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# Test Report No. C814LPEN

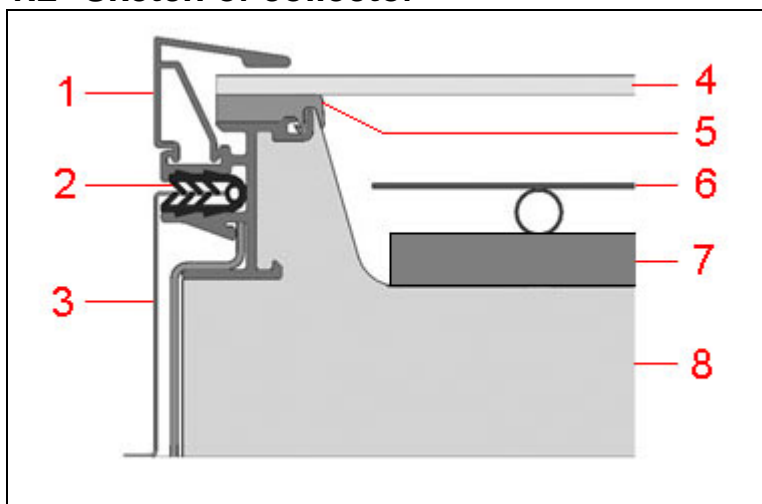
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## 1 Description of collector

### 1.1 Technical data of sample

Product information		Absorber	
Manufacturer	Viridian Solar Limited	Absorber element	Aluminium sheet
Model	V30	Length of absorber element	2800 mm
Type	Flat plate collector	Width of absorber element	1074 mm
Flow	Serpentine	Thickness of absorber element	0.5 mm
Serial product	Yes	Coating	Ceramic-metal-structure (Cermet)
Drawing number	VS-1	Flowed through element	Copper tube
Serial number	VS30-004	Joining technique	Laser welded
Date of manufacture	01.08.2006	Joining seam	--
Physical parameters		Installation	
Gross length	2.895 m	On tilted roof	Yes
Gross width	1.168 m	In tilted roof	No
Gross height	0.088 m	On flat roof	No
Gross area	3.381 m <sup>2</sup>	On flat roof with stand	Yes
Aperture area	3.097 m <sup>2</sup>	Facade	No
Absorber area	3.007 m <sup>2</sup>	Casing and insulation	
Weight (empty, incl. cover)	59.5 kg	Casing material	Aluminium
Fluid capacity	1.4 l	Sealing material	EPDM, Silicone
Construction		Insulation material	Mineral wool, Polyurethane foam
Type	Flat plate collector	Thickness (in mm)	16, 20
Number of absorber elements	1	Aperture dimensions	2.823 m * 1.097 m
Absorber pitch	141 mm	Limitations (manufacturer information)	
Number of hydraulically parallel tubes	1	Max. temperature	200°C
Number of thermally serial glazings	Single-glazed	Max. operating pressure	3 bar
Material of glazing(s)	Toughened glass	Other	--
Thickness of glazing(s)	4.0 mm	Test schedule	
Heat transfer fluid (manufacturer recommendation)		Test procedure	EN 12975, Outdoor
Type	Water-glycol	Sample received	09.08.2006
Specifications	--	Start of test	22.08.2006
Remarks on collector design		End of test	12.10.2006
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## 1.2 Sketch of collector



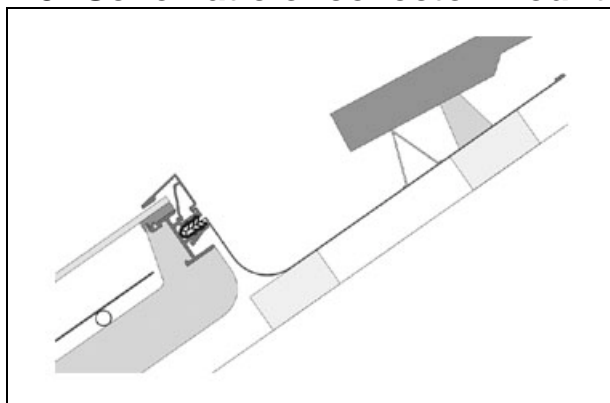
## 1.3 Specifications on elements

<b>1</b>	<b>Frame</b> Type of construction: Material: Profile: Corners:	Frame Aluminium Extruded sheath Riveted corners with corner joints
<b>2</b>	<b>Sealing profile</b> Description:	EPDM
<b>3</b>	<b>Sheet metal surround</b> Description:	Aluminum
<b>4</b>	<b>Glazing</b> Tradename: Material: Thickness [mm]:	Solite Toughened glass 4
<b>5</b>	<b>Sealing</b> Description:	Silicone
<b>6</b>	<b>Absorber</b> Absorber element: Flow-through element: Length of element [mm]: Width of element [mm]: Flow type: Joining technique:	Aluminium sheet Copper tube 2800 1074 serial Laser welded
<b>7</b>	<b>Thermal insulation</b> Material: Thickness [mm]:	Mineral wool 16
<b>8</b>	<b>Thermal insulation</b> Material: Lamination: Thickness [mm]:	Polyurethane foam Aluminum on both sides 20

## 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

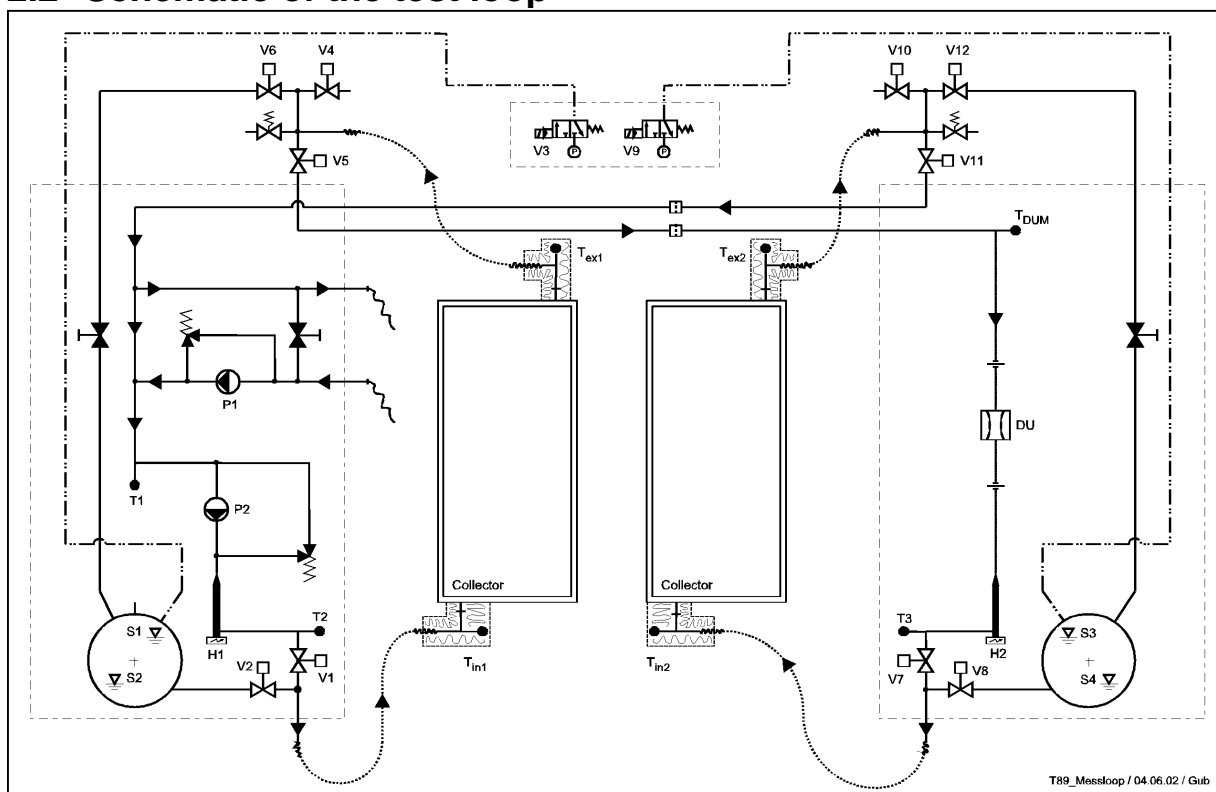


Fig. 2.1: Test loop for efficiency measurements.

## 2.3 Efficiency curve

### 2.3.1 General

Flow rate during test	216.0 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 <sup>2</sup>

### 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

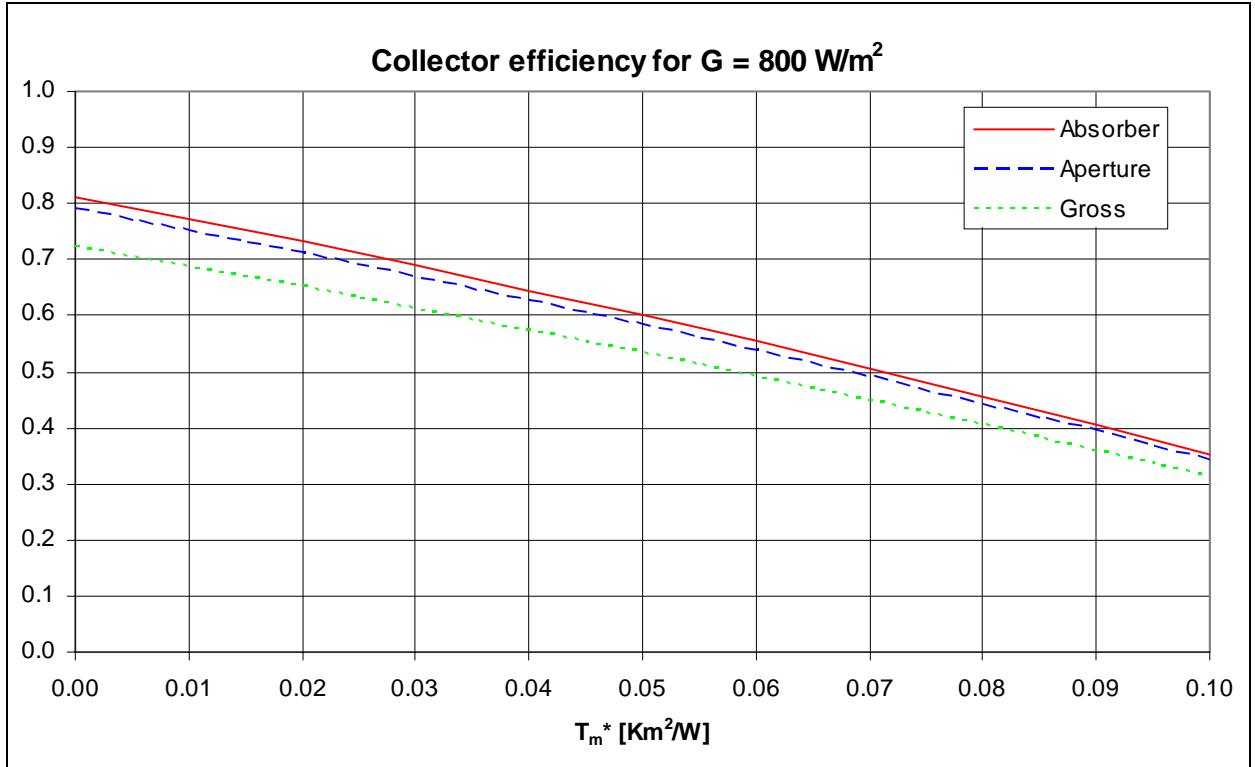


Fig. 2.2: Efficiency diagram for  $G = 800 \text{ W/m}^2$

#### 2.3.2.2 Parameters for efficiency equation:

Reference area:	Absorber area	Aperture area	Gross area
$\eta_0$ (-)	0.812	0.788	0.722
$a_1$ (W/m <sup>2</sup> K)	3.88	3.77	3.45
$a_2$ (W/m <sup>2</sup> K <sup>2</sup> )	0.0089	0.0086	0.0079

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°
$K_{\Theta}$ (longitudinal)	1.00	1.00	1.00	0.99	0.97	<b>0.94</b>	0.87	0.73	0.47	0.00
$K_{\Theta}$ (transversal)	1.00	1.00	1.00	0.99	0.97	<b>0.94</b>	0.87	0.73	0.47	0.00

## 2.5 Time constant

$\tau_c = 60$  s

## 2.6 Effective thermal capacity

### 2.6.1 Determination according to EN12975-2, Annex J3

Determination based on transient behaviour of the collector.

$C_{\text{eff},J3} = 17.9$  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:

$C_{\text{eff},J3} = 1.4 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 12.3$  kJ/K

### 2.6.2 Determination according to EN12975-2, Section 6.1.6.2.

Estimation based on material properties.

$C_{\text{eff},6162} = 17.9$  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:

$C_{\text{eff},6162} = 1.4 \text{ l} * \text{density} * \text{specific heat capacity of fluid} + 12.3$  kJ/K

## 2.7 Power output per collector unit

$T_m - T_a$	Global irradiance G		
	G=400 W/m <sup>2</sup>	G=700 W/m <sup>2</sup>	G=1000 W/m <sup>2</sup>
10 K	857 W	1590 W	2322 W
30 K	603 W	1335 W	2068 W
50 K	326 W	1059 W	1791 W

## 2.8 Pressure drop

### 2.8.1 Diagram

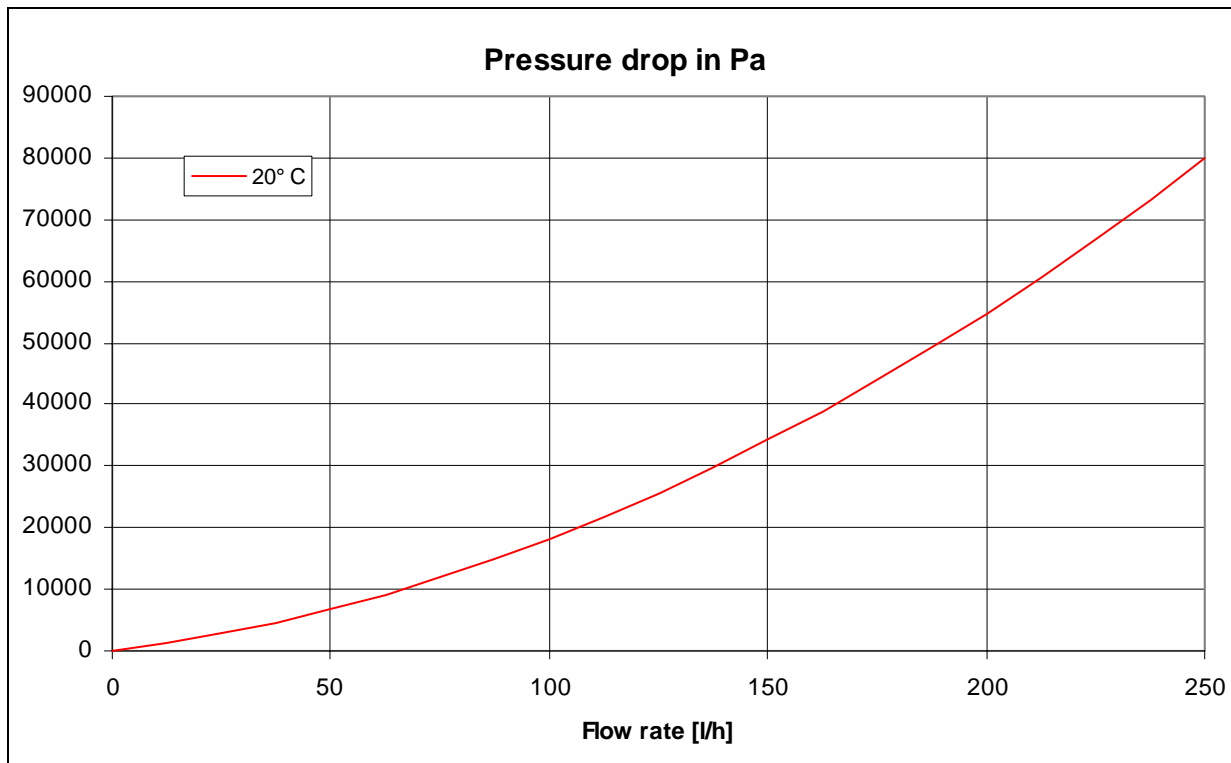


Fig. 2.3: Pressure drop as a function of volume flowrate

### 2.8.2 Pressure drop at rated flowrate

Conditions:

$T_{\text{fluid}} = 20^{\circ}\text{C}$  and  $dV/dt = 216 \text{ l/h}$

$\Delta p = 62375 \text{ Pa}$

### 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	250
Pressure drop [Pa]	0	6773	18163	34172	54799	80044

### 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, 21.11.2006



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	Viridian Solar Limited
Model	V30
Type	Flat plate collector
Flow	Serpentine
Serial number	VS30-004
Drawing number	VS-1

Dimensions	
Gross length	2.895 m
Gross width	1.168 m
Gross height	0.088 m
Gross area	3.381 m <sup>2</sup>
Aperture area	3.097 m <sup>2</sup>
Absorber area	3.007 m <sup>2</sup>

General specifications	
Weight	59.5 kg
Heat transfer fluid	Water-glycol
Flow rate (range)	120 - 250 l/h
Pressure drop at 216 l/h	62375 Pa
Max. operating pressure	3 bar

Thermal performance based on aperture area	
$\eta_0$	0.788
$a_1$	3.77
$a_2$	0.0086

Thermal performance based on absorber area	
$\eta_0$	0.812
$a_1$	3.88
$a_2$	0.0089

Power output per collector			
$T_m - T_a$	Global irradiance G		
	G = 400 W/m <sup>2</sup>	G = 700 W/m <sup>2</sup>	G = 1000 W/m <sup>2</sup>
10 K	857 W	1590 W	2322 W
30 K	603 W	1335 W	2068 W
50 K	326 W	1059 W	1791 W

Test institute: SPF Solartechnik, CH-8640 Rapperswil  
Date: 21.11.2006