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Test Report No. C829LPEN

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

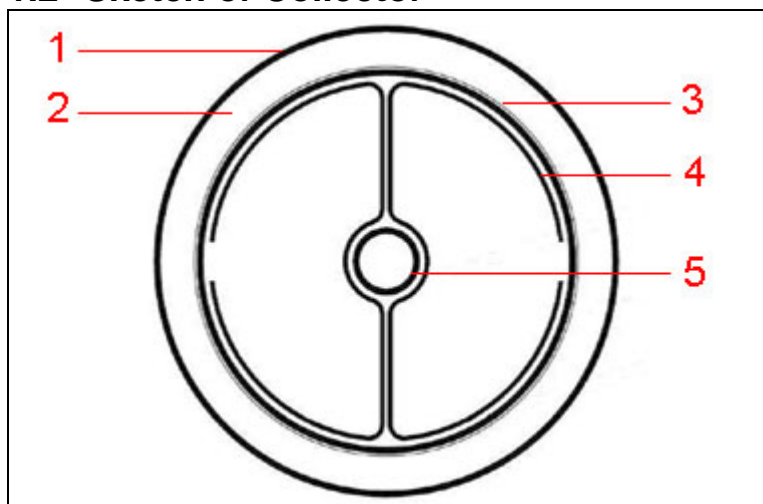
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1 Description of Collector

1.1 Technical Data of the Sample

Product information		Absorber	
Manufacturer	Westech Components Wuxi Co., Ltd.	Absorber element	Evacuated double glass tube
Model	SP-S58/1800A-22	Length of absorber element	1720 mm
Type	Evacuated tube collector	Width of absorber element	47 mm
Flow	Heat Pipe	Thickness of absorber element	1.5 mm
Serial product	Yes	Coating	Aluminiumnitride on Al
Drawing number	A set of technical drawings is filed at the test institute.	Flowed through element	Copper pipe/Heat pipe
Serial number	--	Joining technique	Heat conducting aluminum sheets
Date of manufacture	01.09.2006	Joining seam	--
Physical parameters		Installation	
Gross length	1.970 m	On tilted roof	Yes
Gross width	1.846 m	In tilted roof	No
Gross height	0.155 m	On flat roof	No
Gross area	3.637 m ²	On flat roof with stand	No
Aperture area	2.074 m ²	Facade	No
Absorber area	1.790 m ²	Casing and insulation	
Weight empty	76.5 kg	Casing material	Aluminium
Fluid capacity	1.4 l	Sealing material	EPDM
Construction		Insulation material	Rockwool compression-molded
Type	Evacuated tube collector	Thickness (in mm)	50
Number of absorber elements	22	Aperture dimensions	1.720 m * 0.0548 m * 22
Absorber pitch	80 mm	Limitations (manufacturer information)	
Number of hydraulically parallel tubes	1	Max. temperature	220°C
Number of thermally serial glazings	1	Max. operating pressure	6 bar
Material of glazing(s)	Borosilicate glass	Other	--
Thickness of glazing(s)	1.6 mm	Remarks on collector design	
Heat transfer fluid (manufacturers' recommendation)		--	
Type	Water-antifreeze	Test schedule	
Specifications	--	Test procedure	EN12975:2006, Outdoor test
Flow range (manufacturers' recommendation)		Sample received	22.12.2006
Flow range	132 - 264 l/h	Start of test	05.02.2007
Rated flow rate	132 l/h	End of test	26.04.2007

1.2 Sketch of Collector



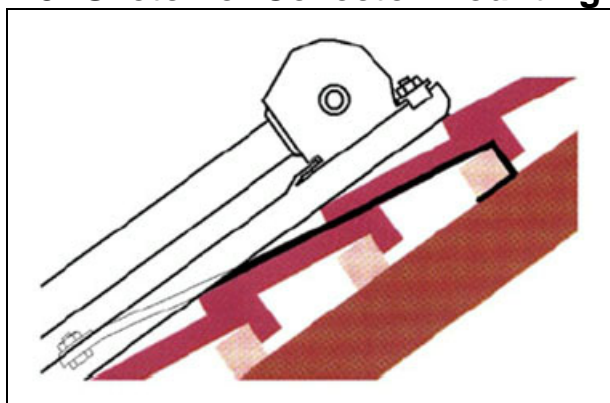
1.3 Specifications on Elements

1	Glazing Material: Thickness [mm]:	Borosilicate glass 1.6
2	Vacuum	
3	Absorber coating Description: Manufacturing process:	Aluminiumnitride on Al Sputtering
3	Absorber Absorber element: Flow-through element: Length of element [mm]: Width of element [mm]: Flow type: Joining technique:	Evacuated double glass tube Copper pipe/Heat pipe 1720 47 Serial Heat conducting aluminum sheets
4	Heat-conducting metal sheet Description:	Aluminum
5	Heat pipe Description:	Copper

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

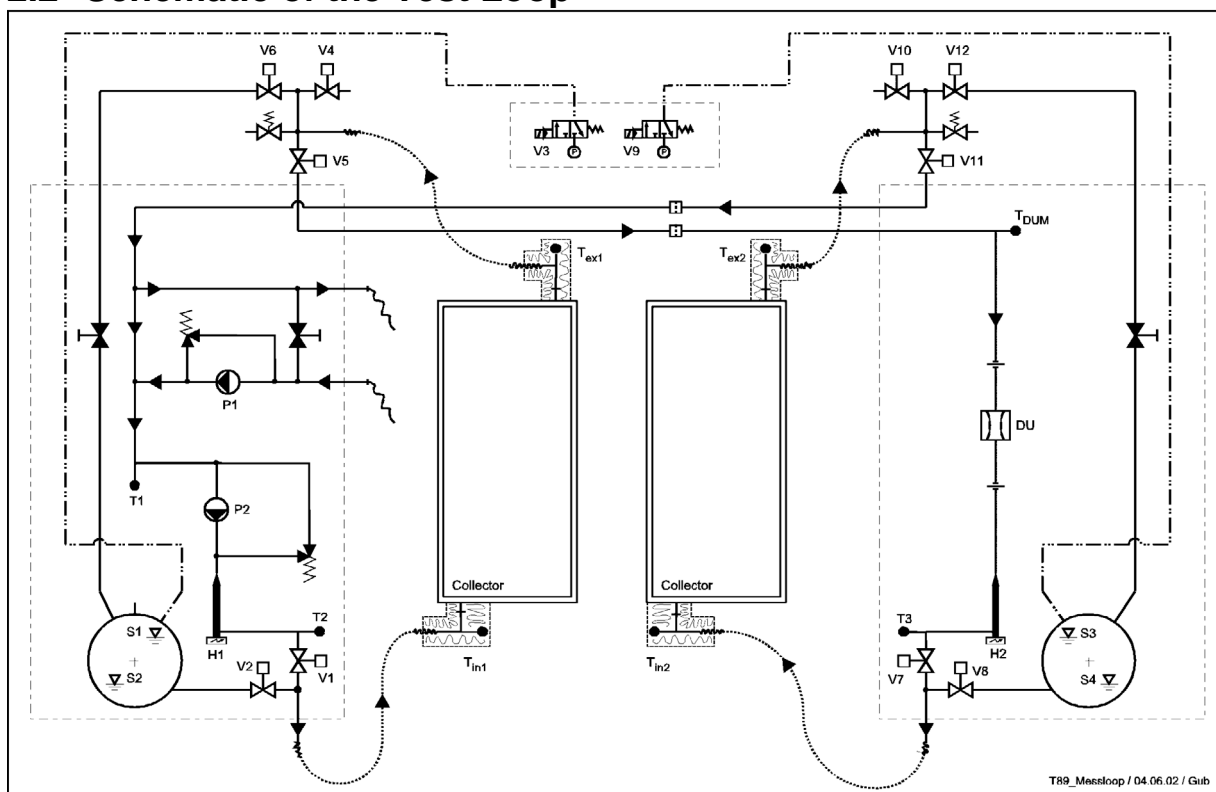


Fig. 2.1: Test loop for efficiency measurements.

2.3 Power Output

2.3.1 General

Flow rate during test	150.0 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} .

$$W_{\text{peak}} = 1280 \text{ [W]}$$

2.3.2.2 Diagram

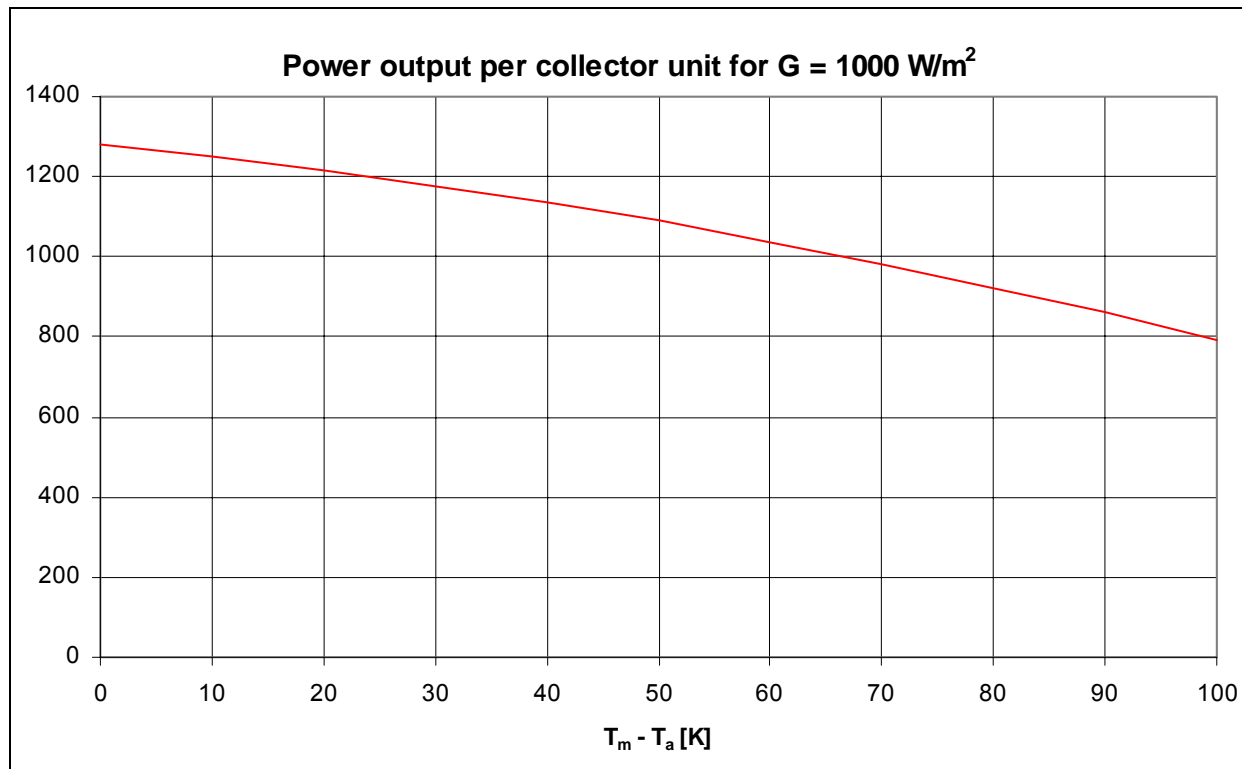


Fig. 2.2: Power output per collector unit at irradiance $G = 1000 \text{ W/m}^2$

2.3.2.3 Power output per collector unit

$T_m - T_a$	Global irradiance G		
	G=400 W/m²	G=700 W/m²	G=1000 W/m²
10 K	482 W	866 W	1250 W
30 K	410 W	794 W	1178 W
50 K	321 W	705 W	1089 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.

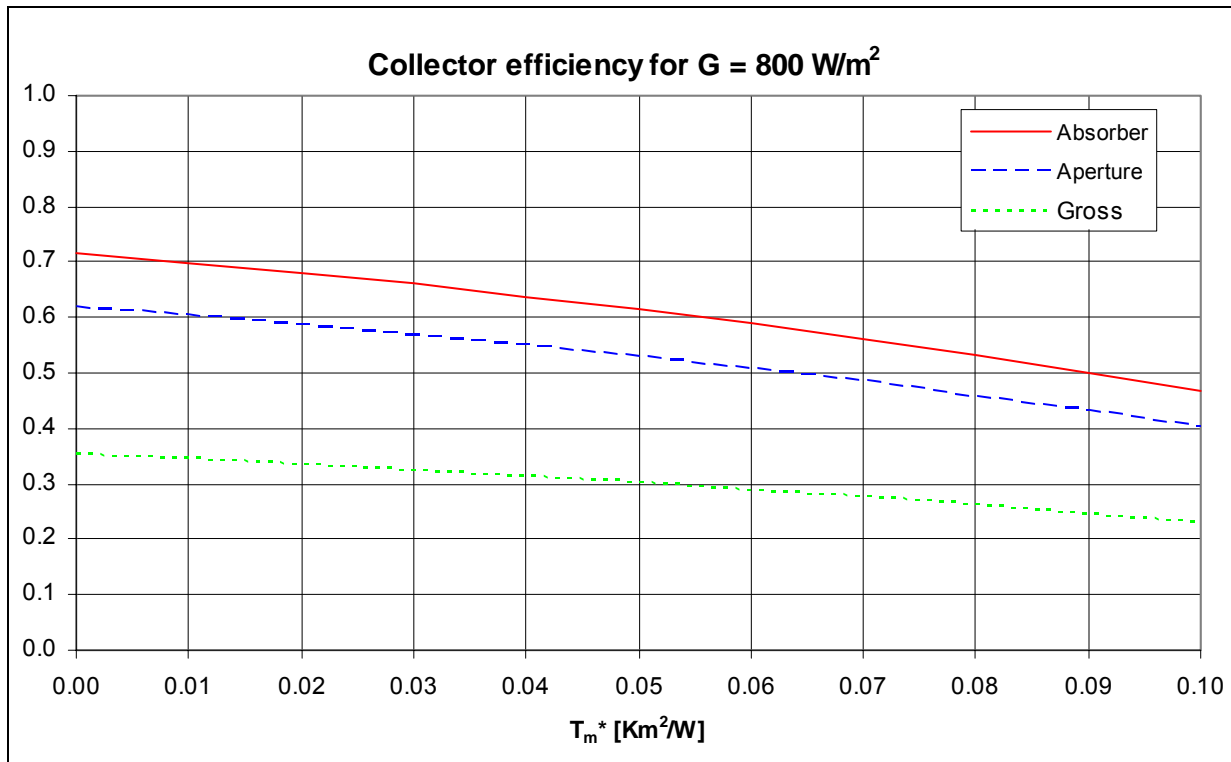


Fig. 2.3: Efficiency diagram for $G = 800 \text{ W/m}^2$

2.3.3.1 Parameters for efficiency equation

Reference area	Absorber area	Aperture area	Gross area
η_0 (-)	0.715	0.617	0.352
a_1 (W/m ² K)	1.55	1.34	0.76
a_2 (W/m ² K ²)	0.0117	0.0101	0.0058

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	0.85	0.71	0.46	0.00
K_{Θ} (transversal)	1.00	1.01	1.05	1.14	1.29	1.50	1.47	1.14	0.62	0.00

2.4.2 Diagram of the Incidence Angle Modifier

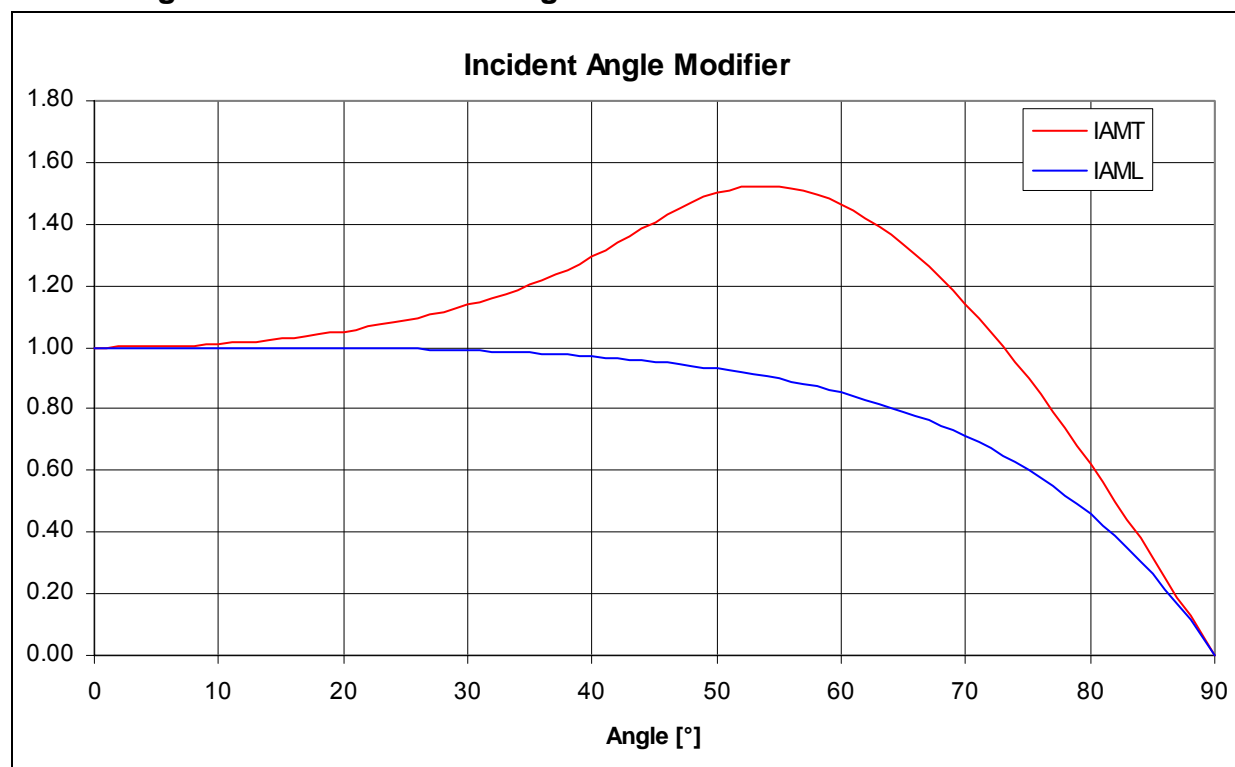


Fig. 2.4: Incident angle modifiers

2.5 Time Constant

$$\tau_C = 546 \text{ s}$$

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.

$$C_{\text{eff,G3}} = 258.8 \text{ kJ/K (Effective thermal capacity of collector filled with fluid)}$$

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

$$C_{\text{eff,G3}} = 1.4 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 253.6 \text{ kJ/K}$$

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

Estimation based on material properties.

$$C_{\text{eff,6162}} = 29.4 \text{ kJ/K (Effective thermal capacity of collector filled with fluid)}$$

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

$$C_{\text{eff,6162}} = 1.4 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 24.2 \text{ kJ/K}$$

2.7 Pressure Drop

2.7.1 Diagram

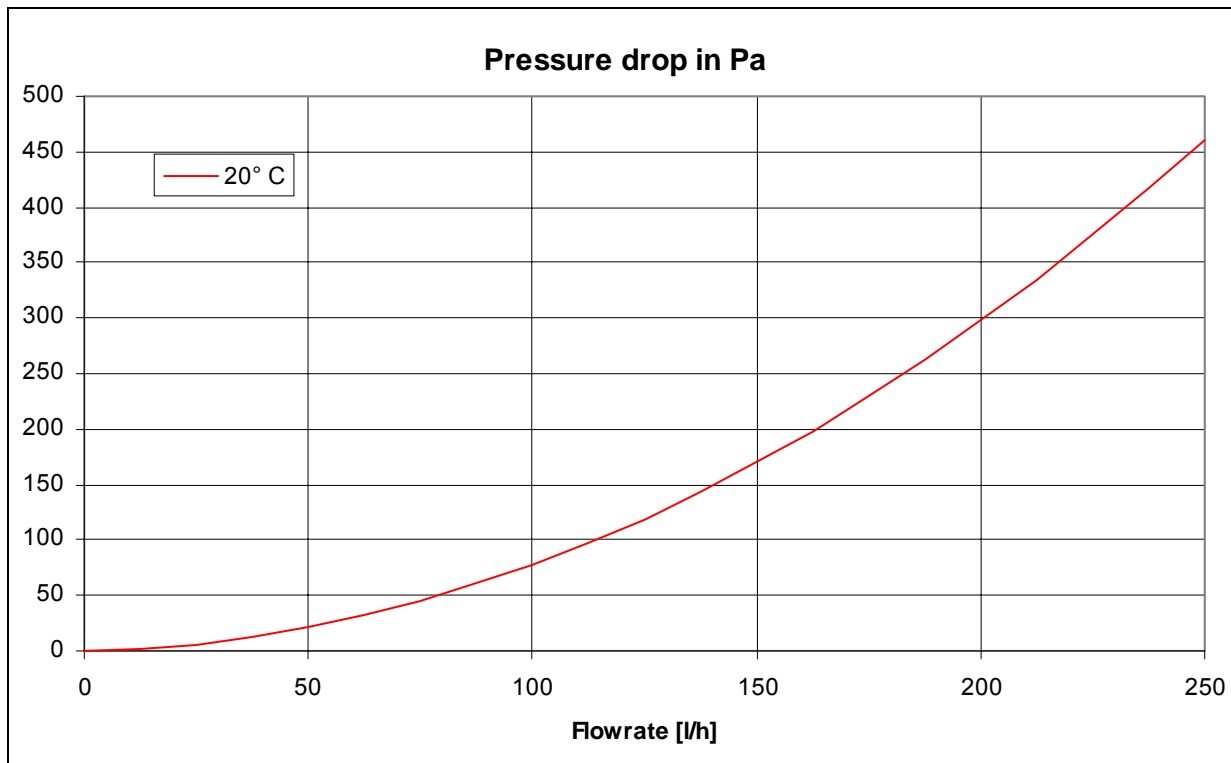


Fig. 2.5: Pressure drop as a function of volume flowrate

2.7.2 Pressure drop at rated flowrate

Conditions:

$T_m = 20^\circ\text{C}$ and $dV/dt = 132 \text{ l/h}$

$\Delta p = 133 \text{ Pa}$

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	21	78	170	298	461

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)	Passed
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, 22.08.2007



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