

---

---

**Solar energy — Solar thermal  
collectors — Test methods**

*Énergie solaire — Capteurs thermiques solaires — Méthodes d'essai*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 9806:2017](https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017)

<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>



**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 9806:2017](https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017)

<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
[copyright@iso.org](mailto:copyright@iso.org)  
[www.iso.org](http://www.iso.org)

# Contents

	Page
<b>Foreword</b> .....	<b>viii</b>
<b>Introduction</b> .....	<b>ix</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Symbols</b> .....	<b>2</b>
<b>5 General</b> .....	<b>5</b>
5.1 Test overview — Sequence of the tests.....	5
5.2 Testing of collectors with specific attributes.....	6
5.2.1 General.....	6
5.2.2 Collectors using external power sources and collectors with active or passive measures for normal operation and self-protection.....	6
5.2.3 Collectors co-generating thermal and electrical power.....	7
5.2.4 Wind and/or infrared sensitive collectors (WISC).....	7
5.2.5 Façade collectors.....	7
5.2.6 Air and liquid heating collectors.....	8
<b>6 Internal pressure tests for fluid channels</b> .....	<b>8</b>
6.1 Objective.....	8
6.2 Fluid channels made of non-polymeric materials.....	8
6.2.1 Apparatus and procedure.....	8
6.2.2 Test conditions.....	8
6.3 Fluid channels made of polymeric materials.....	8
6.3.1 Apparatus and procedure.....	8
6.3.2 Test conditions.....	9
6.4 Results and reporting.....	9
<b>7 Air leakage rate test (air heating collectors only)</b> .....	<b>9</b>
7.1 Objective.....	9
7.2 Apparatus and procedure.....	9
7.3 Test conditions.....	10
7.4 Results and reporting.....	10
<b>8 Rupture or collapse test (air heating collectors only)</b> .....	<b>10</b>
8.1 Objective.....	10
8.2 Apparatus and procedure.....	10
8.2.1 General.....	10
8.2.2 Closed-loop collectors.....	11
8.2.3 Open to ambient collectors.....	11
8.3 Results and reporting.....	11
<b>9 Standard stagnation temperature</b> .....	<b>11</b>
9.1 Objective.....	11
9.2 Testing under stagnation conditions.....	12
9.3 Measurement and extrapolation of standard stagnation temperature.....	12
9.4 Determining standard stagnation temperature using efficiency parameters.....	12
9.5 Results and reporting.....	13
<b>10 Exposure and half-exposure test</b> .....	<b>13</b>
10.1 Objective.....	13
10.2 Initial outdoor exposure.....	13
10.3 Method 1.....	14
10.4 Method 2.....	14
10.5 Method 3.....	14
10.6 Test conditions.....	14

10.7	Results and reporting.....	15
<b>11</b>	<b>External thermal shock.....</b>	<b>15</b>
11.1	Objective.....	15
11.2	Apparatus and procedure.....	15
11.3	Test conditions.....	15
11.4	Results and reporting.....	16
<b>12</b>	<b>Internal thermal shock test (Liquid heating collectors only).....</b>	<b>16</b>
12.1	Objective.....	16
12.2	Apparatus and procedure.....	16
12.3	Test conditions.....	16
12.4	Results and reporting.....	16
<b>13</b>	<b>Rain penetration test.....</b>	<b>16</b>
13.1	Objective.....	16
13.2	Apparatus and procedure.....	16
13.3	Test conditions.....	17
13.4	Results and reporting.....	19
<b>14</b>	<b>Freeze resistance test.....</b>	<b>19</b>
14.1	Objective.....	19
14.2	Freeze resistant collectors.....	19
14.2.1	General.....	19
14.2.2	Test conditions.....	19
14.3	Heatpipe collectors.....	19
14.3.1	General.....	19
14.3.2	Test conditions.....	20
14.3.3	Results and reporting.....	20
<b>15</b>	<b>Mechanical load test with positive or negative pressure.....</b>	<b>20</b>
15.1	Objective.....	20
15.2	Apparatus and procedure.....	20
15.2.1	Mounting.....	20
15.2.2	Methods for the application of the loads.....	21
15.2.3	Particular specifications for tracking collectors or other specific collector types.....	22
15.3	Test conditions.....	22
15.4	Results and reporting.....	22
<b>16</b>	<b>Impact resistance test.....</b>	<b>22</b>
16.1	Objective.....	22
16.2	Test procedure.....	22
16.3	Impact location.....	22
16.4	Method 1: Impact resistance test using ice balls.....	23
16.4.1	Apparatus.....	23
16.4.2	Ice balls.....	23
16.4.3	Specific aspects of the test procedure using ice balls.....	23
16.5	Method 2: Impact resistance test using steel balls.....	23
16.6	Results and reporting.....	24
<b>17</b>	<b>Final inspection.....</b>	<b>24</b>
17.1	Objective.....	24
17.2	Test procedure.....	24
17.3	Results and reporting.....	25
<b>18</b>	<b>Test report.....</b>	<b>25</b>
<b>19</b>	<b>Thermal performance testing.....</b>	<b>25</b>
19.1	General.....	25
19.2	Performance test using a solar irradiance simulator.....	25
19.2.1	General.....	25
19.2.2	Solar irradiance simulator for performance testing.....	25
19.2.3	Solar irradiance simulator for the measurement of incidence angle modifiers.....	26

STANDARD PREVIEW  
(standards.iteh.ai)

<b>20</b>	<b>Collector mounting and location</b>	<b>27</b>
20.1	General	27
20.2	Collector orientation outdoors	27
20.3	Shading from direct solar irradiance	27
20.4	Diffuse and reflected solar irradiance	27
20.5	Thermal irradiance	28
20.6	Surrounding air speed	28
<b>21</b>	<b>Instrumentation</b>	<b>28</b>
21.1	Solar radiation measurement	28
21.1.1	Pyranometer	28
21.2	Thermal radiation measurement	29
21.2.1	General	29
21.2.2	Measurement of thermal irradiance outdoors	29
21.2.3	Measurement of thermal irradiance indoors	29
21.3	Temperature measurements	29
21.3.1	General	29
21.3.2	Heat transfer fluid temperatures (Liquid heating collectors)	29
21.3.3	Volume flow weighted mean temperature $\vartheta_{m,th}$ (Air heating collectors)	30
21.3.4	Measurement of ambient air temperature	30
21.4	Flow rate measurement	31
21.4.1	Measurement of mass flow rate (liquid)	31
21.4.2	Measurement of collector fluid flow rate (Air heating collectors)	31
21.5	Measurement of air speed over the collector	31
21.5.1	General	31
21.5.2	Required accuracy	32
21.6	Elapsed time measurement	32
21.7	Humidity measurement (Air collectors)	32
21.8	Collector dimensions	32
<b>22</b>	<b>Test installation</b>	<b>32</b>
22.1	Liquid heating collectors	32
22.1.1	General	32
22.1.2	Heat transfer fluid	33
22.1.3	Pipe work and fittings	33
22.1.4	Pump and flow control devices	34
22.2	Air heating collectors	34
22.2.1	General	34
22.2.2	Closed loop test circuit	34
22.2.3	Open to ambient test circuit	35
22.2.4	Heat transfer fluid	35
22.2.5	Test ducts	35
22.2.6	Fan and flow control devices	36
22.2.7	Air preconditioning apparatus	36
22.2.8	Humidity ratio	36
<b>23</b>	<b>Thermal performance test procedures</b>	<b>36</b>
23.1	General	36
23.2	Preconditioning of the collector	37
23.3	Test conditions	37
23.3.1	General	37
23.3.2	Flow rates	37
23.3.3	Steady-state method	37
23.3.4	Quasi dynamic test	38
23.4	Test procedure	38
23.4.1	General	38
23.4.2	Steady-state testing of liquid heating collector	38
23.4.3	Steady-state testing of air heating collectors	38
23.4.4	Steady-state testing of WISC collectors	39
23.4.5	Quasi dynamic testing	39

23.5	Measurements	39
23.5.1	General	39
23.5.2	Additional measurements during tests in solar irradiance simulators	40
23.5.3	Data acquisition requirements	40
23.6	Test period	40
23.6.1	Steady-state testing	40
23.6.2	Quasi dynamic testing	41
<b>24</b>	<b>Computation of the collector parameters</b>	<b>44</b>
24.1	Liquid heating collectors	44
24.1.1	General	44
24.1.2	Steady-state test method for liquid heating collectors	45
24.1.3	Quasi dynamic test method for liquid heating collectors	45
24.1.4	Data analysis	45
24.2	Air heating collectors	46
24.2.1	General	46
24.2.2	Steady-state test method for closed loop air heating collectors	46
24.2.3	Steady-state test method for open to ambient air heating collectors	46
24.2.4	Steady-state test method for open to ambient air heating WISC collectors	46
24.3	Standard reporting conditions (SRC)	46
24.4	Standard uncertainties	47
24.5	Reference area conversion	47
<b>25</b>	<b>Determination of the effective thermal capacity and the time constant</b>	<b>47</b>
25.1	General	47
25.2	Measurement of the effective thermal capacity with irradiance	47
25.3	Measurement of the effective thermal capacity using the quasi dynamic method	48
25.4	Calculation method for the determination of the effective thermal capacity	48
25.5	Determination of collector time constant	48
<b>26</b>	<b>Determination of the incident angle modifier (IAM)</b>	<b>49</b>
26.1	General	49
26.2	Modelling	50
26.2.1	Steady-state	51
26.2.2	Quasi dynamic	52
26.3	Test procedures	52
26.3.1	Steady-state liquid heating collectors	52
26.3.2	Air collectors	52
26.4	Calculation of the collector incidence angle modifier	53
26.5	Reporting	53
<b>27</b>	<b>Determination of the pressure drop</b>	<b>53</b>
27.1	General	53
27.2	Liquid heating collectors	53
27.2.1	Apparatus and procedure	53
27.2.2	Pressure drop caused by fittings	54
27.2.3	Test conditions	54
27.3	Air heating collectors	54
27.3.1	Apparatus and procedure	54
27.4	Calculation and presentation of results	55
	<b>Annex A (normative) Test reports</b>	<b>56</b>
	<b>Annex B (normative) Steady-state and quasi dynamic model</b>	<b>80</b>
	<b>Annex C (normative) Density and heat capacity of water</b>	<b>81</b>
	<b>Annex D (informative) Assessment of the standard uncertainty in solar collector testing</b>	<b>82</b>
	<b>Annex E (informative) Measurement of the velocity weighted mean temperature</b>	<b>86</b>
	<b>Annex F (informative) Material efficiency aspects</b>	<b>88</b>
	<b>Annex G (informative) Area conversion of thermal performance parameters</b>	<b>89</b>

**Bibliography** ..... 90

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 9806:2017](https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017)

<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>

## 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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). (standards.iteh.ai)

This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 312, *Thermal solar systems and components*, in collaboration with ISO Technical Committee TC 180, *Solar energy*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition ISO 9806:2013, which has been technically revised.



## Introduction

This document defines procedures for testing fluid heating solar collectors for thermal performance, reliability, durability and safety under well-defined and repeatable conditions. It contains performance test methods for conducting tests outdoors under natural solar irradiance and natural and simulated wind and for conducting tests indoors under simulated solar irradiance and wind. Outdoor tests can be performed either steady-state or as all-day measurements, under changing weather conditions.

Collectors tested according to this document represent a wide range of applications, e.g. glazed flat plate collectors and evacuated tube collectors for domestic water and space heating, collectors for heating swimming pools or for other low temperature systems or tracking concentrating collectors for thermal power generation and process heat applications. This document is applicable to collectors using liquids, as well as air as heat transfer fluid. Similarly, collectors using external power sources for normal operation and/or safety purposes (overheating protection, environmental hazards, etc.), as well as hybrid devices generating thermal power and electrical power are also considered.

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 9806:2017](https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017)

<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 9806:2017](#)

<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>

# Solar energy — Solar thermal collectors — Test methods

## 1 Scope

This document specifies test methods for assessing the durability, reliability, safety and thermal performance of fluid heating solar collectors. The test methods are applicable for laboratory testing and for *in situ* testing.

This document is applicable to all types of fluid heating solar collectors, air heating solar collectors, hybrid solar collectors co-generating heat and electric power, as well as to solar collectors using external power sources for normal operation and/or safety purposes. It does not cover electrical safety aspects or other specific properties directly related to electric power generation.

This document is not applicable to those devices in which a thermal storage unit is an integral part to such an extent that the collection process cannot be separated from the storage process for making the collector thermal performance measurements.

## 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 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 9806:2017

ISO 9488, *Solar energy — Vocabulary*

<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>

## 3 Terms and definitions

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

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

### 3.1

#### **longitudinal plane**

plane defined by the normal to the plane of the collector and the concentrator axis, or the largest symmetry line for flat biaxial geometries

### 3.2

#### **maximum operating temperature**

maximum temperature allowed during collector or system normal operation specified by the manufacturer

### 3.3

#### **outgassing**

process in which any material releases gases when it is exposed to elevated temperatures and/or reduced pressure

**3.4 reflector**

surface intended for reflecting radiant energy

**3.5 transversal plane**

plane defined by the normal to the plane of the collector and the line orthogonal to the concentrator axis, or the shortest symmetry line for flat biaxial geometries

**3.6 trigger temperature**

temperature value at which the safety controls are activated for fail-safe operating condition

**4 Symbols**

$A_G$	Gross area of collector as defined in the ISO 9488	$m^2$
$a_1$	Heat loss coefficient	$W/(m^2 \cdot K)$
$a_2$	Temperature dependence of the heat loss coefficient	$W/(m^2 \cdot K^2)$
$a_3$	Wind speed dependence of the heat loss coefficient	$J/(m^3 \cdot K)$
$a_4$	Sky temperature dependence of the heat loss coefficient	—
$a_5$	Effective thermal capacity	$J/(m^2 \cdot K)$
$a_6$	Wind speed dependence of the zero loss efficiency	$s/m$
$a_7$	Wind speed dependence of IR radiation exchange	$W/(m^2 \cdot K^4)$
$a_8$	Radiation losses	$W/(m^2 \cdot K^4)$
$b_u$	Collector efficiency coefficient (wind dependence)	$s/m$
$C$	Effective thermal capacity of collector	$J/K$
$C_R$	Geometric concentration ratio	—
$c_f$	Specific heat capacity of heat transfer fluid	$J/(kgK)$
$c_{f,i}$	Specific heat capacity of heat transfer fluid at the collector inlet	$J/(kgK)$
$c_{f,e}$	Specific heat capacity of heat transfer fluid at the collector outlet	$J/(kgK)$
$c_{f,a}$	Specific heat capacity of the ambient air	$J/(kgK)$
$E_L$	Longwave irradiance ( $\lambda > 3 \mu m$ )	$W/m^2$
$G_{hem}$	Hemispherical solar irradiance	$W/m^2$
$G_S$	Hemispherical solar irradiance for the calculation for the standard stagnation temperature	$W/m^2$
$G_m$	Average measured hemispherical solar irradiance	$W/m^2$
$G''$	Net irradiance	$W/m^2$
$G_b$	Direct solar irradiance (beam irradiance)	$W/m^2$

iTeH STANDARD PREVIEW  
(standards.iteh.ai)

ISO 9806:2017  
<https://standards.iteh.ai/catalog/standards/sist/3b359ee7-0c5d-46a6-9bb4-338c98b5a666/iso-9806-2017>

$G_d$	Diffuse solar irradiance	W/m <sup>2</sup>
$H$	Irradiation on collector plane for exposure test	MJ/m <sup>2</sup>
$K_{\text{hem}}(\theta_L, \theta_T)$	Incidence angle modifier for hemispherical solar radiation	—
$K_b(\theta_L, \theta_T)$	Incidence angle modifier for direct solar irradiance	—
$K_{\theta L}$	Incidence angle modifier in the longitudinal plane	—
$K_{\theta T}$	Incidence angle modifier in the transversal plane	—
$K_d$	Incidence angle modifier for diffuse solar radiation	—
$\dot{m}$	Mass flow rate of heat transfer fluid	kg/s
$\dot{m}_{\text{min}}$	Minimum mass flow by the performance test	kg/h
$\dot{m}_{\text{max}}$	Maximum mass flow by the performance test	kg/h
$\dot{m}_e$	Downstream air mass flow rate	kg/s
$\dot{m}_i$	Upstream air mass flow rate	kg/s
$\dot{m}_l$	Leakage air mass flow rate	kg/s
$p_{f,e}$	Static pressure of the heat transfer fluid (air) at the outlet of the solar collector	Pa
$p_{f,i}$	Static pressure of the heat transfer fluid (air) at the inlet of the solar collector	Pa
$p_{\text{abs}}$	Absolute pressure of the ambient air	Pa
$\dot{Q}$	Useful power extracted from collector	W
$\dot{Q}_{\text{Peak}}$	Peak power. Power output of the collector for normal incidence, $G_b = 850 \text{ W/m}^2$ , $G_d = 150 \text{ W/m}^2$ and $\vartheta_m - \vartheta_a = 0 \text{ K}$	W
$R_D$	Gas constant for water vapour	461,4 J/(kgK)
$R_L$	Gas constant for air	287,1 J/(kgK)
$T$	Absolute temperature	K
$t$	Time	s
$u$	Surrounding air speed	m/s
$u'$	Reduced surrounding air speed $u' = u - 3 \text{ m/s}$	m/s
$U$	Measured overall heat loss coefficient of collector with reference to $(\vartheta_m - \vartheta_a)/G_{\text{hem}}$	W/(m <sup>2</sup> K)
$V_f$	Fluid capacity of the collector	m <sup>3</sup>
$\dot{V}$	Volumetric flow	m <sup>3</sup> /s

$\dot{V}_e$	Volumetric flow at the outlet of the solar collector	m <sup>3</sup> /s
$\dot{V}_i$	Volumetric flow at the inlet of the solar collector	m <sup>3</sup> /s
$\dot{V}_l$	Volumetric leakage flow rate	m <sup>3</sup> /s
$X_{W,a}$	Water content of the ambient air	kg H <sub>2</sub> O/kg dry air
$X_{W,e}$	Water content of the air at the exit of the solar collector	kg H <sub>2</sub> O/kg dry air
$X_{W,i}$	Water content of the air at the inlet of the solar collector	kg H <sub>2</sub> O/kg dry air
$\Delta p$	Pressure difference between fluid inlet and outlet	Pa
$\Delta t$	Time interval	s
$\Delta T$	Temperature difference between fluid outlet and inlet ( $\vartheta_e - \vartheta_{in}$ )	K
$\gamma$	Solar azimuth angle	°
$\eta_b$	Collector efficiency based on beam irradiance $G_b$	—
$\eta_{hem}$	Collector efficiency based on hemispherical irradiance $G_{hem}$	—
$\eta_{0,b}$	Peak collector efficiency ( $\eta_b$ at $\vartheta_m - \vartheta_a = 0$ K) based on beam irradiance $G_b$	—
$\eta_{0,hem}$	Peak collector efficiency ( $\eta_{0,hem}$ at $\vartheta_m - \vartheta_a = 0$ K) based on hemispherical irradiance $G_{hem}$	—
$\eta_{hem,m_i}$	Collector efficiency, with reference to mass flow $m_i$	—
$\theta$	Angle of incidence	°
$\theta_L$	Longitudinal angle of incidence: angle between the normal to the plane of the collector and incident sunbeam projected into the longitudinal plane	°
$\theta_T$	Transversal angle of incidence: angle between the normal to the plane of the collector and incident sunbeam projected into the transversal plane	°
$\vartheta_a$	Ambient air temperature	°C
$\vartheta_{am}$	Measured ambient air temperature	°C
$\vartheta_{as}$	Ambient air temperature for the standard stagnation temperature	°C
$\vartheta_e$	Collector outlet temperature	°C
$\vartheta_i$	Collector inlet temperature	°C
$\vartheta_m$	Mean temperature of heat transfer fluid	°C
$\vartheta_{max\_op}$	Maximum operating temperature	°C
$\vartheta_{stg}$	Standard stagnation temperature	°C
$\vartheta_{sky}$	Atmospheric or sky temperature	°C

$\vartheta_{\text{trigger}}$	Trigger temperature for safety activation	°C
$\vartheta_{\text{m,th}}$	Volume flow weighted mean temperature	°C
$\vartheta_{\text{mp,e}}$	Fluid temperate at the downstream air mass flow meter	°C
$\vartheta_{\text{mp,i}}$	Fluid temperate at the upstream air mass flow meter	°C
$\vartheta_{\text{sm}}$	Average measured absorber temperature	°C
$\lambda$	Wavelength	µm
$\rho$	Density of heat transfer fluid	kg/m <sup>3</sup>
$\rho_{\text{l}}$	Density of air	kg/m <sup>3</sup>
$\sigma$	Stefan-Boltzmann constant	W/(m <sup>2</sup> K <sup>4</sup> )
$\tau_{\text{c}}$	Collector time constant	s
$\tau$	Transmittance	
$(\tau\alpha)$	Effective transmittance-absorptance product	—

## 5 General

### iTeh STANDARD PREVIEW

#### 5.1 Test overview — Sequence of the tests (standards.iteh.ai)

A full test sequence for solar thermal collectors including durability test and thermal performance measurements is proposed in [Table 1](#). This test sequence may be modified or only single tests may be performed as required. For some tests, however, a certain preconditioning or a half-exposure test (see [Clause 10](#)) is mandatory. For all test sequences and single tests, the final inspection (see [Clause 17](#)) is recommended as concluding test for the proper identification and description of the test sample, as well as to identify problems or deficiencies.

**Table 1 — Test list**

Clause	Test
<a href="#">Clause 7</a>	Air leakage rate test <sup>f</sup>
<a href="#">Clause 8</a>	Rupture or collapse test <sup>f</sup>
<a href="#">Clause 9</a>	Standard stagnation temperature
<a href="#">Clause 10</a>	Exposure test <sup>b</sup>
<a href="#">Clause 11</a>	External thermal shock test <sup>b</sup>
<a href="#">Clause 12</a>	Internal thermal shock test <sup>b,e</sup>
<a href="#">Clause 13</a>	Rain penetration test <sup>f</sup>
<a href="#">Clause 14</a>	Freeze resistance test <sup>c,f</sup>
<a href="#">Clause 6</a>	Internal pressure test for fluid channels <sup>a,d,e</sup>
<a href="#">Clause 15</a>	Mechanical load test <sup>f</sup>
<a href="#">Clause 16</a>	Impact resistance test <sup>g</sup>
<a href="#">Clause 17</a>	Final inspection