
**Solar energy — Collector components
and materials —**

**Part 1:
Evacuated tubes — Durability and
performance**

*Énergie solaire — Composants et matériaux du collecteur —
Partie 1: Tubes sous vide — Durabilité et performance*

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 180, *Solar energy*.

ISO 22975 consists of the following parts, under the general title *Solar energy — Collector components and materials*:

- *Part 1: Evacuated tubes — Durability and performance*
- *Part 2: Heat-pipes for solar thermal application — Durability and performance*
- *Part 3: Absorber surface durability*

The following parts are under preparation:

- *Part 5: Insulation material durability and performance*

Introduction

This part of ISO 22975 is applicable to all categories of evacuated tubes, including double-glass evacuated tubes and glass-metal sealed evacuated tubes.

This part of ISO 22975 provides test methods for inspecting stones and knots in envelope glass tubes.

This part of ISO 22975 also provides test methods for determining durability of evacuated tubes, including vacuum performance, thermal shock resistance, external impact resistance and internal pressure resistance. For each durability test, this part of ISO 22975 specifies general, apparatus, procedure and results of the test.

This part of ISO 22975 also provides test methods for measuring performance of evacuated tubes, including exposure parameter, solar irradiation for temperature increase of double-glass evacuated tube and average heat loss coefficient. For each performance test, principle, test conditions, apparatus, procedure and results of the test are specified.

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Solar energy — Collector components and materials —

Part 1:

Evacuated tubes — Durability and performance

1 Scope

This part of ISO 22975 specifies definitions and test methods for materials, durability and performance of evacuated tubes.

This part of ISO 22975 is applicable to all types of evacuated tubes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9488, *Solar energy — Vocabulary*

ISO 9845-1, *Solar energy — Reference solar spectral irradiance at the ground at different receiving conditions — Part 1: Direct normal and hemispherical solar irradiance for air mass 1,5*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9488 and the following apply.

3.1

double-glass evacuated tube

component of an evacuated tube solar collector, of which both the inner tube and the envelope tube are made of glass

3.2

glass-metal sealed evacuated tube

component of an evacuated tube solar collector, in which the absorber is affixed to a metal fluid channel, that is sealed into the envelope glass tube through a specific glass-metal sealing process

3.3

stone

opaque inclusions in the glass of the evacuated tube

3.4

knot

transparent inclusions in the glass of the evacuated tube

3.5

scratch

abraded area where the surface of the glass is torn or worn off

3.6

vacuum jacket

space between envelope glass tube and absorber in an evacuated tube, wherein air pressure is sufficiently low that thermal conduction and convection of air can be ignored

3.7
stagnation
state where no working fluid passes through the evacuated tube and the temperature of the evacuated tube is determined by the solar irradiance

3.8
exposure temperature
maximum temperature at an accessible part of an evacuated tube with specified irradiance under *stagnation* (3.7) conditions

Note 1 to entry: For double glass evacuated tubes, the temperature with only air in the tube is measured. For direct flow tubes, the measurement is done in the air-filled flow channel within the vacuum tube. For glass-metal sealed tubes with heat pipe, the well-insulated condenser surface temperature is measured.

3.9
exposure parameter
ratio of the difference between *exposure temperature* (3.8) and ambient temperature to the solar irradiance

3.10
sum of solar irradiation for temperature increase
sum of solar irradiation for a certain preset temperature rise range of the water in a *double-glass evacuated tube* (3.1)

Note 1 to entry: This term applies only to double-glass evacuated tubes.

3.11
average heat loss coefficient
ratio of heat loss per m² defined external surface area of absorber tube, without irradiance, to temperature difference between water content of vacuum tube and ambient air

Note 1 to entry: This term applies only to *double-glass evacuated tubes* (3.1).

4 Classification and test list

According to material category of absorber, evacuated tubes can be substantially classified into two types:

- a) double-glass evacuated tube, see [Figure A.1](#);
- b) glass-metal sealed evacuated tube, see [Figure A.2](#).

Tests for the two categories of evacuated tubes are summarized in [Table 1](#).

Table 1 — Test list

Category of evacuated tube	Test
Double-glass, Glass-metal sealed	5.1 Inspection for stones and knots
Double-glass, Glass-metal sealed	5.2 Inspection for scratches
Double-glass, Glass-metal sealed	5.3 Testing of solar transmittance
Double-glass	5.4 Testing of solar absorptance
Double-glass	5.5 Testing of hemispherical emittance
Double-glass	6.1 Vacuum performance
Double-glass	6.2 Resistance to thermal shock
Double-glass, Glass-metal sealed	6.3 Resistance to Impact
Double-glass, Glass-metal sealed direct flow	6.4 Resistance to internal pressure

Table 1 (continued)

Category of evacuated tube	Test
Double-glass, Glass-metal sealed	5.1 Inspection for stones and knots
Double-glass, Glass-metal sealed	7.1 Tests for determination of exposure parameter
Double-glass	7.2 Tests for determination of sum of solar irradiation for temperature increase of double-glass evacuated tube
Double-glass	7.3 Tests for determination the average heat loss coefficient of double-glass evacuated tube

5 Testing of material

5.1 Inspection for stones and knots

5.1.1 General

This test is intended to check the uniformity of the tube glass by visual inspection.

5.1.2 Test conditions

The test room/table for taking observations shall have a minimum illuminance of 1 500 lx.

5.1.3 Apparatus

The dimension measurement instrument shall have an accuracy of $\pm 0,1$ mm.

5.1.4 Procedure

- a) Draw two lines with permanent marker or other non-invasive marking method with thickness no more than 0,5 mm on the surface of tube along the axial direction, such that the surface is split into two equal parts.
- b) With one part upward, count and separately record for this part the numbers of the following:
 - stones with size not over 1 mm;
 - stones with size over 1 mm;
 - knots with size not over 1,0 mm;
 - knots with size between 1,5 mm and 2,0 mm;
 - knots with size over 2,0 mm;
 - cracks around the stones and knots.
- c) Turn the other part of the tube upward and repeat Step b).
- d) Sum the values from Steps b) and c) for each category of stone, knot or crack.
- e) Draw another pair of lines parallel with the first pair of lines, ensuring that the distance between lines is 1/4 of the perimeter. Erase the first pair of lines and count and record the stones, knots and cracks again as in Steps b) to d).
- f) For each category of stone, knot or crack, take the larger of the values recorded in Steps d) and e) as the result.