

Ordered by:

SAMMLER Solar
8, Chiou str.
Aspropyrgos Industrial Zone
GR-19300 Athens

Tel. +30 210 2382867
Fax: +30 210 2320337

Test Report No. C1281LPEN

Performance test according to EN 12975-2:2006, Paragraph 6

Content:	page
1 Description of Collector.....	2
1.1 Technical Data of the Sample.....	2
1.2 Sketch of Collector.....	3
1.3 Specifications on Elements.....	3
1.4 Photo of Collector.....	4
1.5 Sketch of Collector Mounting.....	4
2 Test Methods and Results.....	5
2.1 Test of Thermal Performance.....	5
2.2 Schematic of the Test Loop.....	5
2.3 Power Output.....	6
2.4 Incident Angle Factor.....	9
2.5 Time Constant.....	10
2.6 Effective Thermal Capacity.....	10
2.7 Pressure Drop.....	11
2.8 Observed Failures.....	12
3 Remarks.....	12

1 Description of Collector

1.1 Technical Data of the Sample

Product information	
Manufacturer	SAMMLER Solar
Model	ALTER 2504
Type	Flat plate collector
Flow	Serpentine
Serial product	Yes
Drawing number	A complete set of technical drawings is filed at the test institute.
Serial number	01523
Date of manufacture	01.07.2010

Absorber	
Absorber element	Aluminium sheet
Length of absorber element	1950.0 mm
Width of absorber element	1159.0 mm
Thickness of absorber element	0.50 mm
Coating	Ceramic-metal-structure (Cermet)
Flowed through element	Copper pipe
Joining technique	Laser welded
Joining seam	--

Physical parameters	
Gross length	2.046 m
Gross width	1.246 m
Gross height	0.090 m
Gross area	2.549 m ²
Aperture area	2.288 m ²
Absorber area	2.260 m ²
Weight empty	53.0 kg
Fluid capacity	1.8 l

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

Construction	
Type	Flat plate collector
Number of absorber elements	1
Absorber pitch	90.0 mm
Number of hydraulically parallel tubes	1
Number of thermally serial glazings	1
Material of glazing(s)	Toughened glass
Thickness of glazing(s)	4.0 mm

Casing and insulation	
Casing material	Aluminium
Sealing material	Polyurethane sealant, Silicone
Insulation material	Glass wool, Mineral wool
Thickness (in mm)	20, 55
Aperture dimensions	1.967 m * 1.163 m

Heat transfer fluid (manufacturers' recommendation)	
Type	Water-glycol
Specifications	--

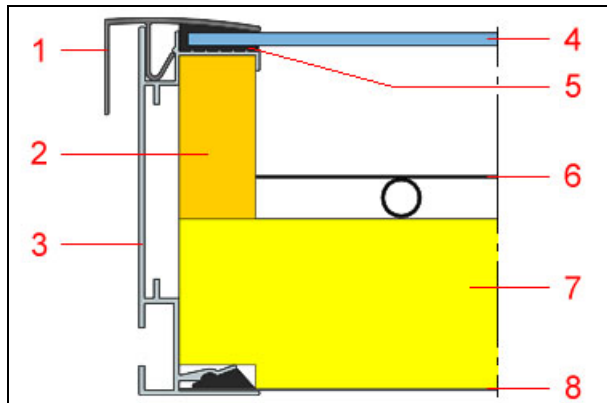
Limitations (manufacturer information)	
Max. temperature	Not specified
Max. operating pressure	10 bar
Other	--

Flow range (manufacturers' recommendation)	
Flow range	90 - 200 l/h
Rated flow rate	150 l/h

Remarks on collector design	
--	

Test schedule	
Test procedure	EN12975:2006, Outdoor test
Sample received	09.08.2010
Start of test	12.08.2010
End of test	30.11.2010

1.2 Sketch of Collector



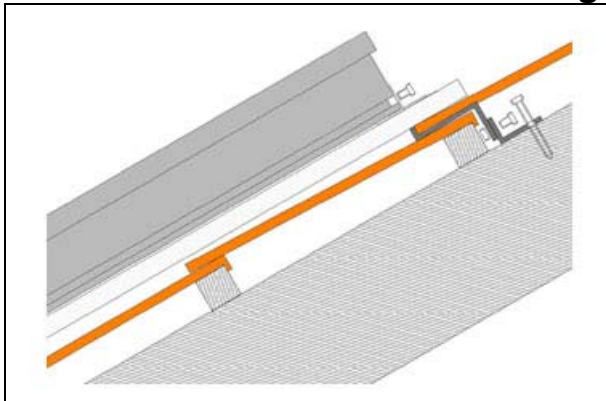
1.3 Specifications on Elements

1	Glass fixing profile Description:	Aluminum
2	Lateral thermal insulation Material: Lamination: Thickness [mm]:	Glass wool Black glass fleece 20
3	Casing Type of construction: Material: Profile: Corners: Coating:	Frame Aluminium Extruded profile Glued corners with corner joints Powder coated
4	Glazing Tradename: Material: Thickness [mm]: Properties:	SILK Toughened glass 4 Low ferrous content, structured on both sides
5	Sealing Description: Remarks:	Polyurethane sealant Glued corners
6	Absorber Absorber element: Flow-through element: Length of element [mm]: Width of element [mm]: Flow type: Joining technique:	Aluminium sheet Copper pipe 1950 1159 Serpentine Laser welded
6	Absorber coating Tradename: Description: Manufacturing process:	Mirotherm Ceramic-metal-structure (Cermet) Physical vapour deposition (PVD)
7	Thermal insulation Tradename: Material: Thickness [mm]:	TERVOL Mineral wool 55
8	Rear panel Description: Thickness [mm]:	Zinc-coated steel sheet 0.5

1.4 Photo of Collector



1.5 Sketch of Collector Mounting



2 Test Methods and Results

2.1 Test of Thermal Performance

Tests carried out according to EN 12975-2: 2006.

Deviations from this standard are indicated by the same formatting that is used for this clause. The reasons for the deviations are mentioned.

2.2 Schematic of the Test Loop

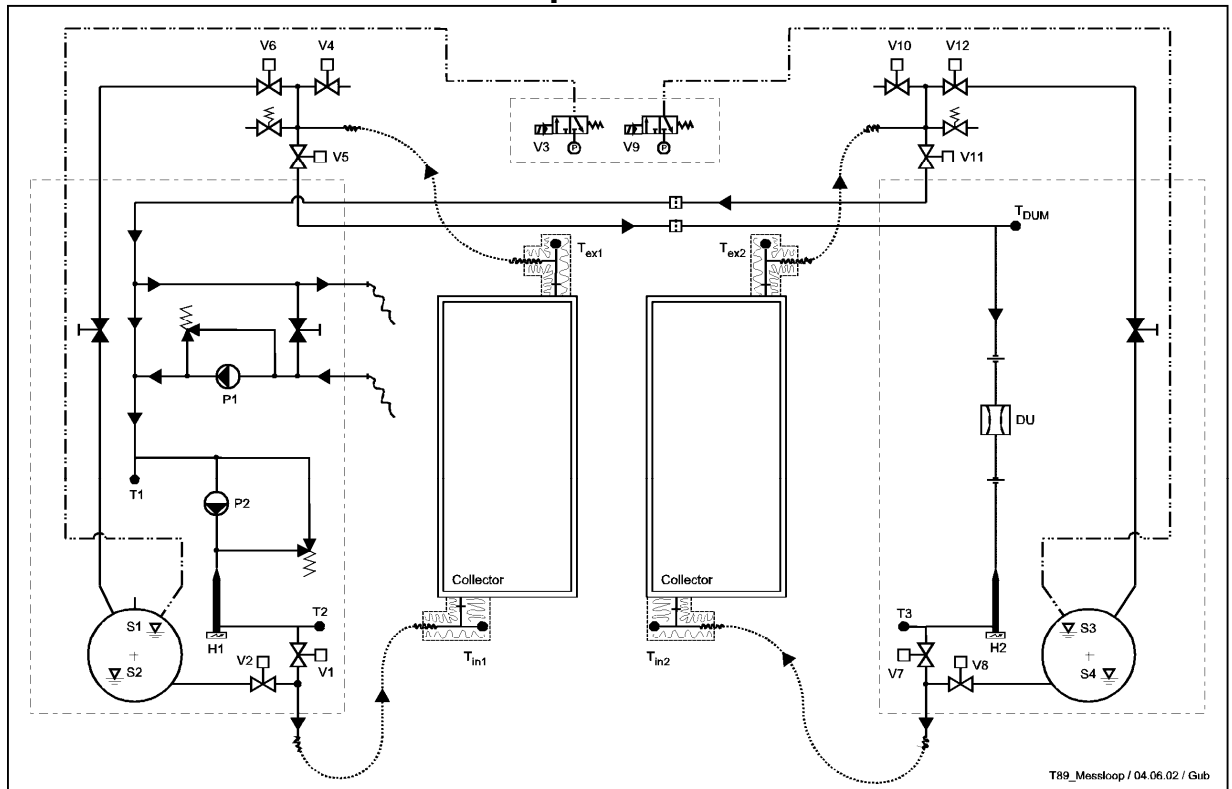


Fig. 2.1: Test loop for efficiency measurements.

2.3 Power Output

2.3.1 General

Flow rate during test	160.0 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
Solar irradiance	G
Solar 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	$T_m^* = (T_m - T_a)/G$
Solar irradiance for efficiency diagrams	G = 800 W/m ²

2.3.2 Power output per collector unit

2.3.2.1 Peak power

Peak power W_{peak} per collector unit for normal incident irradiation of 1000 Wm^{-2} .

$$W_{\text{peak}} = 1846 \text{ [W]}$$

2.3.2.2 Diagram

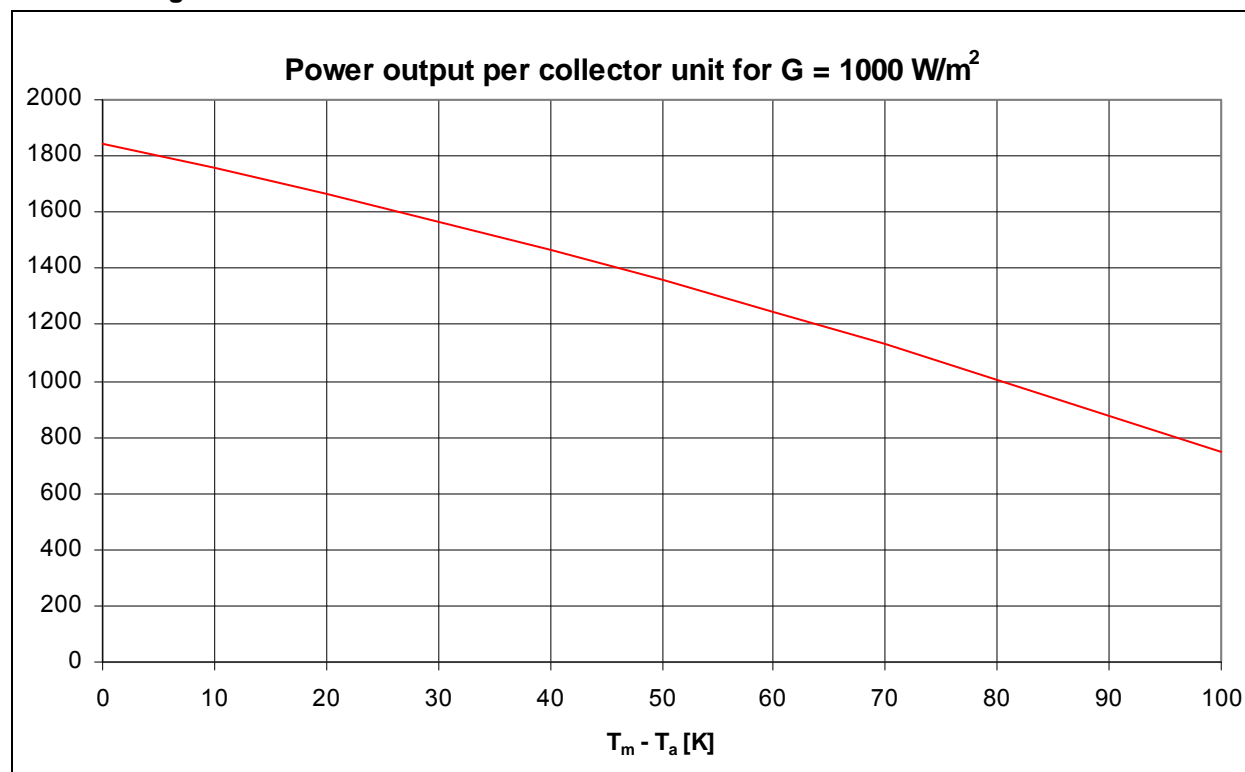


Fig. 2.2: Power output per collector unit at irradiance $G = 1000 \text{ W/m}^2$

2.3.2.3 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	651 W	1205 W	1759 W
30 K	462 W	1015 W	1569 W
50 K	252 W	805 W	1359 W

2.3.3 Efficiency curve

The efficiency curves with reference to the absorber-, aperture- and gross areas are indicated in addition to the requirements of the norm.

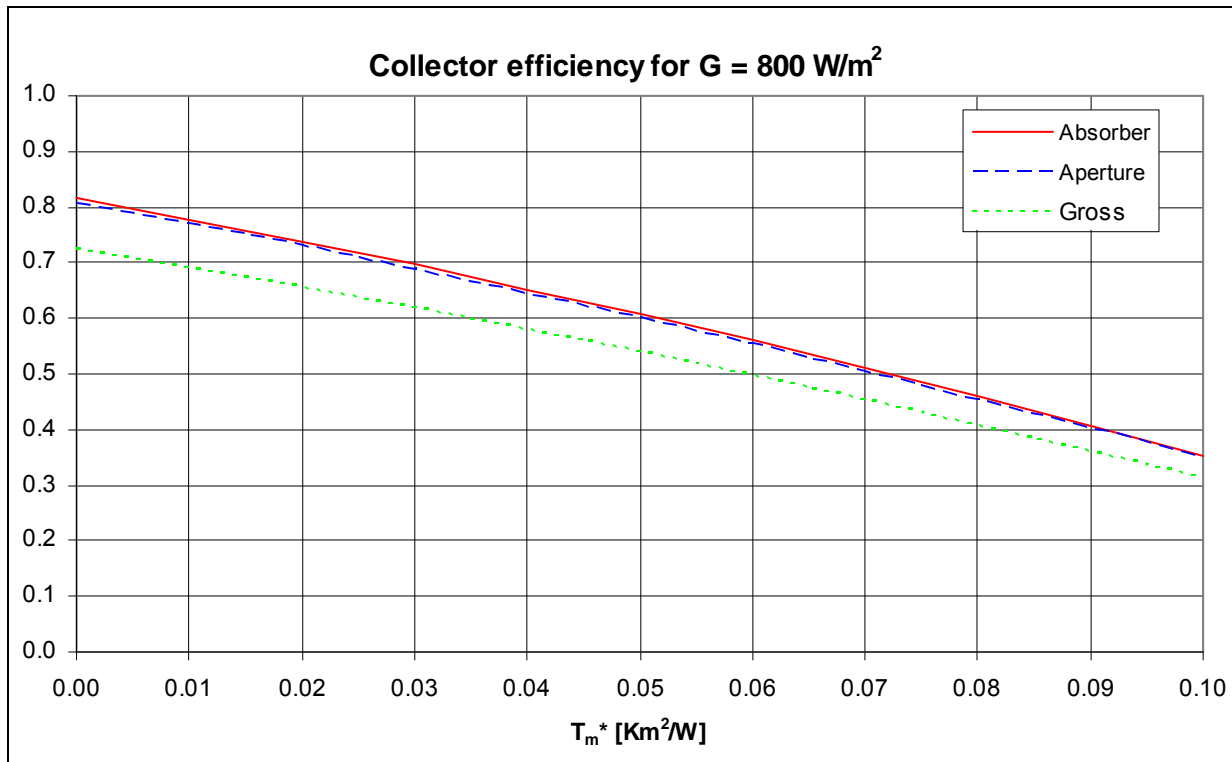


Fig. 2.3: Efficiency diagram for G = 800 W/m²

2.3.3.1 Parameters for efficiency equation

Reference area	Absorber area	Aperture area	Gross area
η_0 (-)	0.817	0.807	0.724
a_1 (W/m²K)	3.75	3.70	3.32
a_2 (W/m²K²)	0.0112	0.0111	0.0099

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 Incident Angle Factor

2.4.1 Table 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	0.97	0.93	0.86	0.72	0.47	0.00
K_{Θ} (transversal)	1.00	1.00	1.00	0.99	0.97	0.93	0.86	0.72	0.47	0.00

2.4.2 Diagram of the Incidence Angle Modifier

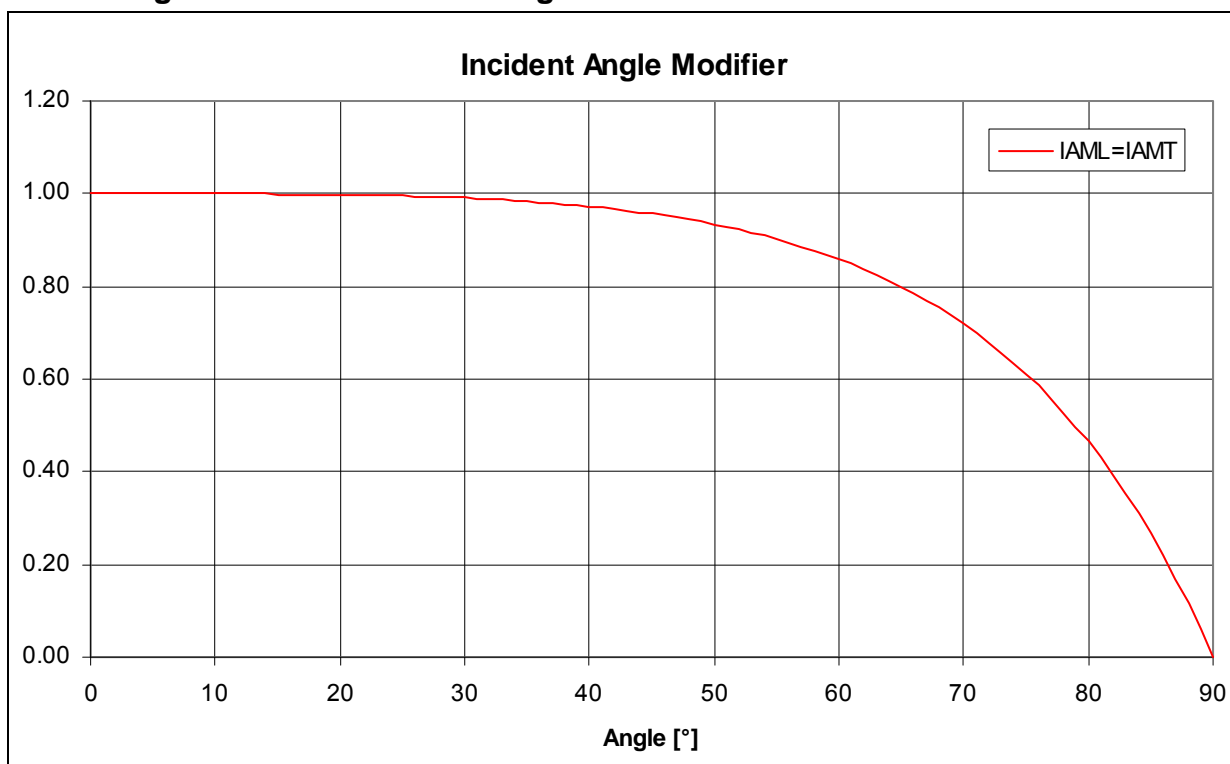


Fig. 2.4: Incident angle modifiers

2.5 Time Constant

$\tau_C = 60 \text{ s}$

2.6 Effective Thermal Capacity

2.6.1 Determination according to EN12975-2:2006, Annex G.3

Determination based on transient behaviour of the collector.

$C_{\text{eff,G3}} = 19.9 \text{ kJ/K}$ (Effective thermal 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:

$C_{\text{eff,G3}} = 1.8 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 13.2 \text{ kJ/K}$

2.6.2 Determination according to EN12975-2:2006, Section 6.1.6.2

Estimation based on material properties.

$C_{\text{eff,G162}} = 13.5 \text{ kJ/K}$ (Effective thermal 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:

$C_{\text{eff,G162}} = 1.8 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 6.8 \text{ kJ/K}$

2.7 Pressure Drop

2.7.1 Diagram

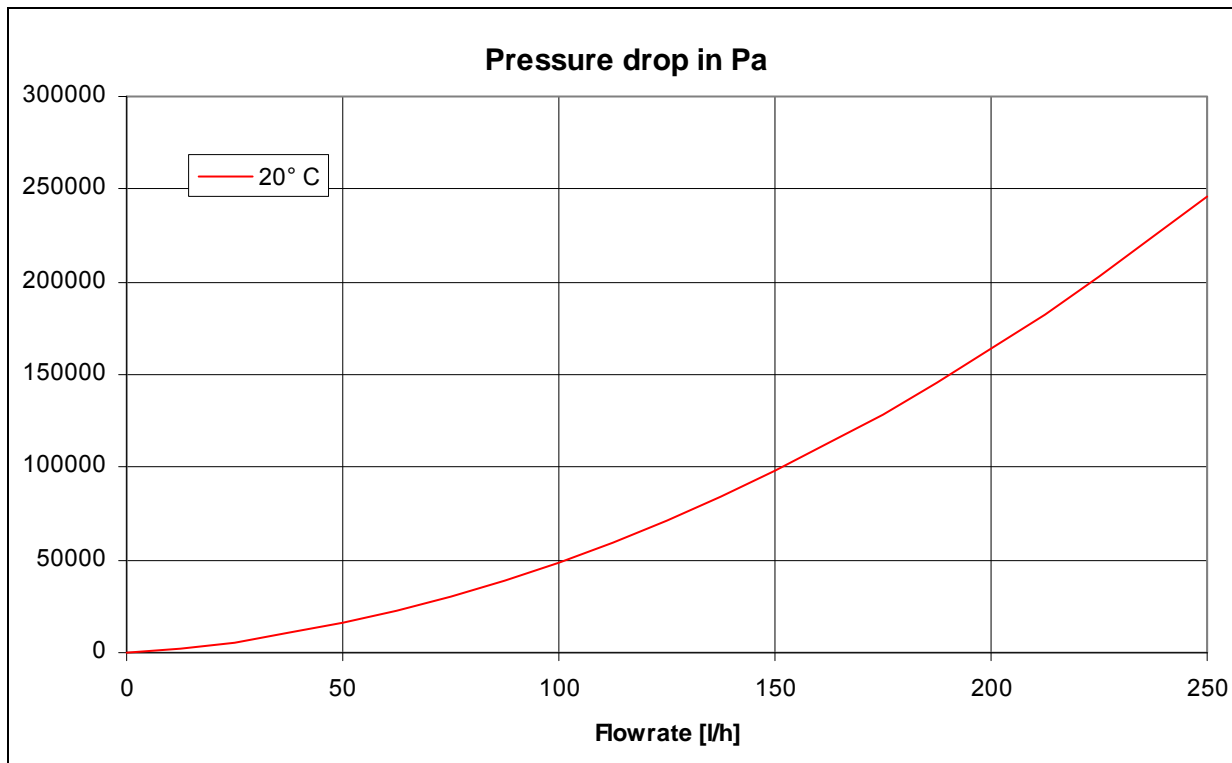


Fig. 2.5: Pressure drop as a function of volume flowrate

2.7.2 Pressure drop at rated flowrate

Conditions:

$T_m = 20^\circ\text{C}$ and $dV/dt = 150 \text{ l/h}$

$\Delta p = 97887 \text{ Pa}$

2.7.3 Table of pressure drop data in Pa

Conditions:

$T_m = 20^\circ\text{C}$

Flow rate [l/h]	0	50	100	150	200	250
Pressure drop [Pa]	0	15990	48619	97887	163794	246341

2.8 Observed Failures

Details about failures that are rated as major failures according to paragraph 5.3.1 of EN12975-1:2006.

Absorber leakage or such deformation that permanent contact between absorber and cover is established.	Passed
Breaking or permanent deformation of cover or cover fixing.	Passed
Breaking or permanent deformation of collector fixing points or collector box.	Passed
Loss of vacuum or low pressure (applicable for vacuum or subatmospheric collectors)	N/A
Accumulation of humidity in form of condensate on the inside of the transparent cover of the collector exceeding 10% of the aperture area	Passed

No major failures according to paragraph 5.3.1 of EN12975-1:2006 were found for this collector.

3 Remarks

This report must not be copied except in full.
The test methods applied fulfil the requirements of EN12975:2006.
The test results only refer to the tested collector sample.
This test report is made according to the requirements of EN12975:2006.
This test report fulfils the requirements of ISO17025.

Rapperswil, 23.12.2010



Dr. Andreas Bohren
Head of SPF Testing



Dipl.-Ing. Walter Gubler
Test engineer