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Test of solar collector (2 appendices)

Task

Testing of solar collector according to EN12975-2.

Test object

Glazed flat plate collector BATEC BA30, serial number 16892 and 16893. Technical specifications of collector see appendix 2.

The test object arrived at SP 2006-08-21 and was checked without remarks (in normal condition). The tests were performed between 2006-08-23 and 2006-10-06.

Measuring equipment

Hemispherical solar irradiance:	Kipp o. Zonen CM 11 SP.nr. 202 185
Diffuse solar irradiance:	Kipp o. Zonen CM 11 SP.nr. 200 940
Temperature:	Temp.sensor Pt-100 (fluid) ET.nr. 181134, 162912 and 12197, Pt-100 (air) ET.nr. SOL-557
Water flow (pressure drop):	Valmet MP115 SP.nr 202 202
Water flow (thermal perf.):	Valmet MP115 SP.nr 202 189
Pressure drop:	Fuji FKCX34V2BKBYAE SP.nr. 200 782
Pressure (mechanical load):	Pressure gauge SP.nr 202 733
Rain penetration:	Chamber for rain penetration SP.nr. 202 210 Humidity meter SP.nr. 200 479, SP.nr. 200 480
Air speed:	Young Gill Three Cup SP.nr. 202 510
Data collection:	HP VXi-system

Results

The solar collector has passed the tests with no remarks

Summary/Data sheet
Results from testing

See appendix 1
See appendix 2

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Laboratorier ackrediteras av Styrelsen för ackreditering och teknisk kontroll (SWEDAC) enligt svensk lag. Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat.



Measuring uncertainties

Irradiance:	$\pm 3 \%$
Temperature water:	$\pm 0,1 \text{ K}$
Temp. difference water:	$\pm 0,05 \text{ K}$
Temperature air:	$\pm 0,5 \text{ K}$ but not less than $\pm 2 \text{ Pa}$
Pressure (pressure drop):	$\pm 4 \text{ mbar}$
Pressure (mechanical load):	$\pm 2 \%$
Water flow:	$\pm 0,8 \%$
Water flow, rain penetration:	$\pm 0.2 \text{ l/m}^2, \text{ min}$
Air speed:	$\pm 2 \%$
Humidity:	$\pm 5 \%$

SP Swedish National Testing and Research Institute
Energy Technology - Building Services Engineering

A handwritten signature in black ink, appearing to read 'Monica Axell'.

Monica Axell
Technical Manager

A handwritten signature in black ink, appearing to read 'Ulrik Pettersson'.

Ulrik Pettersson
Technical Officer

Solar collector data sheet

Description of solar collector

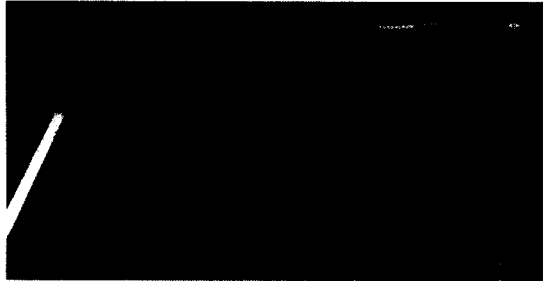
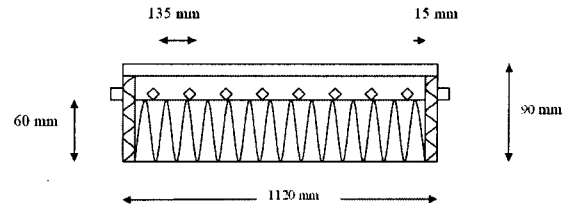


Photo of the collector

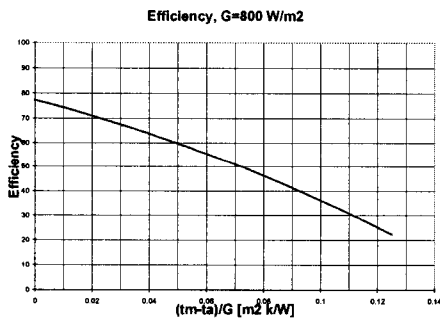


Cross section of collector

Manufacturer:	BATEC A/S	Weight ¹ :	50 kg
Brand name:	BA30	Heat transfer fluid ¹ :	Water or water/glycol
Collector type:	Flat plate	Operating pressure ¹ :	Max 6 bar
Absorber area:		Stagnation temperature:	191°C
Aperture area:	3.00 m ²		
Gross area:	3.16 m ²		

Testing results

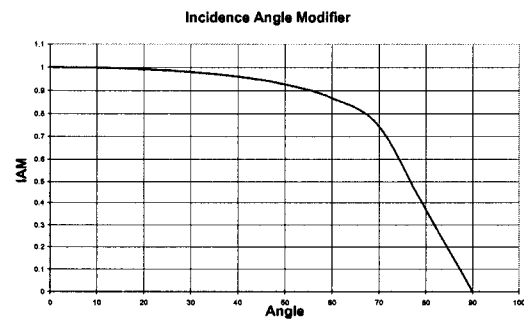
Efficiency based upon aperture area



$$\eta_a = \eta_{0a} - a_{1a}((t_m - t_a)/G) - a_{2a}G((t_m - t_a)/G)^2$$

$$\begin{aligned} \eta_{0a} &= 0.772 [-] \\ a_{1a} &= 2.907 [W/m^2K] \\ a_{2a} &= 0.015 [W/m^2K^2] \\ a_{3a} &= 0.151 [J/m^3K] \end{aligned}$$

Incidence angle modifier



θ	0	10	30	50	70	90
$K_{\theta b}$	1	0.998	0.979	0.926	0.744	0

Outdoor testing

Test method:	Outdoor, semi dynamic, QDT
Latitude:	57.7
Collector tilt:	45°
Longitude:	12.9
Local time at solar noon	12:07
Collector azimuth:	0° (South)
Test flow:	166 l/h

¹ Data from the manufacturer



Appendix 1

Power output per collector unit, without wind (W)			
$t_m - t_a$ [K]	Irradiance [W/m ²]		
	400	700	1000
10	835	1 529	2 224
30	624	1 319	2 014
50	378	1 073	1 767

<p>Thermal capacity: $C = 15\ 100\ J/m^2K$</p> <p>Pressure drop: $\Delta p = 262\ mbar$ using water, 20°C, and 237 l/h</p> <p>$\Delta p = 0.678q + 0.0018q^2$ [mbar]</p> <p>q = flow [l/h]</p>	<p>Terms</p> <p>η_a Collector efficiency</p> <p>η_{0a} Zero loss collector efficiency based on aperture</p> <p>a_{1a} Heat loss coefficient at $(t_m - t_a) = 0$ based on aperture</p> <p>a_{2a} Temperature dependence of the heat loss coefficient based on aperture</p> <p>a_{3a} Wind dependence of the heat loss coefficient based on aperture</p> <p>t_m Mean temp. of heat transfer fluid</p> <p>t_a Ambient air temp.</p> <p>G Hemispherical solar irradiance</p> <p>K_{θ_s} Incidence angle modifier for direct irradiance</p> <p>θ Angle of incidence</p>
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Test results

Record of test sequence and summary of main results

Test		Date		Result
		Start	End	
Internal pressure		2006-10-02	2006-10-02	15 bar, No remarks ²
High temperature resistance		2006-08-28	2006-08-28	No remarks ²
Exposure		--	--	Not performed
External thermal shock	First	2006-08-28	2006-08-28	No remarks ²
	Second	2006-08-28	2006-08-28	No remarks ²
Internal thermal shock	First	2006-08-28	2006-08-28	No remarks ²
	Second	2006-08-28	2006-08-28	No remarks ²
Rain penetration		2006-10-05	2006-10-05	No remarks ²
Freeze resistance		--	--	No remarks ²
Mechanical load		2006-10-04	2006-10-04	No remarks ²
Thermal performance		2006-09-01	2006-09-17	See appendix 1 ³
Impact resistance		--	--	Not performed
Final inspection		--	--	Not performed

Description of solar collector⁴

General

Manufacturer: BATEC A/S
 Address: Danmarksvej 8
 DK-4681 Herfølge

 Telephone: +45 (0) 5627 5050

 Brand name: BA30
 Collector type: Flat Plate
 Year of production: 2006
 Serial number: 16892 and 16893
 Drawing document No: BA22.doc, BA22L-snit.doc, BA22+30L-snit.doc

Dimensions of collector unit

Length: 1120 mm Aperture: 3.00 m²
 Width: 2820 mm Gross area: 3.16 m²
 Height: 90 mm

Technical specifications

Weight: 35 kg
 Fluid content: 2.26 liters
 Heat transfer fluid, recommended: Water or water/glycol
 Pressure drop: $\Delta p=262$ mbar using water, 20°C, and 237 l/h

Operating pressure:
 Stagnation temperature at 1000 W/m²
 and 30 °C ambient temperature 191°C

² On serial number 16892

³ On serial number 16893

⁴ Data from the manufacturer



Appendix 2

Number of covers:	1
Cover material:	Iron free glass
Cover thickness:	4 mm
Absorber:	
Material:	Copper
Surface treatment:	Selective, black chrome
Construction type:	Rolled tubeplate, parallel with 2 manifolds
Thermal insulation and casing:	
Thermal insulation thickness in casing:	Back 50 mm, edges 25 mm
Insulation material:	Mineral wool
Casing material:	Aluminum profile
Gross dimensions:	1120*2820*90 mm (w*l*h)
Sealing material:	Butylic joint filler and silicone
Limitations:	
Maximum operation temperature:	191°C
Maximum operation pressure:	10 bar