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THERMOCOVER ECO-LIGHT



Specification

Thermocover for palletized goods, various dimensions, sewn

Material

Single-layer polyethylene bubble foil, coated with aluminum foil on one side

	Thickness (µm)	Weight (g/m ²)
Airbubblefoil	118.8	108
PE layer	19.8	18
Pure Aluminum	7	20

Total Weight	146 g/m², ± 10%
Material Thickness	3.5 mm, ± 0.5 mm
Reflectivity	95-97%
Thermal resistance	R=0.105 (K*m²)/W



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)

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.

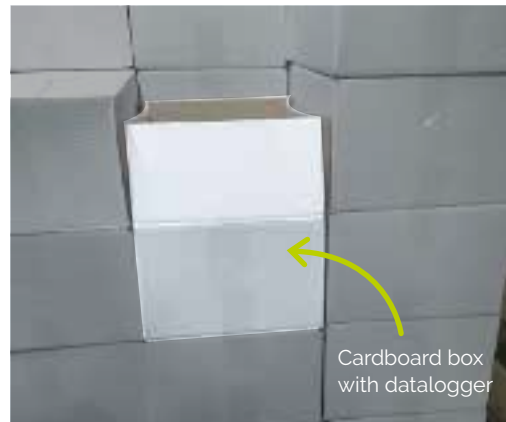
Test setup:

- 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
- 20°C start temperature
- Test duration: 96 hours
- Inside logger temperature at start of test: 15,4°C

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Positioning of inside logger inside the cardboard box



Positioning of inside logger on pallet



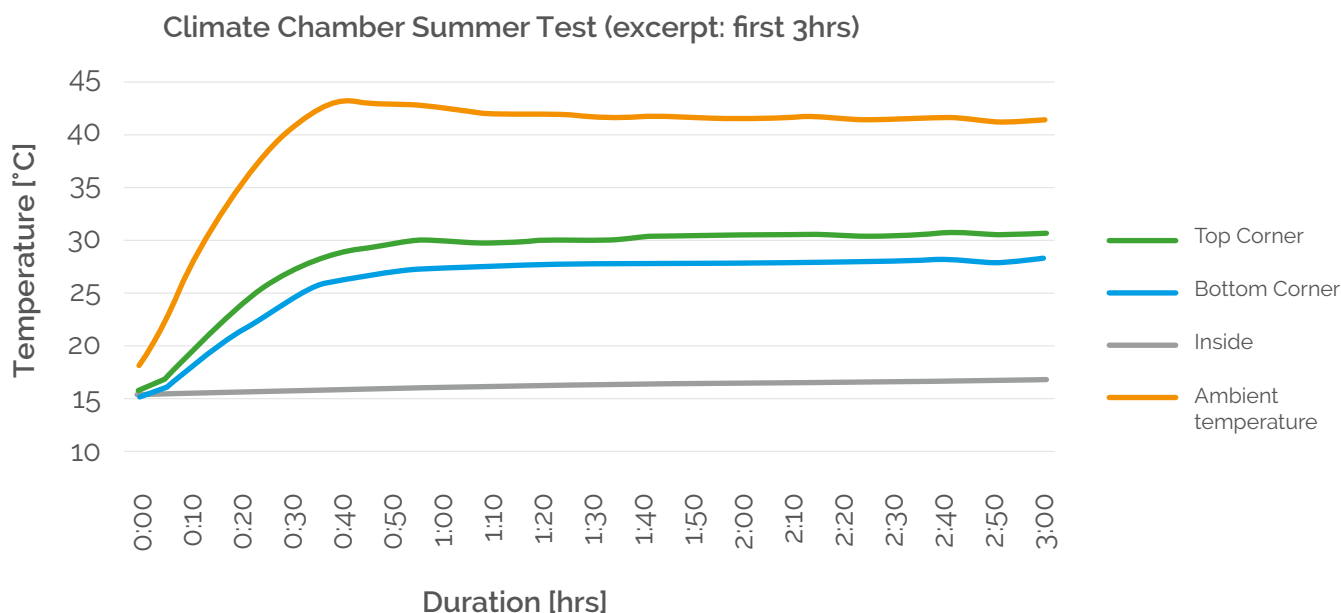
Positioning of outside loggers on the pallet



Pallet prepared with thermocover ECO-LIGHT

Results

Test results are depicted in Graph 1 and tabulated in Table 1 below. The results document the ability of the thermocover ECO-LIGHT to significantly slow down the process of temperature equilibration between the temperature underneath the thermocover or at the dummyload and the ambient temperature. 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)

Inside logger temperature at start of test: 15.4°C	Time to temperature change		
	+Δ5°C	+Δ10°	+Δ15°
Outside top logger	0:15 h	0:30 h	3:10 h
Outside bottom logger	0:20 h	0:35 h	11:50 h
Inside logger	14:10 h	30:00 h	51:25 h

	Temperature change over time (compared to starting value)		
	1 hour	3 hours	6 hours
Outside top logger	14.0 °C	14.8 °C	16.0 °C
Outside bottom logger	11.9 °C	12,8 °C	13.6 °C
Inside logger	0.9 °C	1.4 °C	2.3 °C

	Time to reach		
	25°C	30°C	35°C
Outside top logger	0:25 h	1:20 h	17:35 h
Outside bottom logger	0:35 h	10:00 h	43:35 h
Inside logger	28:40 h	49:20 h	85:25 h

Table 1: Tabulated results of climate chamber summer test

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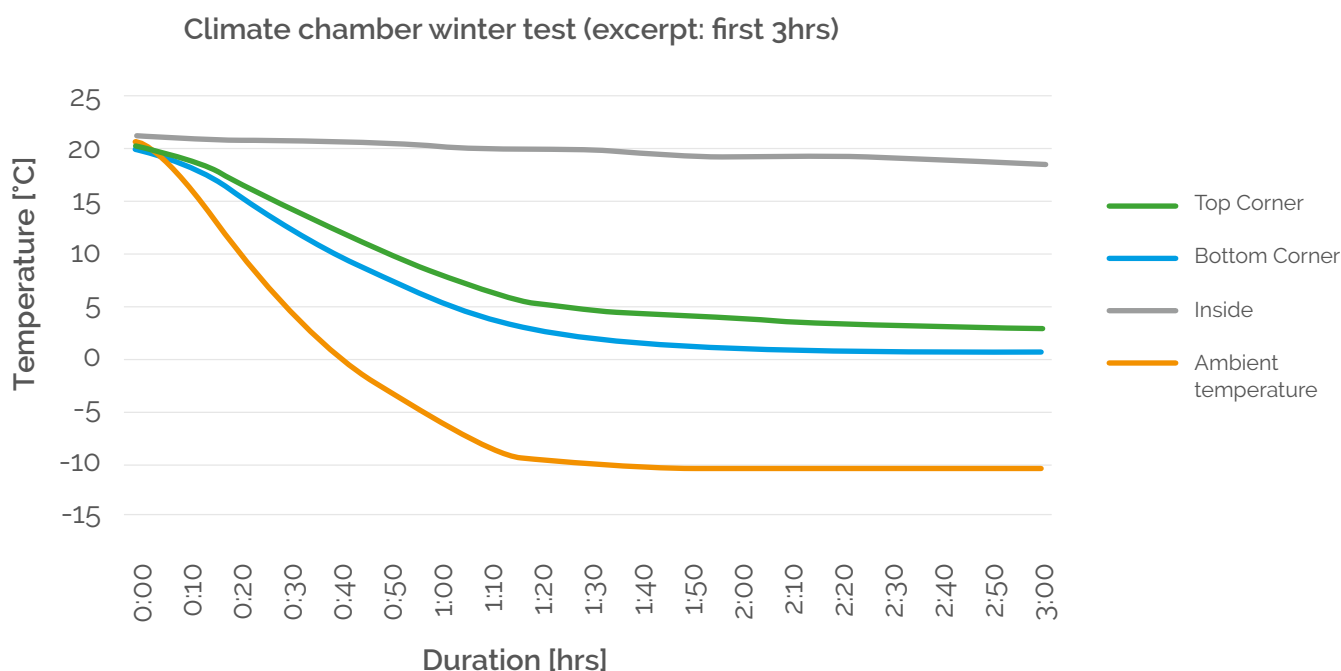
Winter test setup:

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°C start temperature
- Inside logger temperature at start of test: 21.1°C

Results

Test results are depicted in Graph 2 and tabulated in Table 2 below. The results document the ability of the thermocover ECO-LIGHT to significantly slow down the process of temperature equilibration between the temperature underneath the thermocover or at the dummyload and the ambient temperature. 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)



Inside logger temperature at start of test: 21.1°C	Time to temperature change		
	-Δ5°C	-Δ10°	-Δ15°
Outside top logger	0:30 h	0:50 h	1:20 h
Outside bottom logger	0:25 h	0:40 h	1:05 h
Inside logger	6:25 h	14:40 h	24:55 h

	Temperature change over time (compared to starting value)		
	1 hour	3 hours	6 hours
Outside top logger	12.2 °C	17.5 °C	19.5 °C
Outside bottom logger	14.5 °C	19.6 °C	21.4 °C
Inside logger	0.9 °C	2.6 °C	4.7 °C

	Time to reach		
	10°C	5°C	0°C
Outside top logger	0:50 h	1:25 h	7:10 h
Outside bottom logger	0:40 h	1:05 h	3:50 h
Inside logger	16:45 h	27:30 h	43:00 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 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.

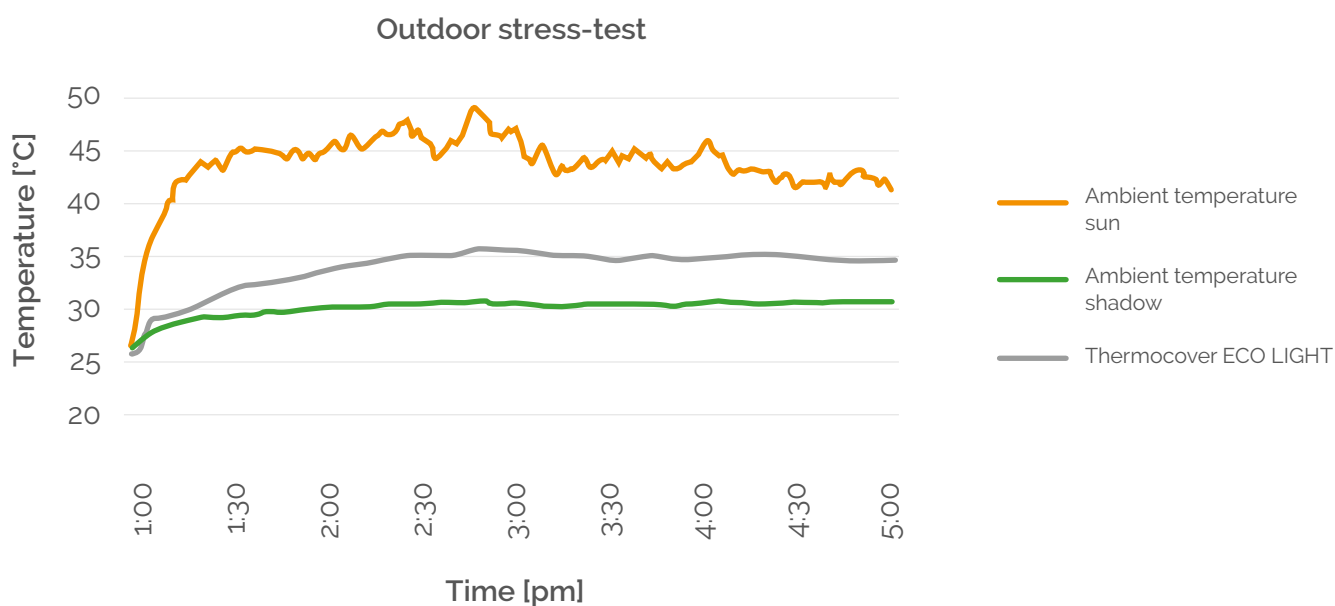
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Outdoor stress-test setup

Results

Test results are depicted in Graph 3 below. The results document the ability of the thermocover ECO-LIGHT to keep the temperatures significantly below the ambient temperatures under direct sun exposure. The average temperature differential over 4 hours was 13.6°C. All other things being equal (i.e. same ambient temperature, sun exposure and wind conditions), the test outcome will improve (bigger temperature differential, i.e. lower temperature and slower temperature increase underneath the thermocover) if the thermal mass on the pallet is increased.



Graph 3: Outdoor stress-test
Test date: 2015/07/01