

Thermal Packaging Design Trade-Offs to Consider

Anthony Alleva, Associate Technical Director

Cryopak[®]



Going through the thermal packaging design process, testing and qualification involves multiple decision points in order to best optimize the resulting package. Here are the some important trade-offs to consider when specifying the package requirements.

1. Custom Packaging Solutions VS « Off the Shelf » Solutions

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The first question that must be asked when specifying a thermal package system is whether to design a new package or implement a previously designed system. Most major cold chain package suppliers are selling [pre-qualified shippers](#) to their customers. The manufacturer would have tested the package against **general industry specifications** and should be able to **provide a report** on the positive results of that testing. Depending on the size of your company, there may also be packages previously designed and/or in use already for other shipping situations.

CUSTOM PACKAGING		OFF THE SHELF	
Pro	Con	Pro	Con
Ability to tailor design specifically to application	Design process is time consuming	Readily available	No cost for designing the package
Optimizing the design will lower the cost over the lifetime of the package	Upfront cost incurred to develop the package can be expensive	Proven track record of performance	Likely oversized in order to meet broad requirements

2. Conventional Refrigerants Gels VS Phase Change Materials

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Phase change materials (PCMs) are chemicals chosen for the temperatures at which they transition between states of matter. The vast majority of PCMs are chosen for use of their solid/liquid phase change temperature. The goal is to match the phase change temperature with the product temperature requirements as the **PCM will naturally maintain that temperature** while melting or freezing.

REFRIGERANT GELS		PHASE CHANGE MATERIALS	
Pro	Con	Pro	Con
Inexpensive direct package cost	Indirect costs can be high for shipping and warehousing	Higher temperature stability within the desired range	Expensive direct package cost
Components easy to source and condition	The phase change temperature not being ideal means a more complex package results	Less complex packages are possible by simply surrounding the product with PCM	Conditioning can be difficult if the proper equipment is not available

3. Lab Temperature Profile Testing VS Real World Shipment

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3. Lab Temperature Profile Testing VS Real World Shipment

When testing to confirm that a package performs as needed it must be put together as though it were being used for a live shipment then **exposed to temperatures** that are representative of the expected shipping environment. This can be done either in a laboratory using an environmental chamber to simulate the environment or via actually shipping the box between representative origins and destinations.

LAB TEMPERATURE PROFILE		REAL WORLD SHIPMENT	
Pro	Con	Pro	Con
Very repeatable from one test to the next	A lot of equipment and manpower needed to conduct the testing	Definitively mimics actual environmental conditions	Likely oversized in order to meet broad requirements
The profiles can be designed to represent the worst case temperature conditions	The profile may be more extreme than really needed resulting in an oversized package	Incorporates other field hazards such as shock and vibration effects on the package	Every box tested will experience different requirements making iterations difficult to analyze

4. Reusable VS Disposable

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All packaging can be designed with reuse as a possibility. Whether a package should be designed with the intention to reuse depends on **cost structures** and the ability of the manufacturer to **retrieve the package** after the product is removed from it.

REUSABLE PACKAGING		DISPOSABLE PACKAGING	
Pro	Con	Pro	Con
Environmentally friendly, less waste per shipment, lower carbon footprint	Reverse logistics are needed along with a refurbishment program	Once the shipment leaves the distribution center it doesn't need to be controlled	Unless the packages are recycled by the recipient, they will end up as garbage in land fills
Cost of the entire system can be less if the number of reuses possible is very high	Initial direct cost of the package fleet is higher	Cost of the individual package is less	If used for a long period of time the cost will work out to be higher overall

5. Minimizing Direct Packaging Costs VS Freight Costs

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When developing the cost model for a shipping package the **cost of the freight** to actually ship it cannot be ignored. The direct cost of the package itself plus the cost of the freight is the actual cost of ownership for the system. The optimal system will **balance these factors** but they can be in conflict with one another so a decision needs to be made which one to focus more heavily upon.

DIRECT PACKAGING COSTS		FREIGHT COSTS	
Pro	Con	Pro	Con
Money tied up by inventorying materials will be lower	Results in a heavier, larger package	A smaller and lighter weight package can result from the process	Specialized materials may be employed that are more difficult to prepare or dispose of
Less expensive packages tend to use water gels and have simpler conditioning requirements	End user will have to dispose of the heavy package materials	Could also result in fewer large packages which would save on labor	Precludes a reuse program to save on any reverse logistics fees



To ensure the most success in designing a thermal package for cold chain distribution, all of the above trade-offs should be factored into the design process and multiple options should be considered.

Cryopak's team of technical engineers can help to guide you through the package design process and qualify packaging that will maintain the integrity of your products within the required temperature profile.

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