

ISO 9806:2017-09 (E)

Solar energy - Solar thermal collectors - Test methods

Contents		Page
Foreword		viii
Introduction		ix
1 Scope	1	
2 Normative references	1	
3 Terms and definitions	1	
4 Symbols	2	
5 General	5	
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	
6 Internal pressure tests for fluid channels	8	
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	
7 Air leakage rate test (air heating collectors only)	9	
7.1 Objective	9	
7.2 Apparatus and procedure	9	
7.3 Test conditions	10	
7.4 Results and reporting	10	
8 Rupture or collapse test (air heating collectors only)	10	
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	
9 Standard stagnation temperature	11	
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
10	Exposure and half-exposure test	13
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
11	External thermal shock	15
11.1	Objective	15
11.2	Apparatus and procedure	15
11.3	Test conditions	15
11.4	Results and reporting	16
12	Internal thermal shock test (Liquid heating collectors only)	16
12.1	Objective	16
12.2	Apparatus and procedure	16
12.3	Test conditions	16
12.4	Results and reporting	16
13	Rain penetration test	16
13.1	Objective	16
13.2	Apparatus and procedure	16
13.3	Test conditions	17
13.4	Results and reporting	19
14	Freeze resistance test	19
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
15	Mechanical load test with positive or negative pressure	20
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
16	Impact resistance test	22
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
17	Final inspection	24
17.1	Objective	24

17.2	Test procedure	24
17.3	Results and reporting	25
18	Test report	25
19	Thermal performance testing	25
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
20	Collector mounting and location	27
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
21	Instrumentation	28
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 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
22	Test installation	32
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
23	Thermal performance test procedures	36
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
24	Computation of the collector parameters	44
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
25	Determination of the effective thermal capacity and the time constant	47
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
26	Determination of the incident angle modifier (IAM)	49
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
27	Determination of the pressure drop	53
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
	Annex A (normative) Test reports	56

Annex B (normative) Steady-state and quasi dynamic model	80
Annex C (normative) Density and heat capacity of water	81
Annex D (informative) Assessment of the standard uncertainty in solar collector testing	82
Annex E (informative) Measurement of the velocity weighted mean temperature	86
Annex F (informative)Materialefficiencyaspects	88
Annex G (informative) Area conversion of thermal performance parameters	89
Bibliography	90