

ECO°COOL

PANEL-KIT ECO-SAFE++

PANEL-KIT + WATER-BLANKETS



Specification

Six-piece, insulating Panel-Kit + five Water-Blankets for shipments of temperature sensitive goods (5°-25°C) or for the protection on transport interfaces of actively temperature controlled transports (2°-8°C). Various dimensions.

Construction

An ECOCOOL Panel-Kits consists of six made-to-measure EPS plates , laminated with Isohood-2L2 insulating foil on the outside. Overlapping flaps with double-sided adhesive tape on the side walls and top lid allow for perfect closure. Wall thickness: 50mm EPS + 7mm Isohood-2L2.

Wall thickness	50mm
Density (kg/m ³)	20.5
Weight	1.025 g/sqm
Thermal resistance	R = 1.45 (K*m ²)/W



ECOCOOL Water-Blankets consist of water-based gel (polyacrylate, cross-linked superabsorber granulate in waterous solution), vacuum-sealed in PA/PA/PE compound foil. The foil and superabsorber granulate comply with EC regulations for packaging materials in direct contact with foodstuffs.

Thermoforming foil

Composition	Thickness (µm)	Weight (g/m ²)	Tolerance
PA/PA/PE	85	83,5	+/-15 %

THERMAL QUALIFICATION SUMMARY

Important note: Results of thermal tests of thermocovers are always specific to the chosen test setup. In particular, the respective thermal mass on the covered pallet, incidence and strength of solar irradiation, ambient temperatures as well as prevalent wind conditions may lead to differing results. Hence, the following results are indicative of relative levels of performance rather than defining absolute levels of performance during real shipments.

Qualification strategy

A broad range of ambient conditions is covered by a combination of three separate test:

- Climate chamber summer test, medium mass
- Climate chamber winter test, medium mass
- Outdoor stress-test, zero mass (worst case scenario)

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Climate Chamber Summer Test

Climate chamber summer tests are indicative of the insulating properties of the tested packaging, disregarding the potential impact of solar irradiation. This is particularly relevant to understand the impact of hot ambient temperatures without direct solar irradiation, such as during loading processes in cloudy tropical locations, in non-insulated warehouses or during non-temperature controlled road- or sea-shipments.



Test setup:

- EUR pallet (80x120x100) loaded with 40 single fluted cardboard boxes
- Each cardboard box contains 4.5L water
- Total load 180L or 19% loading volume
- 40°C ambient temperature
- Test duration: 140 hours
- Inside logger temperature at start of test: 17.7°C



Positioning of inside logger inside the cardboard box



Positioning of inside logger on pallet



Positioning of outside loggers on the pallet



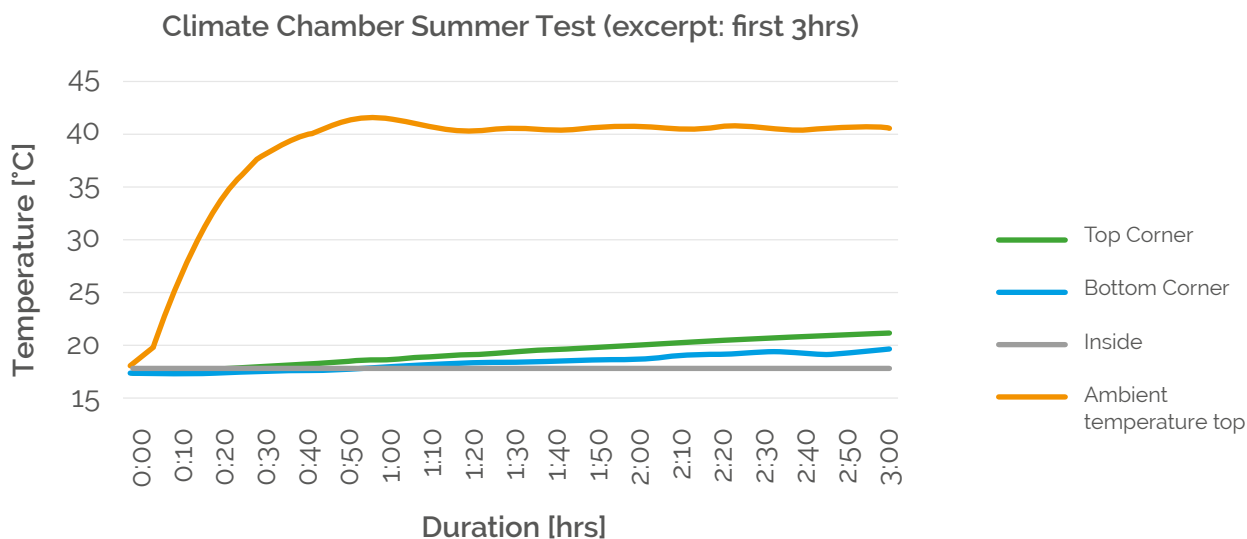
Pallet prepared with thermocover ECO-SAFE++

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Results

Test results are depicted in Graph 1 and tabulated in Table 1 below. The results document the ability of the Panel-Kit ECO-SAFE++ to significantly slow down the process of temperature equilibration between the temperature inside the fully assembled Panel-KIT or at the dummyload and the ambient temperature. In particular, the degree of insulation provided by the Panel-Kit ECO-SAFE++ is of an order of magnitude higher than the next best solution ECO-SAFE+. For instance, the temperature increase at most exposed logger (outside-top) over the first six hours is 5.5°C, compared to 10.6°C in the case of the ECO-SAFE+ solution.

All other things being equal (i.e. same ambient temperature), the test outcome will improve (slow-down of temperature increase) if the thermal mass on the pallet is increased and vice versa.



Graph 1: Climate chamber summer test, (excerpt first 3hrs)

	Time to temperature change		
	+Δ5°C	+Δ10°	+Δ15°
Outside top logger	5:00 h	24:05 h	67:35 h
Outside bottom logger	10:10 h	41:55 h	95:45 h
Inside logger	36:45 h	72:15 h	126:20 h



Temperature change over time (compared to starting value)

	1 hour	3 hours	6 hours
Outside top logger	0.9 °C	3.5 °C	5.5 °C
Outside bottom logger	0.5 °C	2.2 °C	3.7 °C
Inside logger	0.0 °C	0.1 °C	0.2 °C

Temperature to reach

	25 °C	30 °C	35 °C
Outside top logger	11:30 h	42:30 h	107:30 h
Outside bottom logger	25:00 h	69:25 h	> 140:00 h
Inside logger	51:35 h	93:25 h	> 140:00 h

Table 1: Tabulated results of climate chamber summer test

Winter test setup:

Climate chamber winter tests are indicative of the insulating properties of the tested packaging under cold ambient conditions. This is particularly relevant to understand the impact of cold ambient temperatures, as encountered during loading processes in winter conditions or during non temperature controlled road- or sea-shipments.

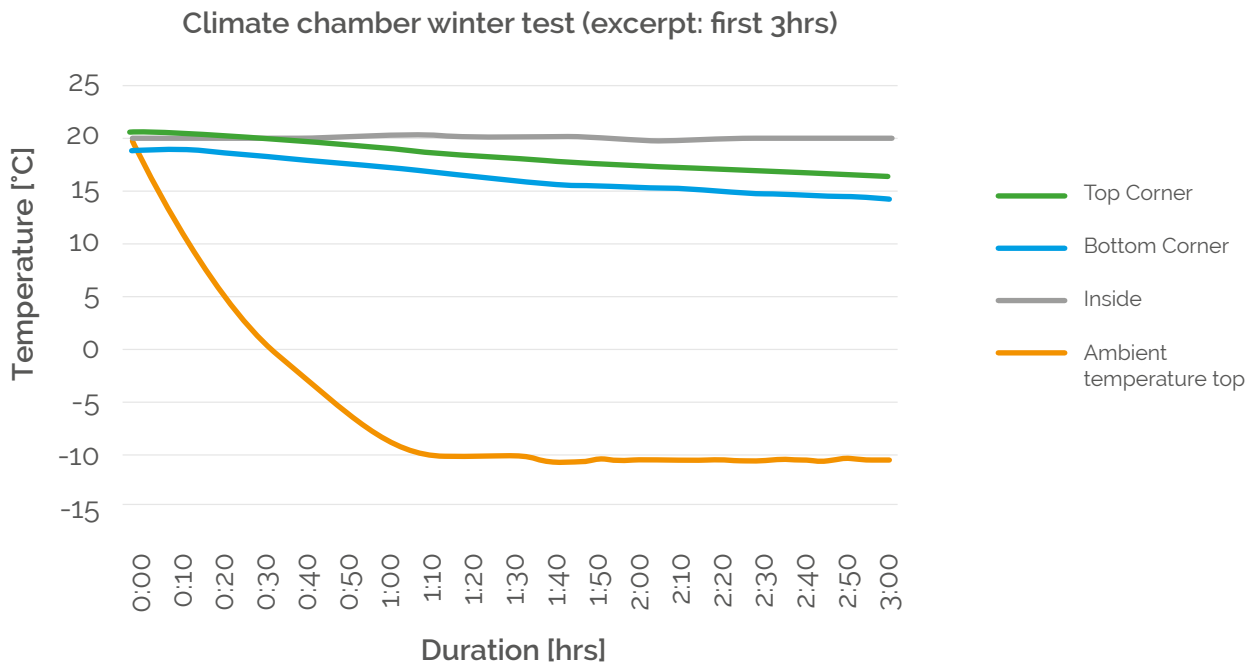
- EUR pallet (80x120x100) loaded with 40 single fluted cardboard boxes
- Each cardboard box contains 4.5L water
- Total load 180L or 19% loading volume
- -10°C ambient temperature
- 20.2°C start temperature

Results

Test results are depicted in Graph 2 and tabulated in Table 2 below. The results document the ability of the Panel-Kit ECO-SAFE++ to provide efficient protection from cold ambient temperatures. Compared with the next best solution ECO-SAFE+, the Panel-Kit ECO-SAFE++ increases the time to reach 10°C (5°C) at the outside of the goods (inside the Panel-Kit) by at least 8:25 hours, thus minimizing the potential for potentially harmful temperature excursions under winter conditions.



All other things being equal (i.e. same ambient temperature), the test outcome will improve (slow-down temperature decrease) if the thermal mass on the pallet is increased and vice versa.



Graph 2: Climate chamber winter test, (excerpt first 3hrs)

Time to temperature change

	-Δ5°C	-Δ10°	-Δ15°
Outside top logger	3:45 h	17:25 h	40:20 h
Outside bottom logger	3:05 h	12:55 h	31:30 h
Inside logger	25:50 h	48:05 h	74:55 h



Temperature change over time (compared to starting value)

	1 hour	3 hours	6 hours
Outside top logger	1.5 °C	4.3 °C	6.2 °C
Outside bottom logger	1.5 °C	4.9 °C	7.3 °C
Inside logger	0.0 °C	0.2 °C	0.7 °C

Time to reach

	10°C	5°C	0°C
Outside top logger	21:05 h	45:05 h	79:40 h
Outside bottom logger	9:45 h	27:35 h	56:05 h
Inside logger	49:20 h	76:15 h	> 96:00 h

Table 2: Tabulated results of climate chamber winter test

Outdoor stress test

A stress-test, based on a zero mass pallet (40 empty cardboard boxes) was conducted to account for conditions encountered in air-cargo shipments of low-mass pharmaceutical products. Covered pallets were exposed to direct sunlight for approximately 4 hours. One data logger was positioned on top of the pallet, directly underneath the Water-Blankets and the thermocover, recording the temperature development at the most vulnerable spot. Ambient conditions were calm and sunny. Ambient shadow temperatures peaked at 30.7°C (average ambient temperatures over 4 hours: 30.2°C), ambient temperatures under direct exposure to sunlight peaked at 49.2°C (average over 4 hours: 41.8°C).

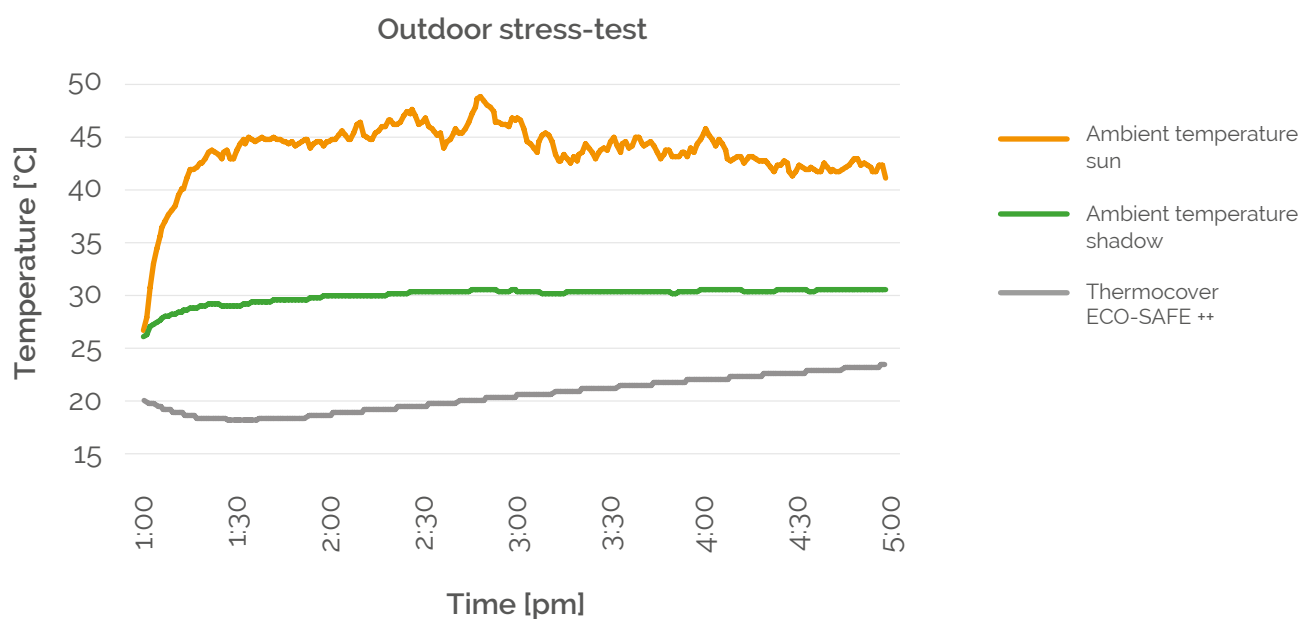


Test date: 2015/07/01, test location: Bremerhaven, Germany.

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Results

Test results are depicted in Graph 3 below. The results obtained with the Panel-Kit ECO-SAFE++ including ECOCOOL Water-Blankets. The results confirm the conclusions drawn from the climate chamber tests that the Panel-Kit ECO-SAFE++ offers the highest protection from extreme ambient temperatures. Even without preconditioned Water-Blankets (temperature of Water-Blankets at start of test approx. 18°C) the recorded inside temperatures remain strictly below the 25°C threshold for pharmaceuticals in the controlled room temperature range (15°-25°C) throughout the 4 hours test period. The average temperature differential obtained via the ECO-SAFE++ solution compared with the ambient temperature with direct sun exposure amounted to 22.6°C over the test period.



Graph 3: Outdoor stress-test