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STS 301

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Test Report No. C1192LPEN

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

Content: **page**

1 Description of Collector

1.1 Technical Data of the Sample

Product information	
Manufacturer	Euroterm d.o.o
Model	ESK 2.5 SB
Type	Flat plate collector
Flow	Parallel grid
Serial product	Yes
Drawing number	A complete set of technical drawings is filed at the test institute
Serial number	ESK 2.5SB 00009
Date of manufacture	18.01.2010

Physical parameters	
Gross length	2.151 m
Gross width	1.162 m
Gross heigth	0.090 m
Gross area	2.499 m²
Aperture area	2.349 m²
Absorber area	2.311 m²
Weight empty	45.0 kg
Fluid capacity	1.7 l

Construction	
Type	Flat plate collector
Number of absorber elements	1
Absorber pitch	92.0 mm
Number of hydraulically parallel tubes	12
Number of thermally serial glazings	1
Material of glazing(s)	Toughened glass
Thickness of glazing(s)	4.0 mm

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

Flow range (manufacturers' recommendation)	
Flow range	50 - 360 l/h
Rated flow rate	120 l/h

Absorber	
Absorber element	Corrugated copper sheet
Length of absorber element	2093.0 mm
Width of absorber element	1104.0 mm
Thickness of absorber element	0.20 mm
Coating	Ceramic-metal-structure (Cermet)
Flowed through element	Copper pipe
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	No

Casing and insulation	
Casing material	Aluminium
Sealing material	Silicone
Insulation material	Mineral wool
Thickness (in mm)	40
Aperture dimensions	2.105 m * 1.116 m

Limitations (manufacturer information)	
Max. temperature	120°C
Max. operating pressure	10 bar
Other	--

Remarks on collector design
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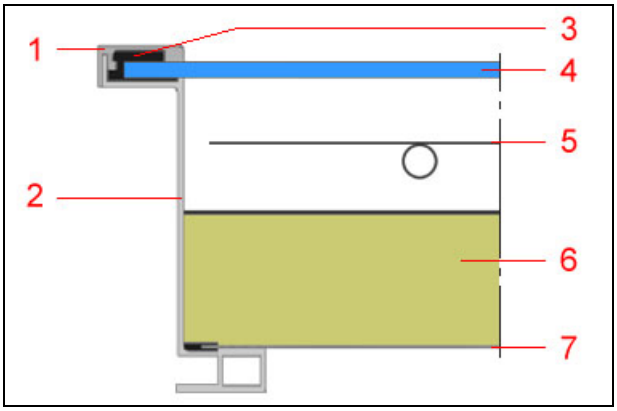
Test schedule	
Test procedure	EN12975:2006, Outdoor test
Sample received	02.02.2010
Start of test	08.03.2010
End of test	13.04.2010

1.2 Sketch of Collector



1.3 Specifications on Elements

1 Glass fixing profile

Description:	Aluminum

2 Casing

Type of construction:	Frame
Material:	Aluminium
Profile:	Extruded profile
Corners:	Glued corners
Coating:	Mill finished

3 Sealing

Tradename:	TERMOSIL N - 6
Description:	Silicone

4 Glazing

Material:	Toughened glass
Thickness [mm]:	4
Properties:	Low iron, not structured

5 Absorber

Absorber element:	Corrugated copper sheet
Flow-through element:	Copper pipe
Length of element [mm]:	2093
Width of element [mm]:	1104
Flow type:	Parallel grid
Joining technique:	Ultrasonic welded
Joining seam:	Blank

5 Absorber coating

Tradename:	EtaPlus
Description:	Ceramic-metal-structure (Cermet)
Manufacturing process:	Sputtering

6 Thermal insulation

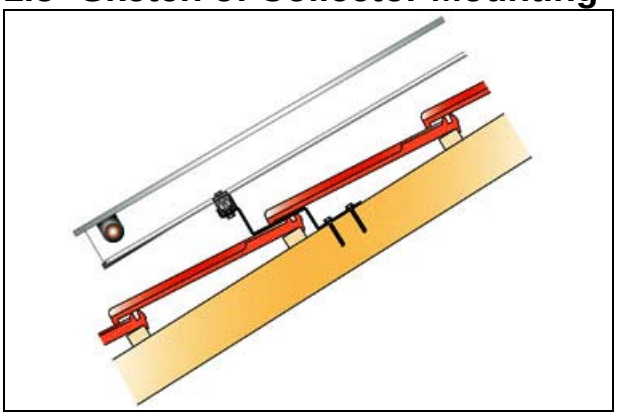
Tradename:	Starflex BFG
Material:	Mineral wool
Lamination:	Black glass fleece
Thickness [mm]:	40

7 Rear panel

Description:	Structured aluminium sheet
Thickness [mm]:	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

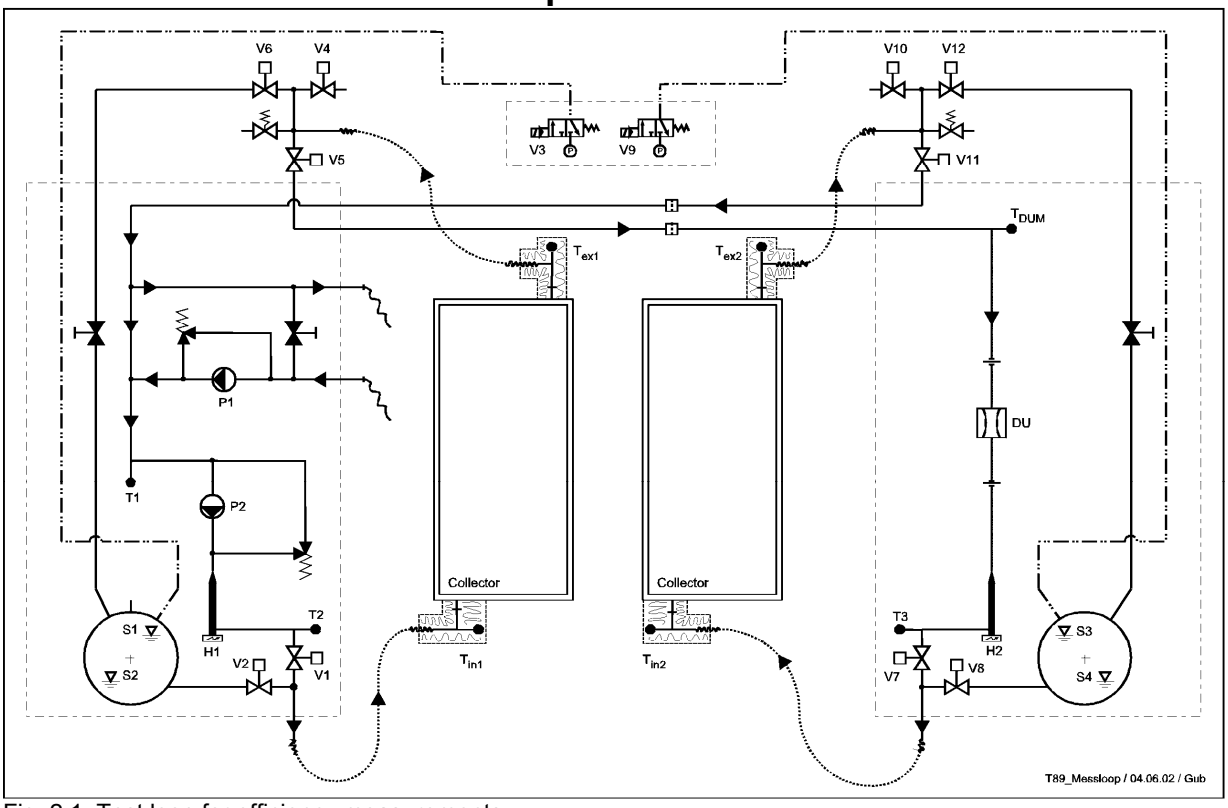


Fig. 2.1: Test loop for efficiency measurements.

2.3 Power Output

2.3.1 General

Flow rate during test	170.0 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/m²

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_{peak} = 1770 [W]

2.3.2.2 Diagram

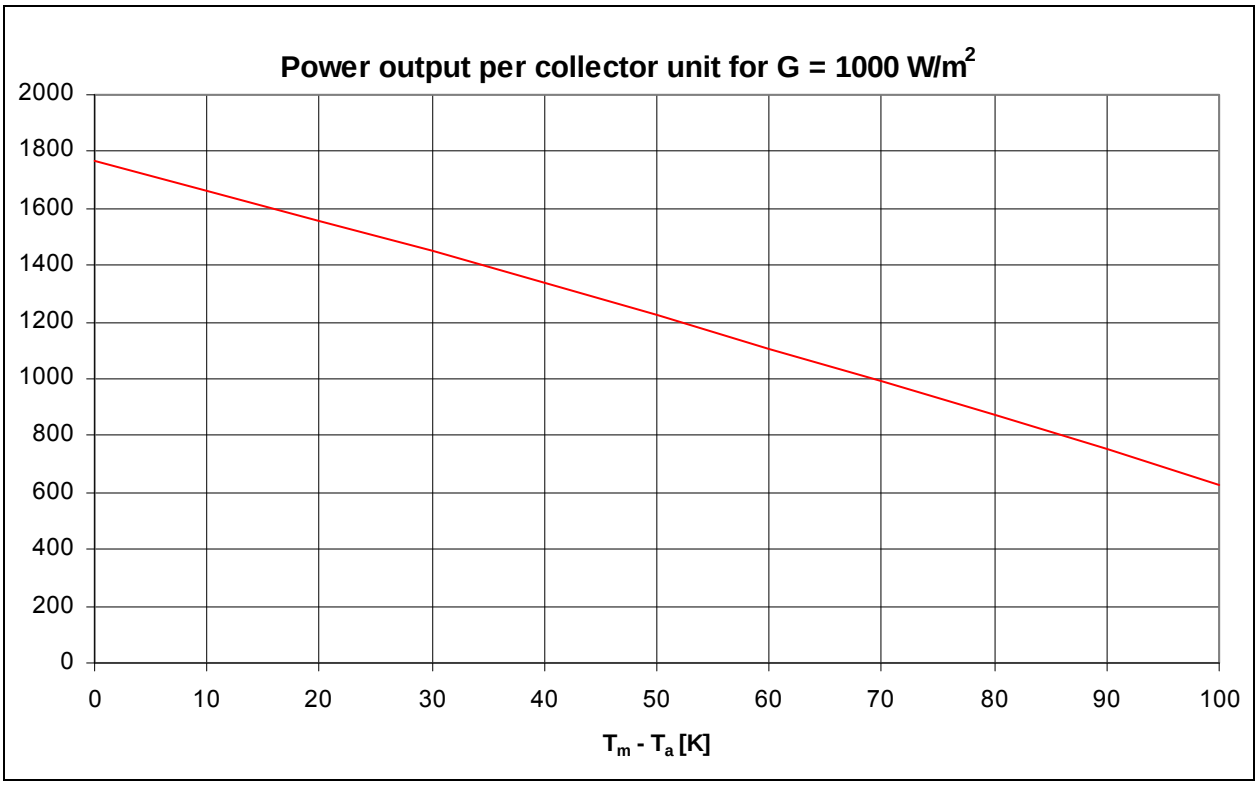


Fig. 2.2: Power output per collector unit at irradiance G = 1000 W/m²

2.3.2.3 Power output per collector unit

$T_m - T_a$	Global irradiance G		
	G=400 W/m²	G=700 W/m²	G=1000 W/m²
10 K	603 W	1134 W	1665 W
30 K	386 W	917 W	1448 W
50 K	162 W	693 W	1224 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.

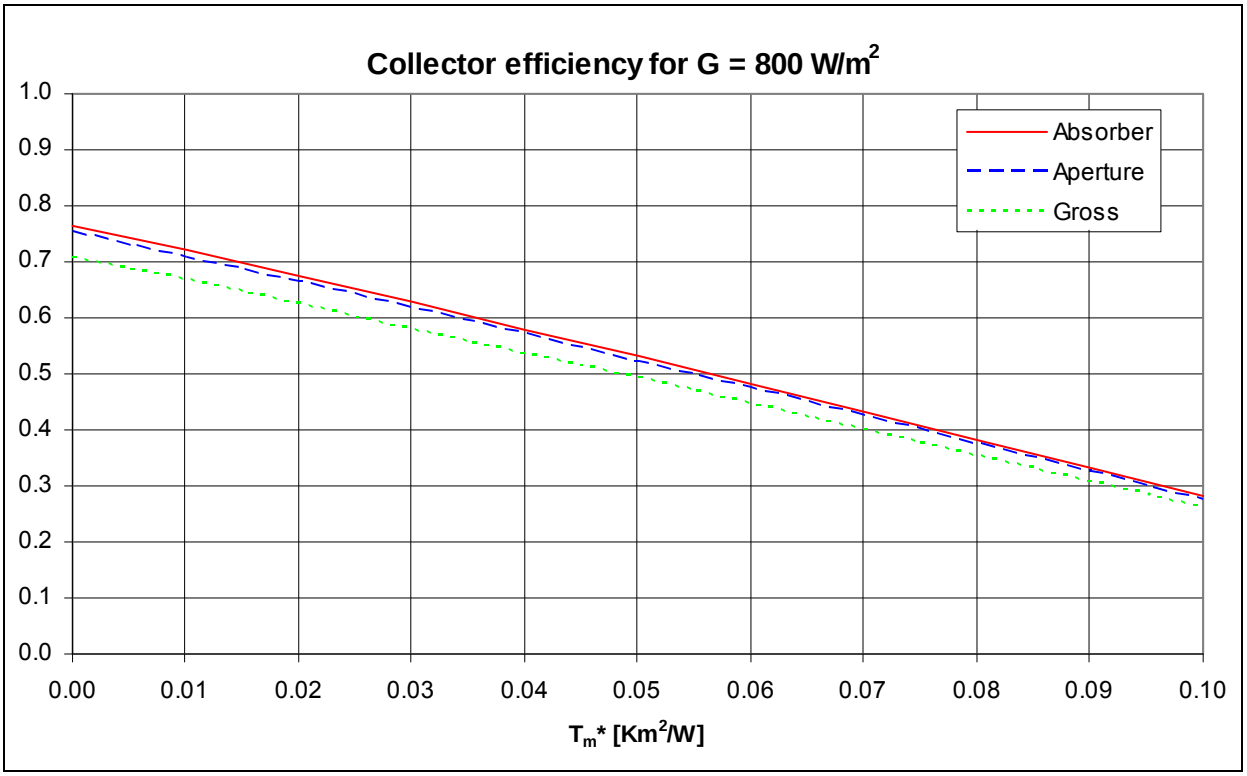


Fig. 2.3: Efficiency diagram for G = 800 W/m²

2.3.3.1 Parameters for efficiency equation

Reference area	Absorber area	Aperture area	Gross area
η_0 (-)	0.766	0.754	0.708
a_1 (W/m²K)	4.52	4.45	4.18
a_2 (W/m²K²)	0.0042	0.0041	0.0039

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	0.98	**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

2.4.2 Diagram of the Incidence Angle Modifier

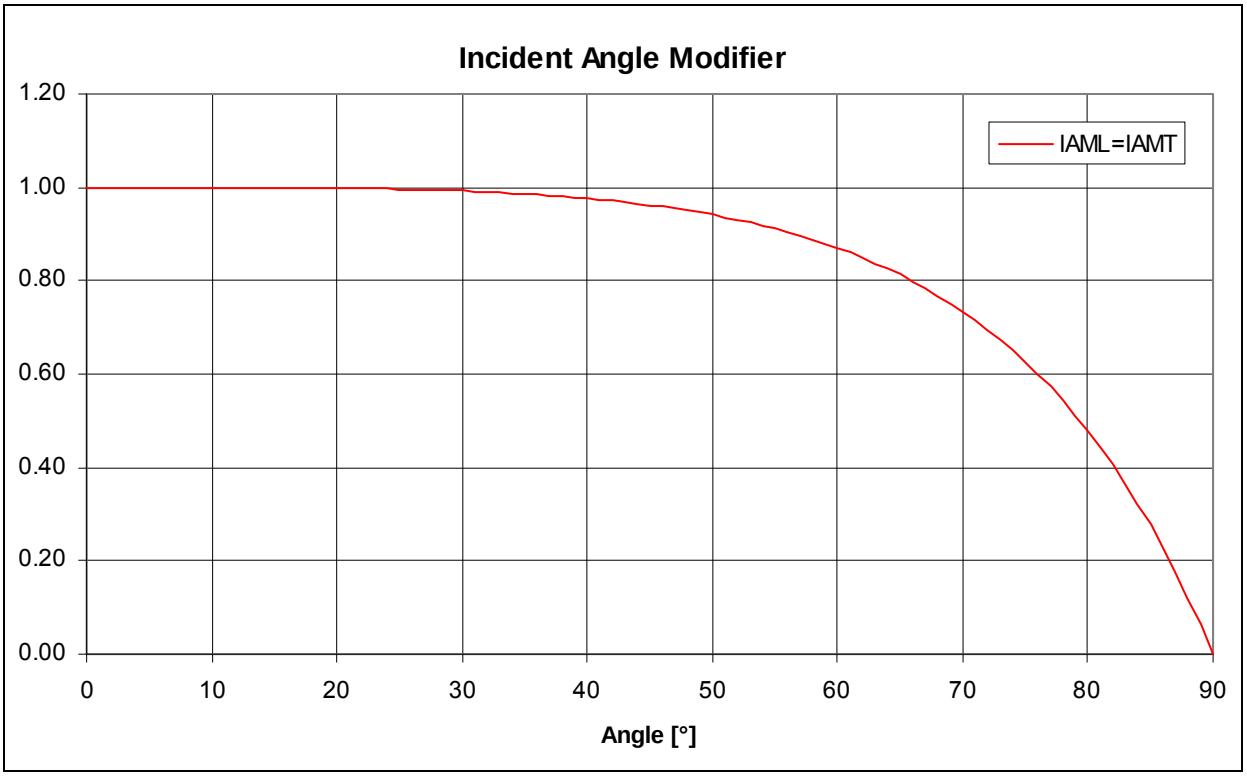


Fig. 2.4: Incident angle modifiers

2.5 Time Constant

τ_C = 59 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.

$C_{eff,G3}$= 21.5 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:

$C_{eff,G3}$ = 1.7 l * density * specific heat capacity of fluid + 14.9 kJ/K

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

Estimation based on material properties.

$C_{eff,6162}$ = 12.5 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:

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

2.7 Pressure Drop

2.7.1 Diagram

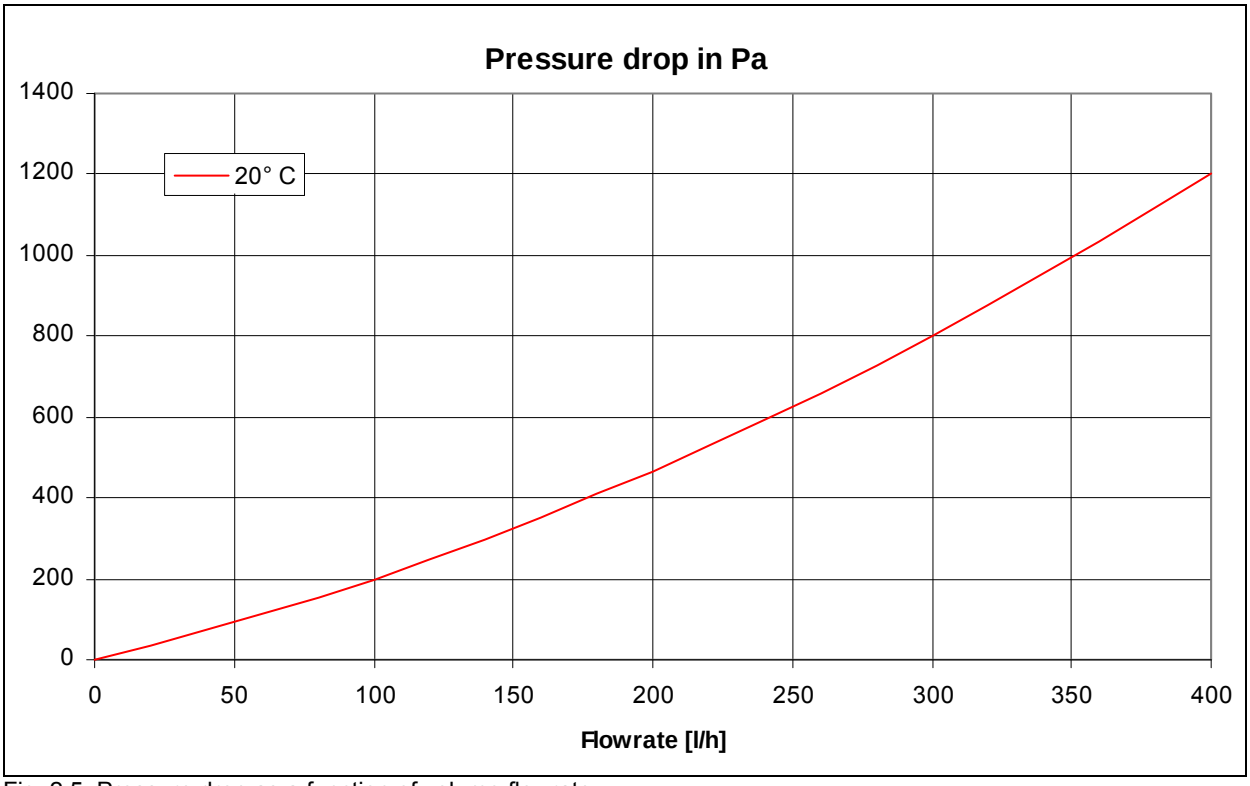


Fig. 2.5: Pressure drop as a function of volume flowrate

2.7.2 Pressure drop at rated flowrate

Conditions:
T_m = 20°C and dV/dt = 120 l/h
Δp = 240 Pa

2.7.3 Table of pressure drop data in Pa

Conditions:
T_m = 20 °C

Flow rate [l/h]	0	80	160	240	320	400
Pressure drop [Pa]	0	155	352	593	877	1203

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, 01.06.2010

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