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Solar energy - Collector fields - Check of performance (ISO/DIS 24194:2021)

Sonnenenergie - Kollektorfelder - Überprüfung der Leistungsfähigkeit (ISO/DIS 24194:2021)

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Solar energy — Collector fields — Check of performance

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Foreword

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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 180, *Solar energy*, Subcommittee SC 4, *Systems - Thermal performance, reliability and durability*.

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 defines procedures for checking the performance of solar thermal collector fields. Measured performance is compared with calculated performance - and conditions for compliance are given.

Two levels for accuracy in the checking can be chosen:

- Level I - giving possibility for giving a very accurate estimate (with low safety factor) - but with requirements for use of expensive measurement equipment.

- Level II - allowing for a less accurate estimate (with higher safety factor) - but possibility to use less expensive measurement equipment..

Solar energy — Collector fields — Check of performance

1 Scope

This document specifies two procedures to verify the performance of solar thermal collector fields. The collectors in the fields can be glazed flat plate collectors, evacuated tube collectors and/or tracking, concentrating collectors.

The check can be done on the thermal power output of the collector field - this is described in the main part of the document.

The check also be done on the daily yield of the collector field - this is described in informative annex.

The document specifies for the two procedures how to compare a measured output with a calculated one.

The document applies for all sizes of collector fields.

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 9488, Solar energy — Vocabulary

ISO 9806, Solar energy — Solar thermal collectors — Test methods

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:

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

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

3.1
reflector
surface intended for reflecting radiant energy

3.2
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

4 Symbols

A_G	Gross area of collector as defined in the ISO 9488	m^2
A_{GF}	Gross area of collector field	m^2
a_1	Heat loss coefficient at $(\vartheta_m - \vartheta_a) = 0$	$W/(m^2 \cdot K)$
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. In some literature and data sheets denoted C_{eff}	$J/(m^2 \cdot K)$
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 dependence	$W/(m^2 \cdot K^4)$
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)
DNI	Solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position	W/m^2
E_L	Longwave irradiance ($\lambda > 3$ µm)	W/m^2
f_P	Safety factor taking into account heat losses from pipes etc. in the collector loop.	-
f_U	Safety factor taking into account measurement uncertainty.	-
f_O	Safety factor for other uncertainties e.g. related to non-ideal conditions such as non-ideal flow distribution and unforeseen heat losses - and uncertainties in the model/procedure itself.	-
f_{safe}	$f_{safe} = f_P \cdot f_U \cdot f_O$	-
f_{sh}	Shading factor	-
G	Gap in between adjacent collectors	m
G_{hem}	Hemispherical solar irradiance on the plane of collector	W/m^2
G_b	Direct solar irradiance (beam irradiance) on the plane of collector	W/m^2
G_d	Diffuse solar irradiance on the plane of collector	W/m^2
H_{hem}	Total daily irradiation sum on collector plane without shadow	kWh/m^2

h	Solar altitude angle. sin h = cos θ_Z	°
h_{min}	Minimum solar altitude angle	°
H_{sh}	Height of the shaded area	m
$K_{hem}(\theta_L,\theta_T)$	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	—
L	Length of a collector	m
L_{pipe}	Overall Length of the pipe system without collectors	m
L_{sh}	Length of the shaded area	m
$\dot{m}$	Mass flow rate of heat transfer fluid	kg/s
N_c	Number of collectors in a row	-
P_X	Coordinate of the point C on the x-axis (C is the point that would reach the shadow formed by the top of the sun facing side of a collector row if it were unobstructed)	-
P_y	Coordinate of the point C on the y-axis	-
$\dot{Q}_{measured}$	Measured power output	W
$\dot{Q}_{estimate}$	Estimated power output	W
$Q_{cap,d}$	Daily capacity heat losses of solar thermal system	J
$Q_{estimate-sys,d}$	Daily yield estimation of solar thermal system	J
$\dot{Q}_{estimate-col,d}$	Daily average gross power output collector field	W
$Q_{HM,d}$	Daily yield measurement of the heat meter	J
$\dot{Q}_{pipe,d}$	Daily average heat losses of piping	W
q_{l-pipe}	Empirical specific heat loses per m pipe	W/m
S	Spacing center to center in between adjacent rows	m
T	Absolute temperature	K
t	Time	s
t_s	Time start of measurement	s
t_e	Time end of measurement	s
u	Surrounding air speed (wind speed)	m/s
u'	Reduced surrounding air speed u' = u - 3 m/s	m/s

V_f	Fluid capacity of the collector	m^3
$\dot{V}$	Volumetric flow rate	m^3/s
$\dot{V}_e$	Volumetric flow rate at the outlet of the solar collector	m^3/s
$\dot{V}_i$	Volumetric flow rate at the inlet of the solar collector	m^3/s
V_{pipe}	Volume of the pipe system without collectors	l
W	Width of a collector	
Δt	Time interval	s
ΔT	Temperature difference between fluid outlet and inlet (ϑ_e - ϑ_i)	K
β	Slope (or tilt), the angle between the plane of the collector and the horizontal. *Note: For collectors rotating around a North-South axis, β is positive in the morning when facing eastwards - and negative in the afternoon when facing westwards*	
γ	Surface azimuth angle, the deviation of the projection on horizontal plane of the normal to the surface from the local meridian, with zero due south, east negative and west positive	°
γ_s	Solar azimuth angle, the angular displacement from south of the projection of beam radiation on the horizontal plan, east negative and west positive	°
δ	Declination, the angular position of the sun at solar noon with respect to the plane of the equator, north positive.	°
ϕ	Latitude, the angular location north or south of the equator, north positive	°
η_b	Collector efficiency based on beam irradiance G_b	—
η_{hem}	Collector efficiency based on hemispherical irradiance G_{hem}	—
$\eta_{0,b}$	Peak collector efficiency (η_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}	—
$\eta_{hem,\dot{m}_i}$	Collector efficiency, with reference to mass flow $\dot{m}_i$	—
ω	Hour angle, the angular displacement of the sun east or west of the local meridian due to rotation of the earth on its axis at 15 ° per hour; morning negative, afternoon positive	°
θ	Angle of incidence	°
θ_L	Longitudinal angle of incidence: angle between the normal to the plane of the collector and incident sunbeam projected into the longitudinal plane	°
θ_T	Transversal angle of incidence: angle between the normal to the plane of the collector and incident sunbeam projected into the transversal plane	°