SPF Solartechnik Prüfung Forschung

STS 301

Ordered by:

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Test Report No. C632LPEN

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1 Description of Collector

1.1 Technical Data of Sample

Product information	
Manufacturer	Focus Technology Co., Ltd
Model	AP-20
Type	ETC with heat pipe and dry coupler
Serial Product	Yes
Drawing Number	--
Serial Number	APSR-20-D-110 APSR-20-D-111
Date when manufactured	07/2003

Sizes	
Gross length	1.929 m
Gross width	1.496 m
Gross height	0.133 m
Gross area	2.886 m²
Aperture area	1.876 m²
Absorber area	1.606 m²
Weight empty	63 kg
Weight without glazing	--
Fluid capacity	0.6 l

Construction	
Type	ETC with heat pipe and dry coupler
Number of absorber elements	20
Absorber pitch	0.070 m
Number of hydraulically parallel tubes	1
Number of thermally serial glazings	1
Material of glazings	Borosilicate glass
Thickness of glazings	1.6 mm

heat transfer fluid	
Recommended type	Water-Glycol
Specifications	--

Absorber	
Absorber materials	Glass
Length of absorber element	1.725 m
Width of absorber element	--
Thickness of absorber	--
Coating	Graded Al-N/Al on glass
Construction of absorber	Evacuated double glass tube, Heat-conducting metal sheet, Heat pipe Cu

Mounting	
On tilted roof	Yes
In tilted roof	No
On flat roof	No
In flat roof	No
On flat roof with stand	Yes

Collecor box and Insulation	
Housing material	Stainless steel 0.8 mm
Sealing material	Silicone rubber
Insulation material	Glass Wool
Thickness	--
Aperture dimensions	20 * 1.709 m * 0.0549 m

Limitations	
Maximum temperature	250°C
Maximum pressure	6 bar
Other limitations	--

Test schedule	
Test procedure	EN 12975, Outdoor
Sample received	03.12.2003
Start of test	03.12.2003
End of test	10.03.2004

Remarks on collector design
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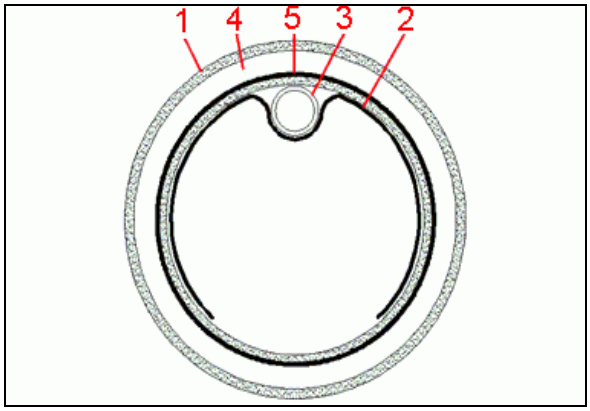
1.2 Sketch of Collector



Index

1 Glazing
2 Heat conducting metal sheet
3 Heat pipe
4 Vacuum
5 Absorber

1.3 Specifications on elements

1.3.1 Absorber

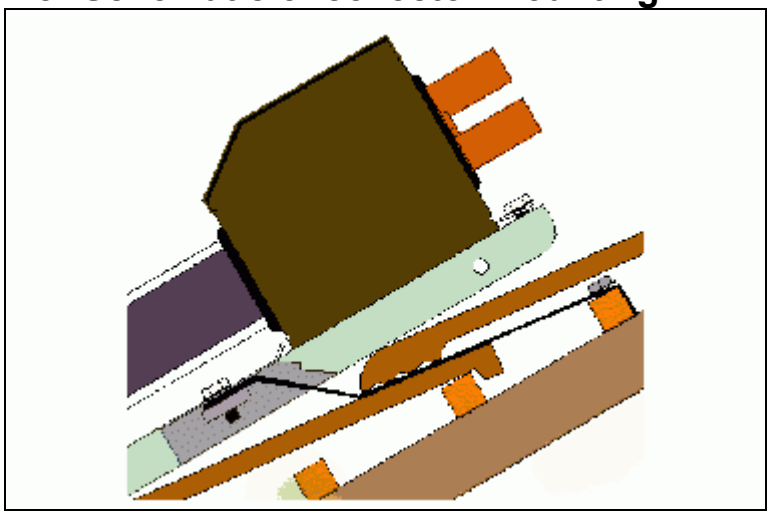
Index No.	5
Material(s)	Glass
Construction	Evacuated double glass tube, Heat-conducting metal sheet, Heat pipe Cu
Coating	Graded Al-N/Al on glass

1.3.2 Glazing

Index No.	1
Material	Borosilicate glass
Thickness	1.6 mm

1.4 Photo of Collector

1.5 Schematic of collector mounting



Remarks

2 Test method and results

2.1 Test of thermal properties

Tests carried out according to EN 12975-2: 2001.
Deviations of this standard are formatted in the way of this clause in the test report and reasons for the deviations are given.

2.2 Schematic of test loop

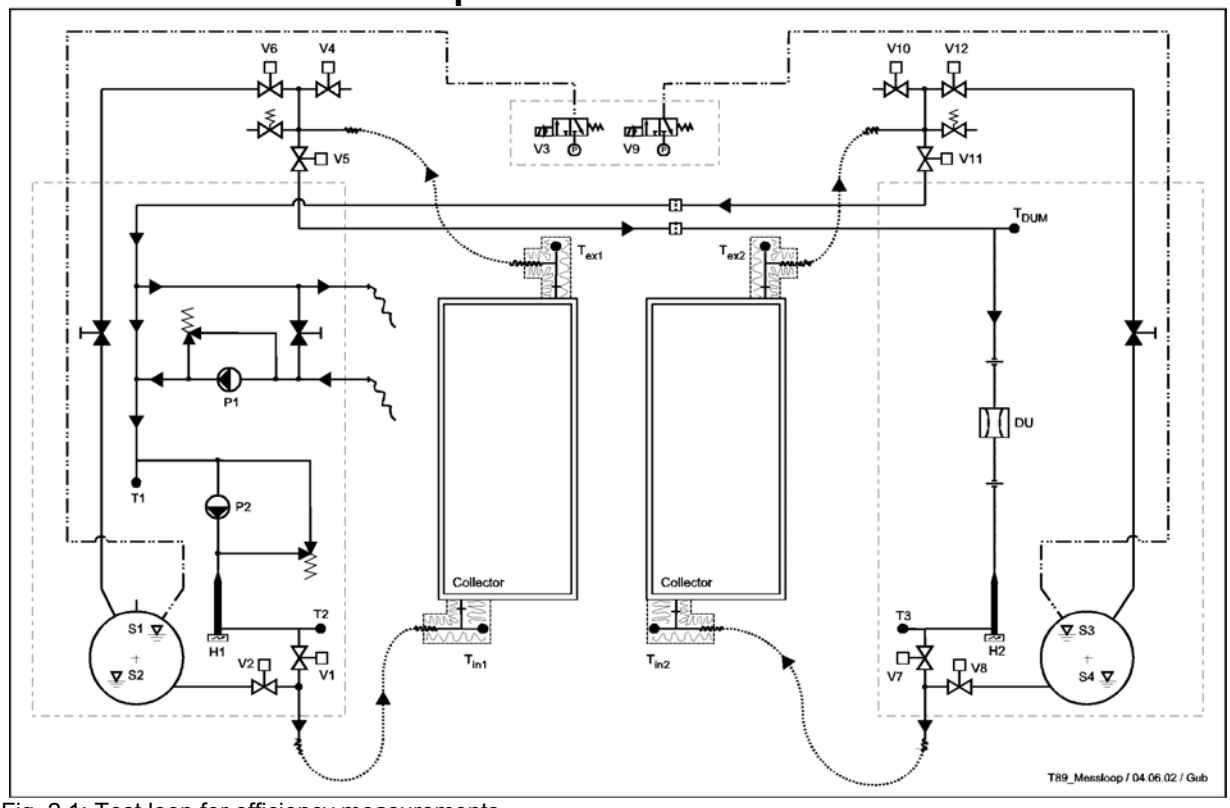


Fig. 2.1: Test loop for efficiency measurements

2.3 Efficiency curve

2.3.1 General

Flow rate during test	120 l/h
Fluid	33.3 Vol-% ethylene glycol
Test method	stationary (steady state)
Geographical position of test site	47.2°N / 8.8°E, 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	A
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/m²

2.3.2 Efficiency

Values with reference to the absorber area are given additionally to the reference areas requested by the standard.

2.3.2.1 Diagram

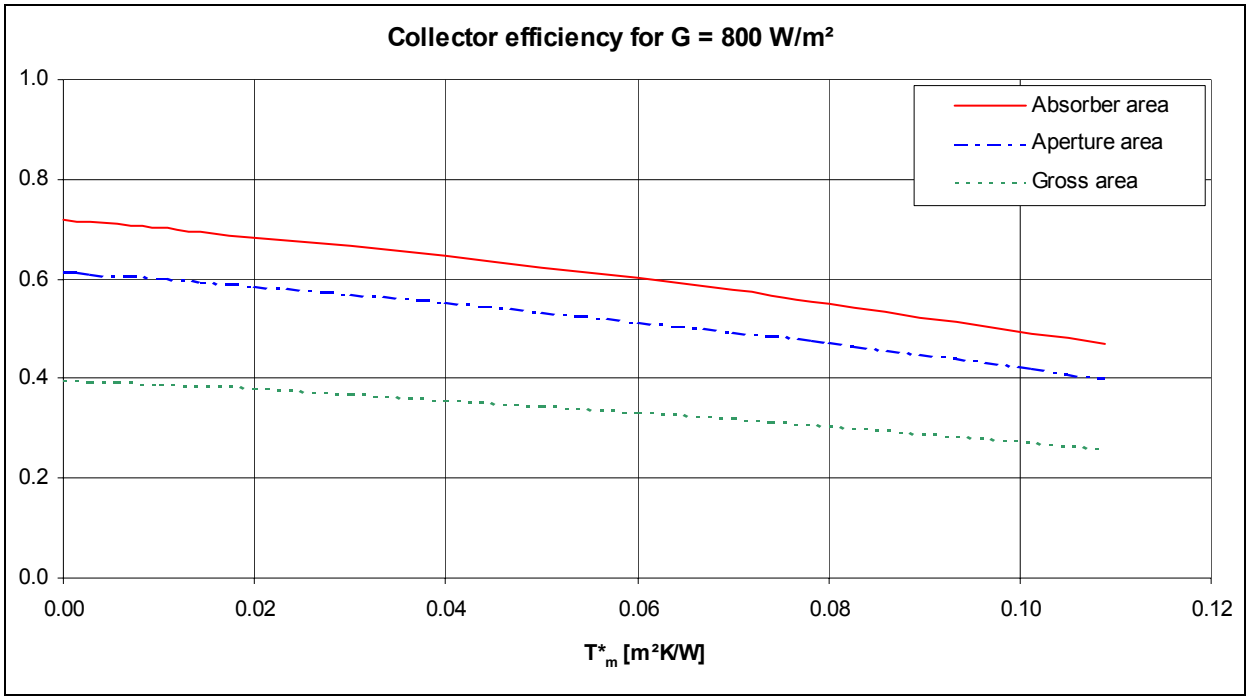


Fig. 2.2: Efficiency diagram G = 800 W/m²

2.3.2.2 Parameters for efficiency equation:

Reference area:	Absorber area	Aperture area	Gross area
η_0 (-)	0.717	0.614	0.399
a_1 (W/m²K)	1.52	1.30	0.85
a_2 (W/m²K²)	0.0085	0.0073	0.0047

From repetetive 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 Tm*=0.02: 0.27 Efficiency-%,
at Tm*=0.05: 0.44 Efficiency -%,
at Tm*=0.08: 0.62 Efficiency -%.

2.4 Measured values of the Incidence Angle Modifier

	0°	10°	20°	30°	40°	**50°**	60°	70°	80°	90°
K_Θ (longitudinal)	1.0					**0.93**				0.0
K_Θ (transversal)	1.0	1.02	1.08	1.18	1.37	**1.40**	1.34	1.24	0.95	0.0

2.5 Time Constant

τ_C = 1160 s

2.6 Effective Thermal Capacity

Estimation on material propertys according to data provided by the manufacturer.

C = 264.8 kJ/K

Additional information: The thermal capacity was estimated with the propertiess of „Antifrogen N“. For other fluids, thermal capacity can be calculated to:

C = 0.6 l * Density * specific heat capacity of fluid Fluids + 262.6 kJ/K

2.7 Stagnation Temperature

Stagnation temperature at G =1000 W/m² and t_a = 30°C

T_{Stag} = 245°C

Remarks: Computed according to EN12975-2 Annex C.2, Approach 1

2.8 Power Output per Collector Unit

$T_m - T_a$	Global irradiance		
	400 W/m²	700 W/m²	1000 W/m²
10 K	435 W	780 W	1'126 W
30 K	375 W	721 W	1'066 W
50 K	304 W	650 W	995 W

3 Remarks

This report must not be copied except in full.
The test methods applied fulfil the requirements of EN 12975, ISO 9806-2, DIN 4757T4.
The test reports only refer to the tested collector sample.
This test report is made according to the requirements of EN 12975.
The test reports fulfills the requirements of ISO 17025.

Rapperswil, 22.03.2004

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	Focus Technology Co., Ltd
Model	AP-20
Type	ETC with heat pipe and dry coupler
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Absorber area	1.606 m²

General data	
Weight	63 kg
Heat transfer fluid	Water-Glycol
Flowrate	120 - 600 l/h
Pressure drop at 120 l/h	--
Working pressure	6 bar

Efficiency based on aperture area	
η_0	0.614
a_1	1.30
a_2	0.0073

Efficiency based on absorber area	
η_0	0.717
a_1	1.52
a_2	0.0085

Heat power output per collector			
$T_m - T_a$	Global irradiance G		
	G = 400 W/m²	G = 700 W/m²	G = 1000 W/m²
10 K	435 W	780 W	1'126 W
30 K	375 W	721 W	1'066 W
50 K	304 W	650 W	995 W

Test performed by: SPF Solartechnik, CH-8640 Rapperswil
Date: 22.03.2004