 7D Winter profile using four different coolers, with each cooler having two different configurations: one water-based gel pack configuration and one PCM18 Mat configuration. The coolers included:

Cooler Model Number	Cooler Size
RA1377092	8 - liter cooler
RA1377050	13 - liter cooler
RA1377100	26 - liter cooler
RA1377135	50 - liter cooler

Results and Analysis

The below table outlines the resulting shipper weights, available inner payload volumes, and performance duration.

Attribute	8 L PCM18 Mat	8 L Gel Pack	18 L PCM18 Mat	18 L Gel Pack	26 L PCM18 Mat	26 L Gel Pack	50 L PCM18 Mat	50 L Gel Pack
Tare Weight (lbs)	4.82	13.87	5.86	16.62	8.02	35.38	16.22	46.8
Available Payload Volume (L)	2.86	0.97	5.91	2.85	14.94	5.97	29.91	19.17
Time between 15 - 25 °C (h)	50	32	48	36	50	48	54	53

The below table outlines the change in critical attributes comparing the PCM18 Mat configurations vs. the gel pack configurations.

Attribute	8 L Cooler	18 L Cooler	26 L Cooler	50 L Cooler
Weight Reduction	65%	69%	77%	69%
Available Payload Volume Increase	125%	124%	75%	38%
Performance Duration Improvement	56%	33%	4%	2%

The PCM18 configurations weigh an average of 70% less than gel pack configurations. At the same time, we were able to demonstrate the ability to increase the available payload volume by 90.5% while improving performance durations by an average of 24%.

Statistically, in every case, the smaller the cooler payload, the more the potential savings.

Translating Results to Total Cost of Ownership

Utilizing PCM mats instead of gel packs enables companies to downsize their containers without compromising payload capacity. This reduces required warehousing space for storing coolers and refrigerants and provides recipients with a lighter and less bulky container to handle and dispose of upon receipt. Moreover, there is an immeasurable environmental impact, as less energy is required to ship smaller coolers and fewer pallets.

For larger shipments or when there is a need to send more product to a single receiver, customers can use the same sized box and cooler they currently use but ship more product. Consolidating two shipments into one enables a substantial improvement in packing efficiency and has the potential for cost savings, increased productivity, and improved logistics.

As mentioned earlier, PCMs offer a superior solution for maintaining temperature stability during shipments. This performance enhancement minimizes temperature excursions, reducing the costs associated with product replacement and ensuring customer safety.

PCM performance allows for longer-duration shipments, offering a cost-effective alternative to overnight shipping. Customers can confidently ensure the integrity of their products while optimizing their shipping processes.

For CRT shipments where the payload volume is small, such as a single patient shipment by a pharmacy (under 9" x 7" x 2"), many customers are adopting our unique SpeedyPac™ PCM CRT Envelope. This envelope features integrated PCM mats between protective insulation layers, resulting in a more compact, mailer-sized unit. It further reduces the weight and size of the container compared to the smallest cooler options.

The SpeedyPac PCM Envelope integrates PCMs into it's construction, reducing materials, weight, and cost by upwards of 40%

Beyond ROI: Packaging Affects the Environmental Footprint and Perceptions of Your Brand

Beyond the cost savings associated with shipping smaller and lighter shipments, and using less energy to transport them, improvements in the environmental footprint of cold chain packaging can have a significant impact on patients' perception of a company's commitment to the environment.

Patients are becoming increasingly aware of environmental issues and are more likely to choose products and services from companies that demonstrate a commitment to sustainability. Here are some ways in which demonstrating improvements in the environmental impact of cold chain packaging can benefit a company's perception among patients:

1. **Increased trust:** Patients may perceive a company actively working to reduce the environmental impact of their packaging as being more trustworthy and responsible, leading to increased loyalty and positive word-of-mouth referrals.

2. **Improved reputation:** This environmental commitment can also improve a company's reputation among patients and other stakeholders, enhancing its brand value and differentiating it from competitors.

3. **Enhanced patient satisfaction:** Patients may be more satisfied with a company's products or services if they perceive them to be environmentally responsible, increasing patient retention and loyalty.

4. **Positive impact on the environment:** Contributing to a healthier planet is often seen as a positive action by patients who care about the environment.

The conclusion is that the actual cost savings and the perceived environmental impact of reducing a shipment's size and weight can impact a company's bottom line and brand perception.

Conclusions

The tests conducted in this study prove that for every cooler size, the PCM18 configuration maintained 15 – 25°C against the ISTA 7D Winter profile for a more extended period compared to that of the water-based gel configuration and were also significantly lighter and had a much larger payload box size to store product.

Factoring the cost savings of using a smaller cooler (or even a PCM envelope), along with a reduction in the room temperature maintaining materials required and the cost of shipping, companies can show significant savings in their current costs of materials and shipping.

Those cost savings can be even more impactful for smaller shipments or individual doses.

In addition, improving the environmental impact of cold chain packaging can help a company build a positive image among patients, enhance its reputation, and increase patient satisfaction and loyalty. For more information, specific testing data, or pricing on any of these configurations, visit www.tempaid.net or contact us directly at info@tempaid.net or 1-800-cold-hot.

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