

Ordered by:

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Test Report No. C799LPEN

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1 Description of collector

1.1 Technical data of sample

Product information	
Manufacturer	EKOSOLARIS, a.s.
Model	Therma Blue
Type	Flat plate collector
Flow	Parallel grid
Serial product	Yes
Drawing number	--
Serial number	--
Date of manufacture	01.04.2006

Physical parameters	
Gross length	2.070 m
Gross width	1.109 m
Gross height	0.101 m
Gross area	2.296 m ²
Aperture area	2.059 m ²
Absorber area	2.040 m ²
Weight (empty, incl. cover)	40.5 kg
Fluid capacity	1.7 l

Construction	
Type	Flat plate collector
Number of absorber elements	10
Absorber pitch	101 mm
Number of hydraulically parallel tubes	10
Number of thermally serial glazings	Single-glazed
Material of glazing(s)	Toughened glass
Thickness of glazing(s)	3.2 mm

Heat transfer fluid (manufacturer recommendation)	
Type	Water-Propyleneglycol
Specifications	--

Remarks on collector design	
--	

Absorber	
Absorber element	Copper fins
Length of absorber element	1940 mm
Width of absorber element	105 mm
Thickness of absorber element	0.2 mm
Coating	Ceramic-metal-structure (Cermet)
Flowed through element	Copper tube
Joining technique	Ultrasonic-welded
Joining seam	Blank

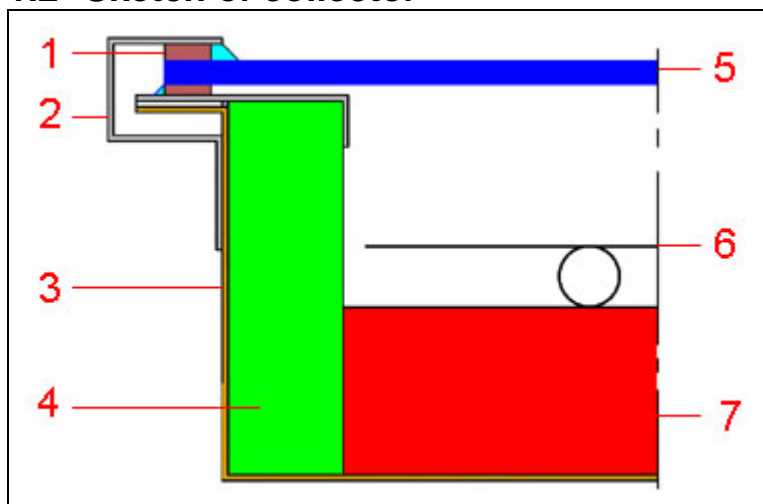
Installation	
On tilted roof	Yes
In tilted roof	No
On flat roof	No
On flat roof with stand	Yes
Facade	Yes

Casing and insulation	
Casing material	Aluminium
Sealing material	EPDM
Insulation material	Rockwool, Rockwool
Thickness (in mm)	20, 50
Aperture dimensions	2.015 m * 1.022 m

Limitations (manufacturer information)	
Max. temperature	140°C
Max. operating pressure	6 bar
Other	--

Test schedule	
Test procedure	EN 12975, Outdoor
Sample received	31.05.2006
Start of test	26.07.2006
End of test	04.09.2006

1.2 Sketch of collector



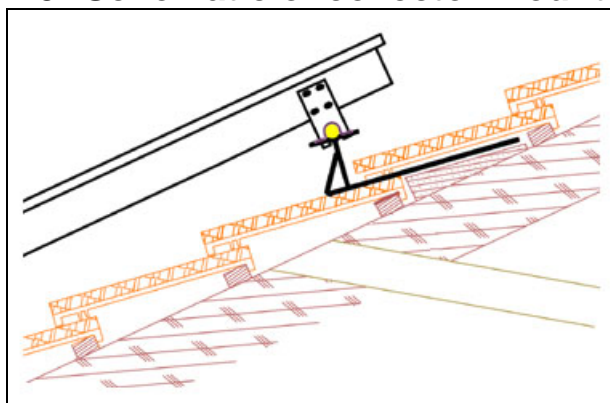
1.3 Specifications on elements

1	Sealing Description:	EPDM
2	Glass fixing profile Description:	Aluminum
3	Frame Type of construction: Material:	Casing Aluminium
4	Lateral thermal insulation Material: Lamination: Thickness [mm]: Remarks:	Rockwool None 20 only left and right
5	Glazing Tradename: Material: Thickness [mm]:	Albarino T Toughened glass 3.2
6	Absorber Absorber element: Flow-through element: Length of element [mm]: Width of element [mm]: Flow type: Joining technique: Joining seam:	Copper fins Copper tube 1940 105 Parallel grid Ultrasonic-welded Blank
6	Absorber coating Tradename: Description: Manufacturing process:	EtaPlus Ceramic-metal-structure (Cermet) sputtering
7	Thermal insulation Material: Lamination: Thickness [mm]:	Rockwool Black glass fleece 50

1.4 Photo of collector



1.5 Schematic of collector mounting



2 Test methods and results

2.1 Test of thermal performance

Tests carried out according to EN 12975-2: 2001.

Deviations from this standard are indicated by the formatting identic to this clause. The reasons for the deviations are mentioned.

2.2 Schematic of the test loop

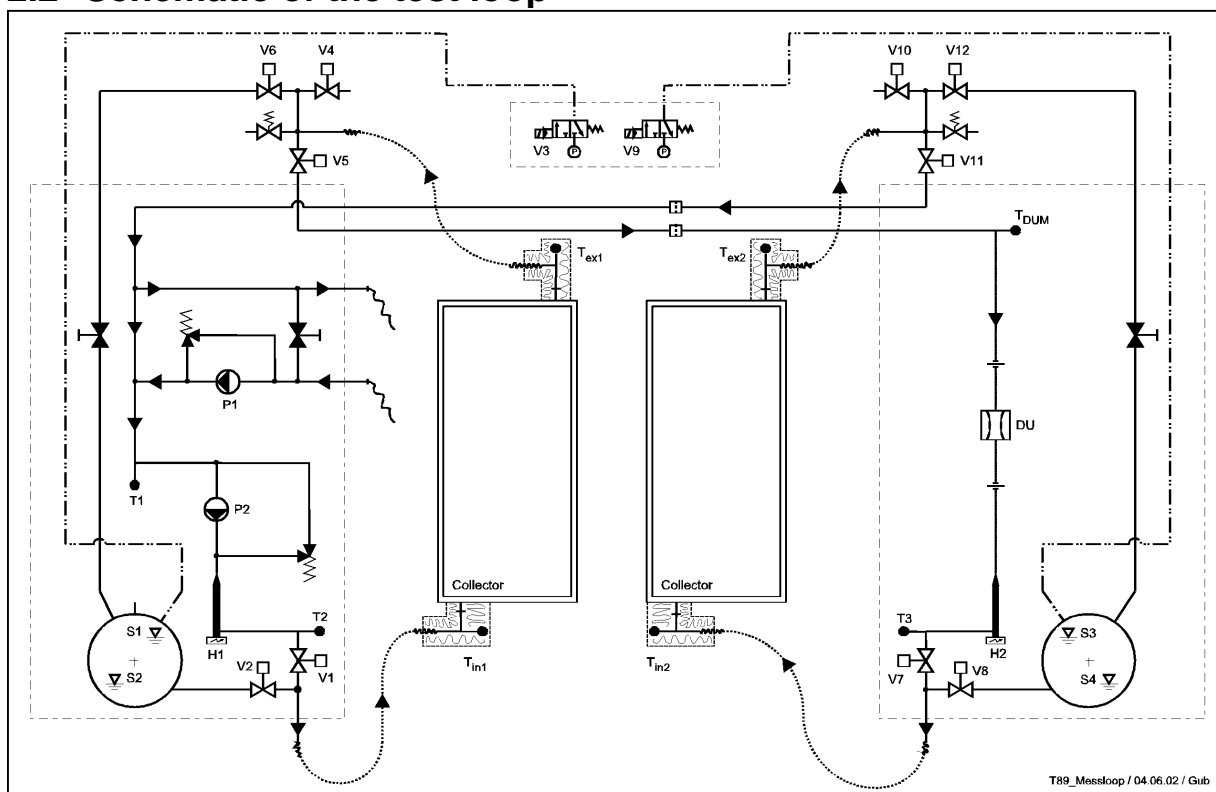


Fig. 2.1: Test loop for efficiency measurements.

2.3 Efficiency curve

2.3.1 General

Flow rate during test	120.0 l/h
Fluid for tests	33.3 Vol-% ethylene glycol
Test method	stationary (steady state)
Geographical position of test site	47.2°N / 8.8°O, 417 m NN
Collector tilt angle	tracked (45±5)°
Collector azimuth angle	tracked (0±48)°
Definition of efficiency	$\eta = \dot{Q} / A \cdot G$
Thermal output power of collector	\dot{Q}
Reference area	A
Global irradiance	G
Global irradiance on reference area	A·G
Efficiency equation	$\eta = \eta_0 - a_1 \cdot T_m^* - a_2 \cdot G \cdot T_m^{*2}$
Temperature at collector inlet	T_{in}
Temperature at collector outlet	T_{ex}
Ambient temperature	T_a
Mean collector temperature	$T_m = (T_{in} + T_{ex}) / 2$
Reduced collector temperature	$T_m^* = (T_m - T_a) / G$
Global irradiance for efficiency diagrams	G = 800 W/m ²

2.3.2 Efficiency

Data with reference to the absorber area are given in addition to the reference areas required by the standard.

2.3.2.1 Diagram

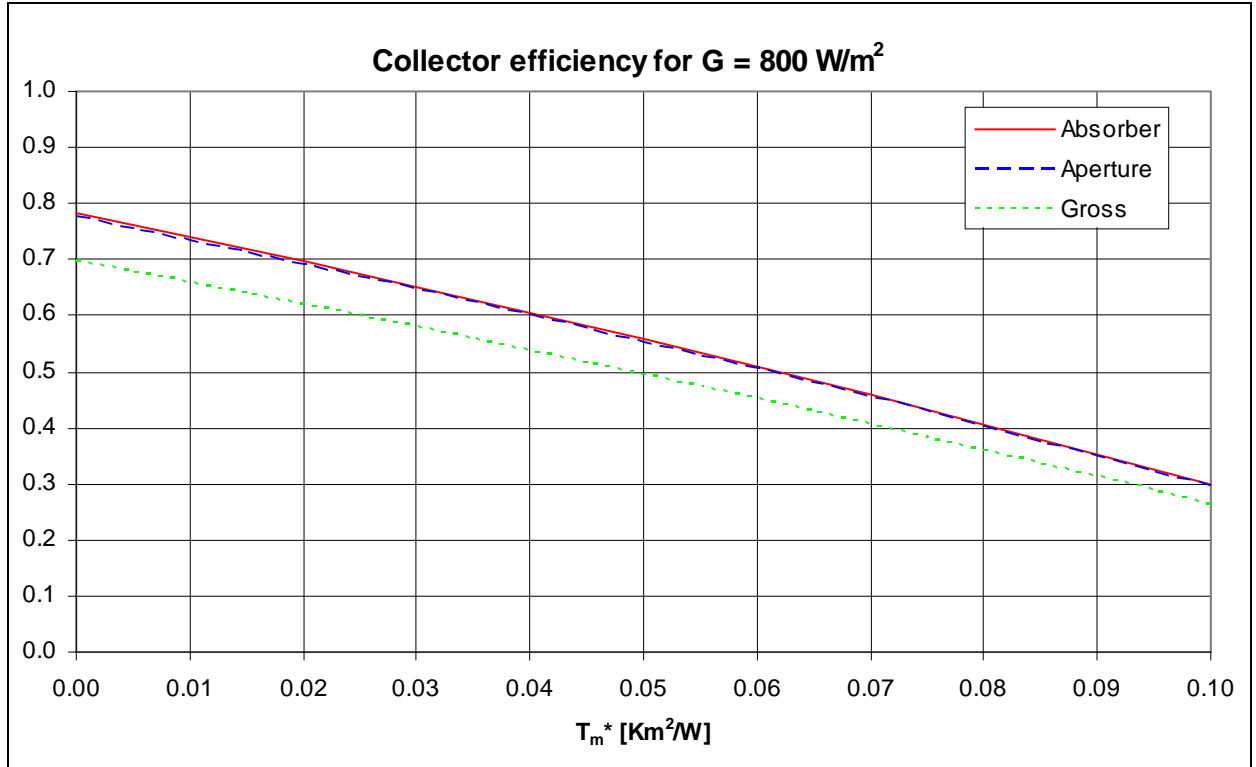


Fig. 2.2: Efficiency diagram for G = 800 W/m²

2.3.2.2 Parameters for efficiency equation:

Reference area:	Absorber area	Aperture area	Gross area
η_0 (-)	0.784	0.777	0.697
a_1 (W/m ² K)	4.17	4.13	3.71
a_2 (W/m ² K ²)	0.0086	0.0085	0.0076

From repetitive measurements of a reference collector, we estimate the following dispersion for the efficiency measurement (standard deviation of the mean, multiplied with a coverage factor 2):

At T_m*=0.02: 0.27 Efficiency-%,
 at T_m*=0.05: 0.44 Efficiency-%,
 at T_m*=0.08: 0.62 Efficiency-%.

2.4 Measured values of the Incidence Angle Modifier (IAM)

	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
K_{Θ} (longitudinal)	1.00	1.00	1.00	0.99	0.98	0.94	0.87	0.73	0.48	0.00
K_{Θ} (transversal)	1.00	1.00	1.00	0.99	0.98	0.94	0.87	0.73	0.48	0.00

2.5 Time constant

$$\tau_c = 62 \text{ s}$$

2.6 Effective thermal capacity

2.6.1 Determination according to EN12975-2, Annex J3

Determination based on transient behaviour of the collector.

$$C_{\text{eff},J3} = 17.8 \text{ kJ/K (Effective heat capacity of collector filled with fluid)}$$

Additional information: The thermal capacity was measured with the properties of „Antifrogen N“. For other fluids, the thermal capacity is calculated as follows:

$$C_{\text{eff},J3} = 1.7 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 11.2 \text{ kJ/K}$$

2.6.2 Determination according to EN12975-2, Section 6.1.6.2.

Estimation based on material properties.

$$C_{\text{eff},6162} = 12.5 \text{ kJ/K (Effective heat capacity of collector filled with fluid)}$$

Additional information: The thermal capacity was measured with the properties of „Antifrogen N“. For other fluids, the thermal capacity is calculated as follows:

$$C_{\text{eff},6162} = 1.7 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 5.9 \text{ kJ/K}$$

2.7 Power output per collector unit

$T_m - T_a$	Global irradiance G		
	G=400 W/m ²	G=700 W/m ²	G=1000 W/m ²
10 K	553 W	1033 W	1513 W
30 K	369 W	849 W	1328 W
50 K	171 W	650 W	1130 W

2.8 Pressure drop

2.8.1 Diagram

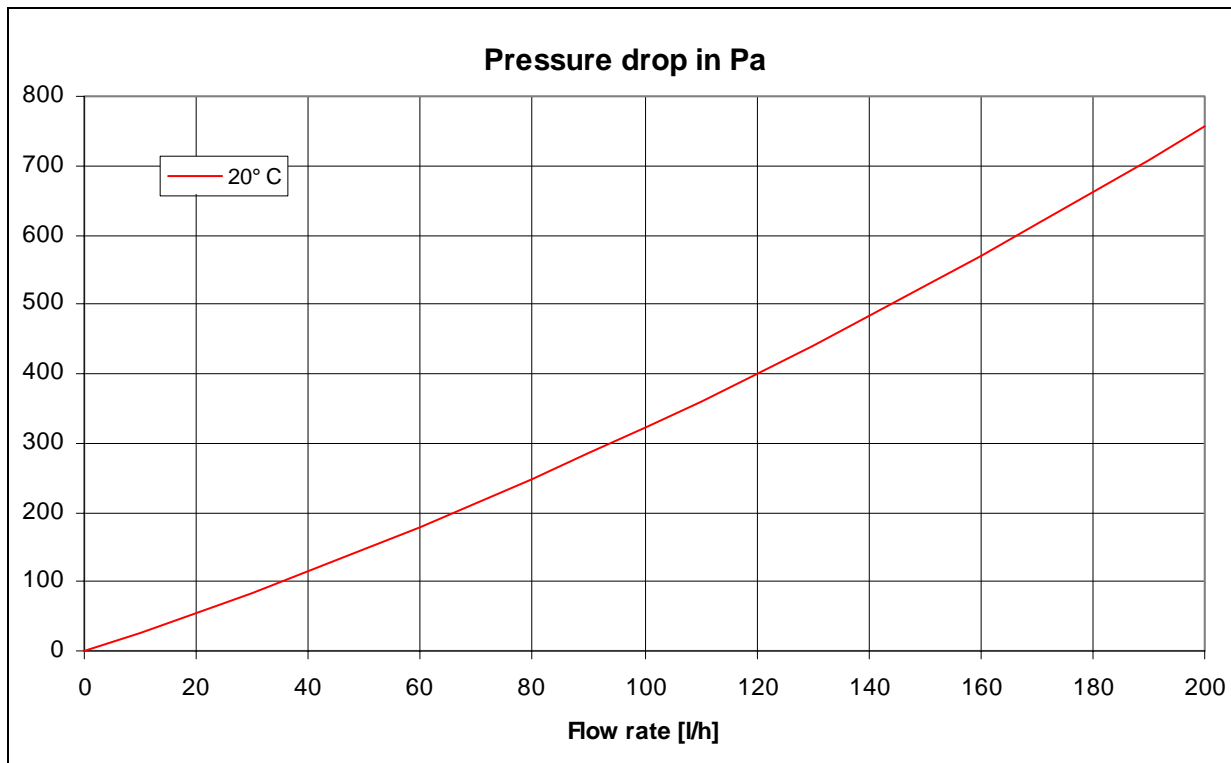


Fig. 2.3: Pressure drop as a function of volume flowrate

2.8.2 Pressure drop at rated flowrate

Conditions:

$T_{\text{fluid}} = 20^{\circ}\text{C}$ and $dV/dt = 90 \text{ l/h}$

$\Delta p = 285 \text{ Pa}$

2.8.3 Table of pressure drop data in Pa

Conditions:

$T_{\text{fluid}} = 20^{\circ}\text{C}$

Flow rate [l/h]	0	50	100	150	200
Pressure drop [Pa]	0	147	322	525	757

3 Remarks

This report must not be copied except in full.
The test methods applied fulfil the requirements of EN 12975.
The test results only refer to the tested collector sample.
This test report is made according to the requirements of EN 12975.
This test reports fulfills the requirements of ISO 17025.

Rapperswil, 13.11.2006



Dr. Andreas Bohren
Head of collector department



Dipl.-Ing. Walter Gubler
Test engineer

Annex: Performance test report summary

(according to EN12975 Annex E)

Collector identification	
Manufacturer	EKOSOLARIS, a.s.
Model	Therma Blue
Type	Flat plate collector
Flow	Parallel grid
Serial number	--
Drawing number	--

Dimensions	
Gross length	2.070 m
Gross width	1.109 m
Gross height	0.101 m
Gross area	2.296 m ²
Aperture area	2.059 m ²
Absorber area	2.040 m ²

General specifications	
Weight	40.5 kg
Heat transfer fluid	Water-Propyleneglycol
Flow rate (range)	30 - 120 l/h
Pressure drop at 90 l/h	285 Pa
Max. operating pressure	6 bar

Thermal performance based on aperture area	
η_0	0.777
a_1	4.13
a_2	0.0085

Thermal performance based on absorber area	
η_0	0.784
a_1	4.17
a_2	0.0086

Power output per collector			
$T_m - T_a$	Global irradiance G		
	G = 400 W/m ²	G = 700 W/m ²	G = 1000 W/m ²
10 K	553 W	1033 W	1513 W
30 K	369 W	849 W	1328 W
50 K	171 W	650 W	1130 W

Test institute: SPF Solartechnik, CH-8640 Rapperswil
Date: 13.11.2006