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Transport Packaging — Temperature controlled transport packages for parcel shipping —

Part 2: General specifications of testing

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 122, *Packaging*.

A list of all parts in the ISO 22982 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document has been developed following a reflection on the situation where producers and users experience confusion regarding the test procedures of temperature-controlled transport packages for parcel shipping. Despite the increasing international attention to product safety and quality of cold chain parcel shipping through electronic commerce, an International Standard addressing the variations in the use of proper package testing has been missing.

Physical test methods are based on ISO 2233, ISO 4180 and test methods on insulation performance are based on the methodologies specified in ISTA Procedure 7E, ASTM D 3103.

Under special circumstances where the weight or products and temperature show differences, agreements made between stakeholders are followed.

EXAMPLE

a) heavy weighted products;

b) presence of dry ice or possible hazardous materials inside the package;

c) any specific requirements which need to be verified, i.e. recording devices in the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be used for such Carriage (ATP)

Transport Packaging — Temperature controlled transport packages for parcel shipping —

Part 2: General specifications of testing

1 Scope

This document specifies the test methods of temperature-controlled packages for parcel shipping. Tests include physical, thermal conductivity and insulation performances of transport packages that use insulation for the purpose of blocking thermal conduction between the inside and the outside of a product package that need temperature control.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21067-1, *Packaging — Vocabulary — Part 1: General terms*

ISO 2233, *Packaging — Complete, filled transport packages and unit loads — Conditioning for testing*

ISO 4180, *Packaging — Complete, filled transport packages — General rules for the compilation of performance test schedules*

ISO 22007-1, *Plastics — Determination of thermal conductivity and thermal diffusivity — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21067-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
eutectic system
material or mixture in which phase change occurs at a pre-designed temperature

3.2
phase changing material
PCM
material that absorbs or releases large amounts of thermal energy when changing from one phase to another

3.3
outside atmosphere temperature
air temperature outside the transport package

3.4
inside atmosphere temperature
air temperature inside the transport package

3.5
thermal conductivity
k
parameter related to the rate at which heat flows through a material

Note 1 to entry: $k = (Q \cdot d)/(A \cdot t \cdot \theta)$

where

k is the thermal conductivity;

Q is the amount of heat that flows;

t is the time;

d is the material of thickness;

A is the cross-sectional area;

Θ is the temperature difference.

Note 2 to entry: The typical unit is $W \cdot m^{-1} \cdot K^{-1}$.

[SOURCE: ISO 13943:2017, 3.385]

3.6
overall heat transfer coefficient
q

ratio between the density of the heat flow rate per unit of surface area and the prevailing difference in temperature (low temperature, T_L, and high temperature, T_H) across the relevant walls of the packaging material

4 Test method

4.1 Sample preparation

4.1.1 Sampling

All tests shall be performed with new and unused package and product. Tests shall not be performed within 72 h after the production of the packages. Packages subject for testing shall be randomly selected. If this is not possible, packages as identical as possible to actual packages shall be used and addressed in the report with the agreement of the stakeholders.

4.1.2 Test sample

Test samples used for the tests shall include an actual product. If it is not available, a dummy product having characteristics as identical as possible may be used. Characteristics include physical and thermal properties, composition and physical status (e.g. liquid, powder, solids). A product may be packaged with primary package or unpackaged.

Outside dimension, weight, and total weight including the product shall be measured and recorded prior to testing according to the mean value obtained from five sample measurements. If a refrigerant or temperature stabilizer is used to maintain the temperature of the package and product, the characteristics and performance of this refrigerant or temperature stabilizer shall be recorded in the report.

4.1.3 Preconditioning

All samples shall be preconditioned at 23 °C ± 1 °C for 24 h prior to testing in accordance with ISO 2233.

4.2 Physical performance test of a package

Physical performance test of packages shall be performed in accordance with test methods specified in ISO 4180.

4.3 Thermal performance test of a package

4.3.1 Setting temperature conditions

4.3.1.1 Outside atmosphere temperature

An environmental chamber that can consistently maintain the determined outside temperature shall be used. The environmental chamber shall be pre-cooled or pre-heated to the intended temperature condition before the test. Air velocity of the chamber should be uniform and is recommended to be controlled between 0,1 m/s and 2 m/s.

Depending on the circumstances, the outside atmosphere temperature shall be determined either by temperature profiles collected from recorded data or pre-determined temperatures set by stakeholders.

Clause A.1 gives examples of temperature profiles expressed at different seasons, e.g. summer, winter and spring/autumn. The predetermined temperatures shown in A.2 may be used, e.g. −30 °C ±1 °C, 23 °C ± 1 °C, 40 °C ± 1 °C, etc.

Temperature shall be constant within testing periods depending on the parcel delivery duration, e.g. 24 h, 48 h and 72 h.

4.3.1.2 Inside atmosphere temperature

When no refrigerant or phase change material is used, temperature changes inside a package can demonstrate the performance of thermal resistance. The following are three types of applications that use refrigerants or phase change materials:

a) phase change material, cold water or ice above 10 °C ± 1 °C;

b) solid CO_2 that can maintain temperature down to −78,5 °C ± 1 °C (dry ice or eutectic system);

c) liquid nitrogen that can maintain temperature down to −195,79 °C ± 1 °C.

Commercial parcel shipping usually takes the form of a) or b).

Data loggers with built-in temperature measurement sensor and memory are used to measure the outside and inside temperatures of the packages, record the measurement period, and store the data. Sensitivity shall be less than or equal to 0,1 °C and accuracy shall be less than or equal to ±1 °C. Data loggers shall be calibrated before use.

The quantity of data loggers, measurement frequencies and measurement locations shall be determined as needed before testing. In cases where refrigerants or phase change material are used, they shall be handled with caution so that the data logger does not contact directly with the product or cooling agents such as PCM or dry ice.

4.3.2 Measuring overall heat transfer rate of a material

If required, thermal conductivity performance test of a material shall be performed in accordance by measuring overall heat transfer rate according to ISO 22007-1.

The heat transfer rate, q (in W/m^2) should be calculated with Formula (1):

$$q = U\,(T_H - T_L) \quad (1)$$

where

U is the overall heat transfer coefficient in W/m^2 K);

T_H is the higher temperature in K;

T_L is the lower temperature in K.

U is composed of three heat transfer processes:

— between T_H and its facing surface temperature;

— conductive heat transfer within the insulating material; and

— between the other side surface temperature and T_L.

Conductive heat transfer is the major contributor for the heat insulation that can be obtained by the thickness of heat insulation material (in m) and its thermal conductivity (in W/m K).

4.3.3 Testing insulation performance of a package

4.3.3.1 General

This test is to measure insulation performance of temperature-controlled packages based on existing or predicted parcel shipping temperature profiles.

4.3.3.2 Insulation performance test conditions

The conditions for insulation performance tests are as follows:

a) test in a chamber that is not influenced by direct sunlight, heat sources and can maintain and adjust temperature with less than or equal to ±1 °C during the measurement period;

b) preheat or pre-cool the package until the inside temperature is stabilized;

c) measure the temperature every 10 min;

d) mark the measurement temperature as the mean value of measurement points inside the chamber (package outside) and the package inside respectively; and

e) equalize the inside temperature of the package.

4.3.3.3 Placement of sensors for temperature measurement

For common practice, at least 3 sensors are needed for the accurate temperature measurement. Sensors shall be located upper middle, centre, and lower middle of the package, respectively. If a limited number of sensors is available, it is recommended to place them in the following order: lower middle, upper middle and centre of package. The sensor shall not be directly attached the product or cooling agent such as PCM, dry ice, etc. The inside and outside temperature of the package should be continuously recorded and reported.

4.3.3.4 Placement of cooling agent in a package

Cooling agents such as ice packs and PCM may be used to maintain optimum temperature of the package inside. It is recommended to place a cooling agent on the upper middle and 4 sidewalls in a

