REPORT
issued by an Accredited Testing Laboratory

Date	Reference	Page
2009-02-12	P900253-4	1 (1)

1002
ISO/IEC 17025

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Test of solar collector
(3 appendices)

Assignment
Test of solar collector according to EN 12975-2:2006, chapter 6.1.5, Steady-state efficiency test using a solar simulator.

Test Object
Flat plate collector, Sunmark GJ 140D-001.5. New glass was mounted and teflon film was removed before test at SP, by manufacturer. Technical specifications of the collector, see appendix 1.

The test object arrived at SP 2009-01-19 and was checked without remarks (in normal conditions). The test was performed 2009-02-09 and 2009-02-10.

The empty collector was exposed at 850 W/m² for 4 hrs before test with teflon. See SP test report P900253-3. Teflon film was removed before test at SP, by manufacturer.

Results
See appendix 2 for test results. The results in the report are only valid for the tested object.

SP Technical Research Institute of Sweden
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Appendices
1. Description of the solar collector
2. Thermal performance
3. Terms and definitions, Measuring equipment, Measuring uncertainties

Appendix 1

Description of the solar collector
Based on data from the manufacturer

General

Manufacturing plant:	Sunmark A/S
Address:	Jyllandsgde 30 DK-6400 SØNDEBORG Denmark

Solar collector description

Brand name:	Sunmark GJ 140D-001.5
Collector type:	Flat plate
Year of production:	2008-12
Drawing document No:	--
Operating pressure:	max 3.5 bar
Stagnation temperature at 1000 W/m^2 and 30°C ambient temperature:	-- C

Dimensions of collector unit

Length:	5.96 m	Aperture:	13.72 m^2	(Measured by SP)
Width:	2.52 m	Gross area:	15.0 m^2	
Height:	0.20 m			

Technical specifications

Fluid content:	14 liter
Heat transfer fluid, recommended:	Mono-propylene glycol / Water

Cover

Number of covers:	1 (divided into 5 parts)
Cover material:	Glass, Iron free, anti-reflective, Teflon film
Cover thickness:	4 mm

Absorber:

Type:	Sunstrip NIOX cupper/alumniuim
Construction:	18 parallel, 2 branch pipes
Surface treatment:	Selective

Thermal insulation and casing:

Thermal insulation thickness in casing:	90 mm
Insulation material:	Mineral wool
Frame material:	Aluminium
Backside material:	Aluminium
Connections:	Flexibel steel tubes 1¼', 2 connections on top

Limitations:

Maximum operation temperature:	-- °C
Maximum operation pressure:	8 bar
Other limitations:	

Thermal performance indoor

Test conditions

Mean solar irradiance:	874 W/m^2
Wind speed:	2.2 m/s
Type of lamps:	Xenon
Collector tilt:	60°
Fluid used during test:	Water
Fluid rate used for the test:	0.26 l/(s* m^2)
Aperture area:	13.72 m^2
Collector gross area:	15.0 m^2
The instantaneous efficiency is defined by:	η_0 =Q / AG

Instantaneous efficiency curve based on aperture area and mean temperature of heat transfer fluid.

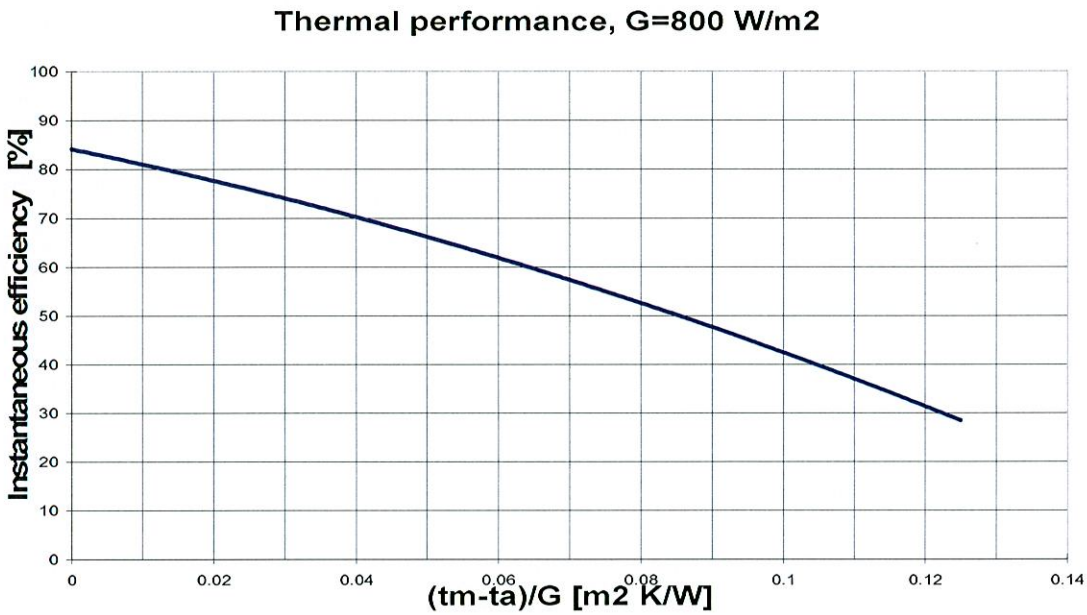

Figure 1 – Thermal efficiency based on aperture area

Second order fit data:

$\eta_a = \eta_{oa} - a_{1a}((t_m - t_a) / G) - a_{2a} G ((t_m - t_a) / G)^2$

Coefficient based on:

Aperture area		Gross area	
η_{0a}	*0.841 [-]*	η_{0G}	*0.770 [-]*
a_{1a}	*3.016 [W/m^{2}K]*	a_{1G}	*2.759[W/m^{2}K]*
a_{2a}	*0.014 [W/m^{2}K^2]*	a_{2G}	*0.013 [W/m^{2}K^2]*

Power output per module (W)

t_m-t_a [K]	Irradiance [W/m^2]		
	400	**700**	**1 000**
10	4184	7646	11109
30	3199	6662	10124
50	2057	5520	8982

Terms and definitions

Symbol	Term	Unit
A	Area (Aperture, gross or absorber)	m^2
η_0	Zero-loss coefficient	-
η_a	Collector efficiency based on aperture	-
η_{0a}	Zero loss collector efficiency based on aperture	-
η_{0G}	Zero loss collector efficiency based on gross area	-
Q	Useful power extracted from the collector	W
G	Solar irradiance	W/m^2
t_m	Mean temp. of heat transfer fluid	°C
t_a	Ambient air temperature	°C
a_1	Heat loss coefficient at $(t_m-t_a)=0$ including wind dependence	$W/m^2/K$
a_{1a}	Heat loss coefficient, based on aperture area	$W/m^2/K$
a_{1G}	Heat loss coefficient, based on gross area	$W/m^2/K$
a_2	Temperature dependence of the heat loss coefficient	$W/m^2/K^2$
a_{2a}	Temperature dependence of the heat loss coefficient, based on aperture area	$W/m^2/K^2$
a_{2G}	Temperature dependence of the heat loss coefficient, based on gross area	$W/m^2/K^2$

Measuring equipment

Solar irradiance:	Kipp o. Zonen CM 11 SP.nr. 202 185
Temperature:	Temp.sensor Pt-100 (fluid) ET.nr. 2311373 and 07051603
	Pt-100 (air) ET.nr. 07051606 and 12196
Water flow:	Valmet MP115 SP.nr 202 861 and 701 362
Air speed:	Swema Air SP.nr. 201 643
Data collection:	HP VXI-system SP.nr. 202 878

Measuring uncertainties

Thermal performance:	± 3.3 %
Irradiance:	± 3 %
Temperature water:	± 0,1 K
Temp. difference water:	± 0,05 K
Temperature air:	± 0,5 K
Water flow:	± 0,8 %
Air speed:	± 2 %
Aperture:	± 1%