Qualifying a Packaging System Under Most Challenging Conditions

A case study to detail the nuances, benefits and ramifications of qualifying a packaging system to the most challenging conditions

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The Problem

Temperature Assurance Packaging is generally qualified for minimum and maximum product loads of a specific product or product range. These shipping systems are normally qualified to a standard shipping lane or distribution channel. Once they have been qualified there is little flexibility to alter the bracketed product loads without updating documentation and repeating operational and performance qualifications. The time and cost associated with such documentation updates further limits shipping systems flexibility.

To address this, “pre-qualified” shippers are available throughout the industry. But, these shippers may not have been tested against a representative product volume. A large payload is slower to change temperature when exposed to a given ambient temperature profile and conversely, a small payload will change temperature more rapidly. In addition, the ambient temperature profiles tested may not be representative of the actual shipping lane. A deviation from the representative shipping lane may result in a shipping system which is over or under designed resulting in higher costs, excess components, or poor performance.

The location of the temperature probes used during testing is defined by the manufacturer of the shipping system but there is a temperature gradient within the shippers. These disparities can add up to enough of a difference to where the “pre-qualified” shipper has not been challenged against the extreme temperatures that may be experienced outside of the standard shipping lane.

Methodology

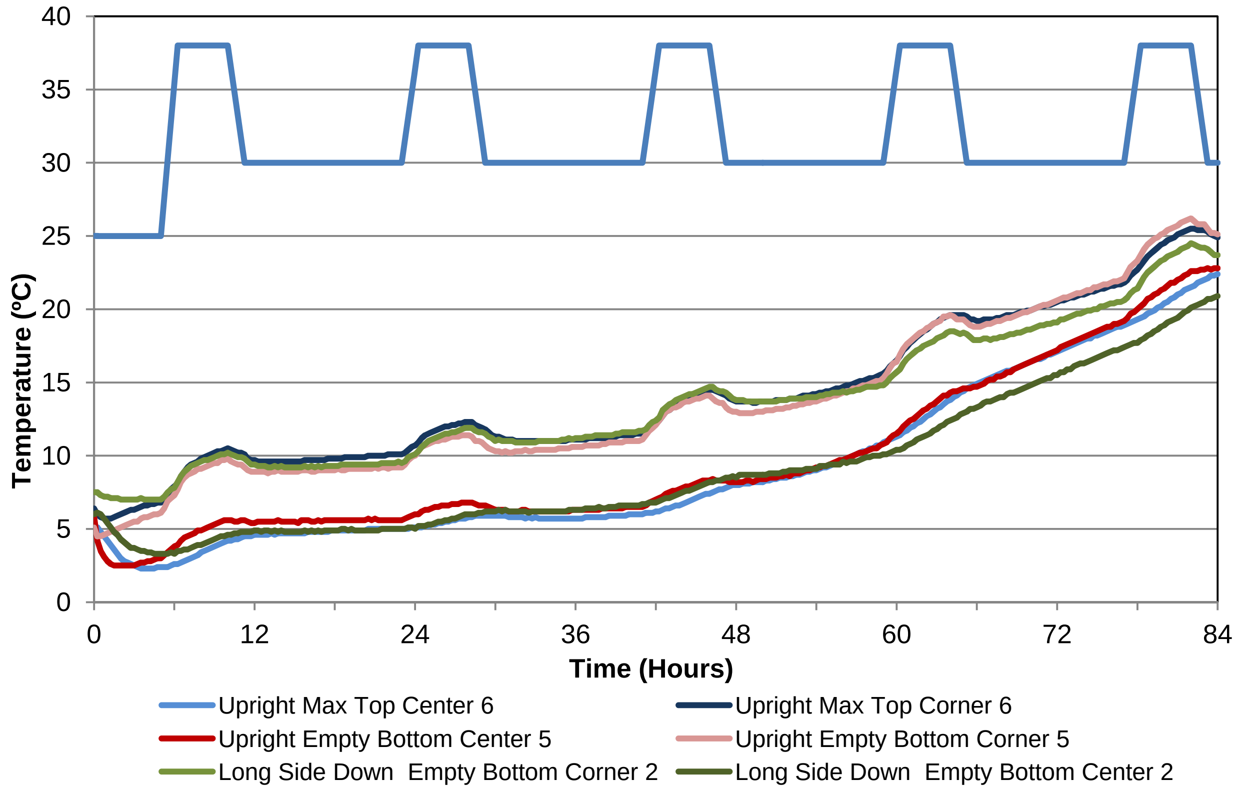
To determine the most challenging conditions, testing was conducted using a variety of product densities. These densities and the thermal properties of various materials illustrated the rate at which different materials change temperature when subjected to identical ambient temperature profiles and shipping system designs. Testing was conducted to understand different fill or dunnage materials. These materials impact the airflow within each shipping system.

Essential Concepts

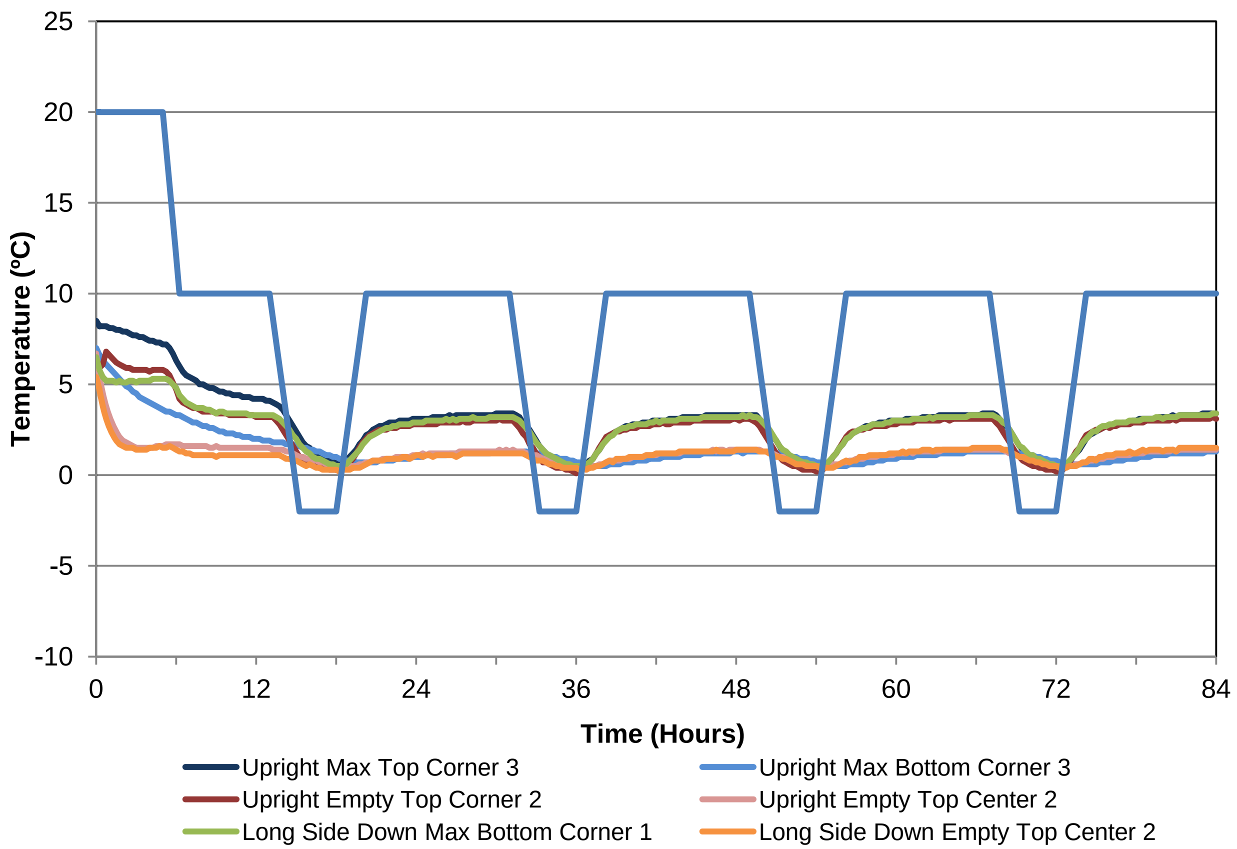
The definition of the most challenging conditions stretches variables of a package to its worst case extremes. Worst case for the thermal properties is to test air. Air has a significantly greater thermal diffusivity than other materials commonly used as product loads. Air is the most responsive to the changes in ambient temperatures and has little ability to retain the heat which it does absorb. The worst case product volume would be an infinitesimally small mass which takes up the entire volume available. The worst case dunnage material tested was an empty product carton. Combining these challenging conditions, our product space was defined as a corepack filled with product cartons which in turn were filled with air. Defining the product space allows the consistency of the product volume between the minimum and maximum product loads.

Findings

Data illustrated the coldest cold probes and the warmest warm probes for each testing configuration were located in the shippers using air as the product load within a corepack using cartons as dunnage material. This load representing the maximum volume also represented the most challenging testing condition. The temperature within the shipper changed more rapidly than the other configurations. In the parcel shippers tested, conduction is the dominant mode of heat transfer but convection became increasingly more important as the size of the shipper and product load grew.



40
35
30
25
20
15
10
5
0
Temperature (ºC)
0
12
24
36
48
60
72
84
Time (Hours)
Upright Max Top Center 6
Upright Max Top Corner 6
Upright Empty Bottom Center 5
Upright Empty Bottom Corner 5
Long Side Down Empty Bottom Corner 2
Long Side Down Empty Bottom Center 2



25
20
15
10
5
0
-5
-10
Temperature (ºC)
0
12
24
36
48
60
72
84
Time (Hours)
Upright Max Top Corner 3
Upright Max Bottom Corner 3
Upright Empty Top Corner 2
Upright Empty Top Center 2
Long Side Down Max Bottom Corner 1
Long Side Down Empty Top Center 2

Benefits

The qualification using air as a product load encompasses all product images. Since the temperature changes the quickest with air, this can be used as a more conservative representation of vials, syringes, medical devices or even tablets. Another benefit is it eliminates the need to obtain product to conduct thermal qualifications. This methodology allows the end user to create standard testing procedures to be able to compare testing from various projects or product loads.

Limitations

This methodology may results in solutions which are too conservative for an individual customer. If a customer has a consistent single load or the primary packaging volume which is always a significant liquid volume then the result will be over designed. These product packouts would not be representative of the air load which was tested. This inefficiency could result in a more expensive solution.

Summary

Air as a product load is the most challenging means to test a shipping system. Air is far more susceptible to changes in ambient temperatures than any other product load. Fixing the product volume through the use of a corepack allowed for the most repeatable results and consistency.

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Sonoco ThermoSafe, a unit of Sonoco, is the leading provider of temperature assurance packaging for the safe and efficient transport of pharmaceuticals, biologics, vaccines, and other temperature sensitive products. For more information about Sonoco ThermoSafe's complete line of packaging solutions, please visit the company website at www.thermosafe.com or contact customer service at (800) 225-7443.

Sonoco ThermoSafe's ISC Labs® is the global leader in innovative design and testing services within the temperature assurance packaging industry. Our industry-leading thermal modeling capabilities enable rapid development of highly optimized custom solutions. Our modular platforms allow for hundreds of configurations using standard components, resulting in very short development times and lower costs. Contact us today to discuss your unique temperature assurance packaging requirements.

ABOUT SONOCO

Founded in 1899, Sonoco is a global provider of a variety of consumer packaging, industrial products, protective packaging and packaging supply chain services. With annualized net sales of approximately $4.8 billion, the Company has more than 19,000 employees working in over 340 operations in 34 countries, serving many of the world's best-known brands in some 85 nations. Sonoco is a proud member of the 2012/2013 Dow Jones Sustainability World Index. For more information on the Company, visit our website at sonoco.com.

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