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Test Report

Project Designation

Durability and reliability test of
a new flat plate collector according to
ÖNORM EN 12975-1 and 2

Client

RIPOSOL Handels GmbH
Industriepark 12
9330 – Althofen
Austria

Order from / No. 23 January 2004

Project number 2.04.00241.1.0-Q *Test Engineer* Thomas Huger

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Annex: number of pages	-

Durability and reliability test of a covered solar collector in new condition

according to ÖNORM EN 12975-2 chapter 5

Test center:

ARSENAL RESEARCH Ges.m.b.H

Test number:	2.04.00241.1.0-Q
Client:	RIPOSOL Handels GmbH
Receipt of test sample:	18 February 2004
Test periode:	from 06 July to 19 September 2004

1 MEASURING INSTRUMENTS USED

1.1 Measuring instruments

1 Pyranometer, Kipp & Zonen type CM11, device no. 945367, Sensitivity: 4,77x10^{-6} [V/Wm^{-2}]

1 Temperature measurement sensor Fluke 51 K / J, ÖKD measurement uncertainty ± 0,1 K

1 Scale, Jadever JPS 2030, device No. 40003617, DKD measurement uncertainty ± 0,1 kg

1 Digital spring balance MWT, 5-500 kg device No. 120530,
expanded measurement uncertainty U = 051 kg + 0,0028 * m_w

1 Manometer, Wika, 0-16 bar, ser. No. 114.43.73, ÖKD measurement uncertainty ± 0,077 bar

1 Variable area flow meter, Krohne VA 20R/ 100-1000 l/h,
calibrated according VDI/VDE 3513, accuracy class 1,0

1 Pt-100 temperature measurement sensor for measuring the ambient air temperature,
ÖKD measurement uncertainty ± 0,05 K

1 Rain sensor, Conrad, device No. 115274

1 Humidity Transmitter HMD 30 UB, calibrated
ÖKD temperature measurement uncertainty ± 0,1 K
ÖKD humidity measurement uncertainty ± 2,0 % r.F.

1 Tape measure, Convex-Stop, JIS 1 OC 16-55, calibrated,
expanded measurement uncertainty U = 0,3 mm

1.2 Data acquisition

1 Data acquisition unit, Hydra 2635A Data Bucket 3625A, serial No. 610 1307,
ÖKD measurement uncertainty DCV ± 0,04 %
ÖKD measurement uncertainty ACV ± 0,02 %
ÖKD measurement uncertainty DCA-Resistance ± 0,30 %

2 GENERAL SPECIFICATIONS OF THE TESTED COLLECTOR

Manufacturer of the collector:	Suntec Produktions GmbH
Distributed by:	RIPOSOL Handels GmbH Industriepark 12 A-9330 – Althofen
Collector type and name:	RP 200 VF Neu 2,75 (flat plate collector)
Measurements (without pipe connection):	2276 mm x 1226 mm x 104 mm
Heat transfer fluid content:	*) 2,2 l
Maximum operation pressure:	*) 6 bar

Type of collector cover: *) solar glass, τ = 0.914, inside structured

Structure of absorber: absorber sheet Cu 0,2 mm, ultrasonic welding, harp connection with 10 (5x2) parallel pipes (∅ 10 mm) and connecting pipe (∅ 22 mm)

Absorber coating: *) TiNOX coating, absorptance α = 0,95, emittance ε = 0,05

Collector insulation: back side, 50 mm mineral wool (40-50 kg/m^3), laminated with black glass fleece
side wall, 10 mm mineral wool (40-50 kg/m^3), laminated with black glass fleece

Collector frame: *) aluminium

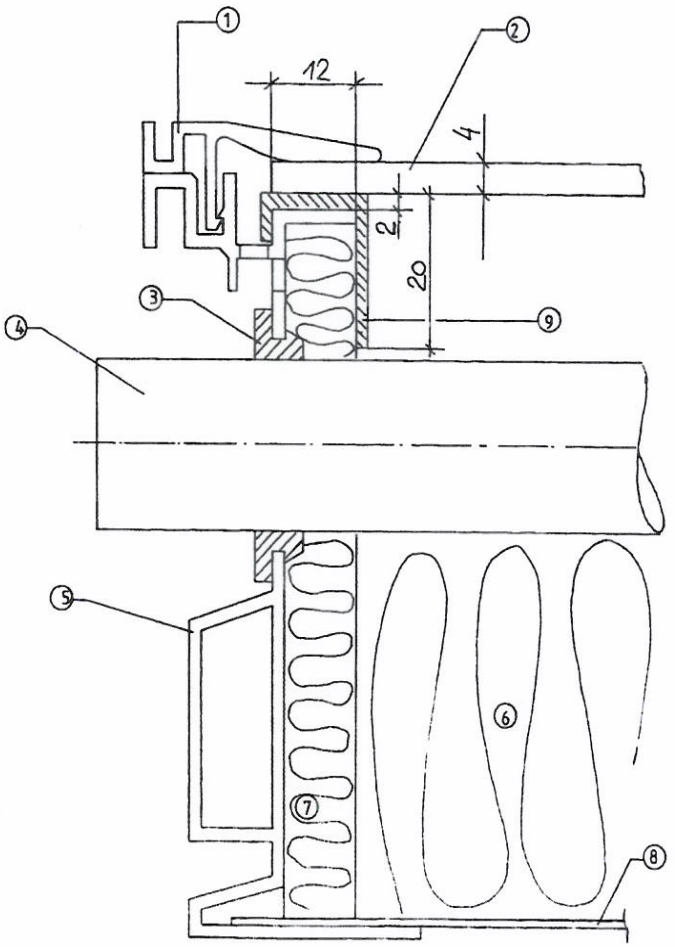
Collector back side: *) aluminium

Sealing material: *) EPDM

Recommended heat transfer fluid: propylene glycol / water (45:55)

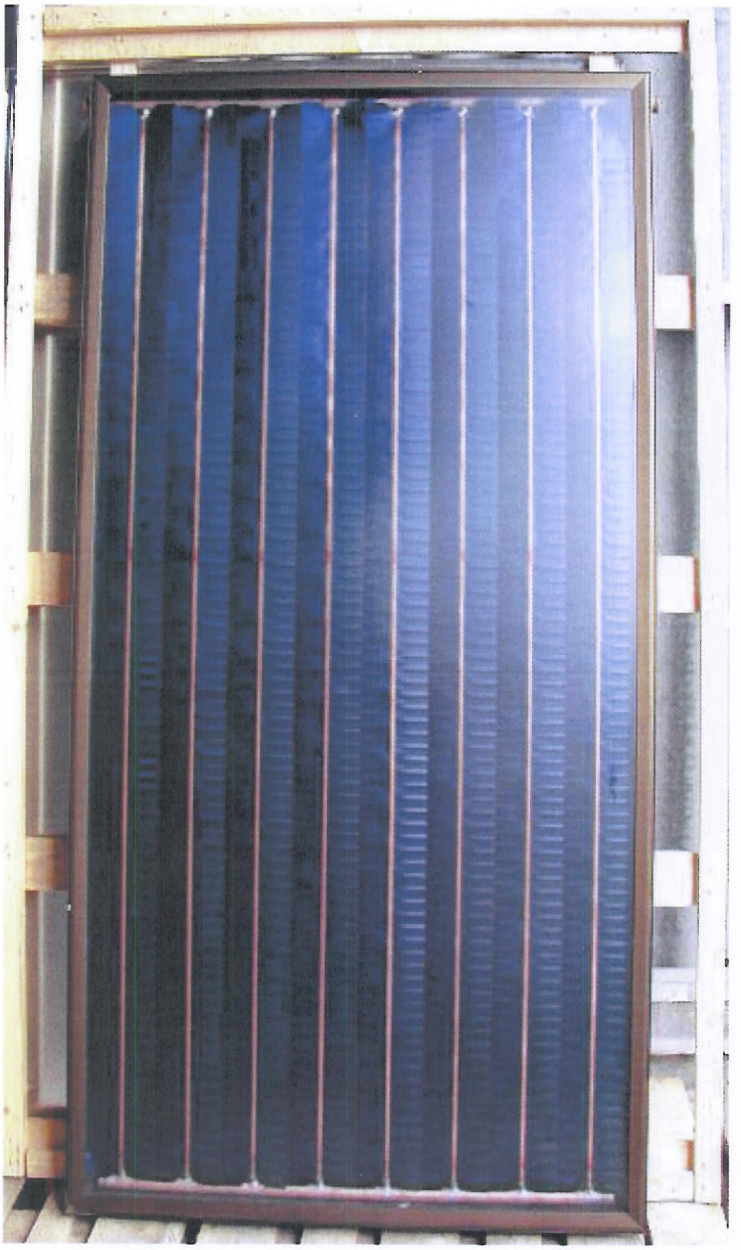
*) Specifications with this sign are manufacturer´s instructions

Schematic diagram of solar collector (according to client´s information)



- 1 aluminium clamping profile
- 2 solar glass
- 3 flange
- 4 connecting pipe 22 / 0,8
- 5 aluminium frame profile
- 6 back side insulation 50 mm
- 7 side wall insulation
- 8 back side plate
- 9 EPDM sealing profile

Photograph of solar collector



3 TEST PROCEDURE

The collector was tested, according to ÖNORM EN 12975-2, point 5.

The following tests were made:

1. Internal pressure for absorber (1)
2. High temperature resistance
3. Exposure test
4. External thermal shock (2x)
5. Internal thermal shock (2x)
6. Rain penetration test
7. Internal pressure for absorber (2)
8. Mechanical load test
9. Final inspection

3.1 Internal pressure for absorber (1)

The tested product is a covered frame collector. The maximum operation pressure, according to the manufacturer, is 6 bar.

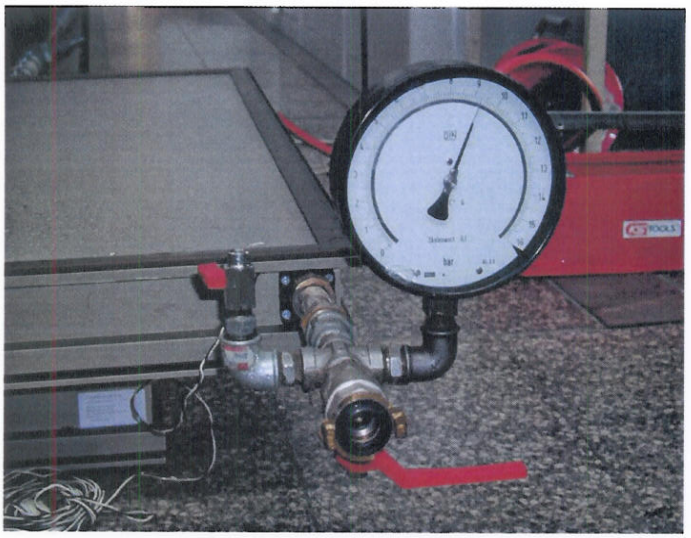
3.1.1 Method

Load test with a 1,5 times higher pressure than maximum operation pressure.

3.1.2 Test conditions

The collector is mounted horizontally.

Ambient air temperature:	22,8 °C
Test pressure:	920 k Pa
Test duration:	17 min
Heat transfer fluid:	water



3.1.3 Result

No visible changes.

3.2 High temperature resistance

3.2.1 Method

At the outdoor test under natural solar radiation.

3.2.2 Test conditions

Collector tilt angle	26°
Average hemispherical solar irradiance during testing	1050,7 W/m²
Average ambient air temperature	31,8 °C
Average ambient air velocity	< 1 m/s
Average temperature of the absorber	184,9 °C
Duration of test	60 min

The absorber sensor was mounted on 2/3 of the height and half of the width of the absorber.

3.2.3 Result

No visible changes were realized.

3.3 Exposure test

3.3.1 Method

The long-term-test was performed in the period from 21July 2004 to 04 October 2004 at the outdoor test track of arsenal research. The collector was mounted on a fix-standing frame.

3.3.2 Test conditions

date	*hours with I> 850 Wm^2*	*hemispherical solar irradiance (MJm^{-2})*	*ambient temperature /averaged (°C)*	*rain*	*relevant days*
21.07.2004	4,0	28,30	28,42	no	1
22.07.2004	2,5	25,51	29,02	yes	2
23.07.2004	2,0	14,24	20,41	no	3
24.08.2004	1,0	16,56	22,90	no	4
27.08.2004	1,5	16,49	19,23	no	5
28.08.2004	3,0	24,87	24,58	no	6
29.08.2004	3,0	23,26	24,59	no	7
30.08.2004	3,0	23,31	24,61	yes	8
01.09.2004	3,5	25,80	21,07	no	9
02.09.2004	0,5	18,04	19,93	no	10
03.09.2004	0,5	14,28	18,27	no	11
04.09.2004	2,0	19,17	22,81	no	12
05.09.2004	0,0	16,20	20,87	no	13
06.09.2004	3,5	25,32	23,96	no	14
07.09.2004	3,5	25,33	23,88	no	15
08.09.2004	1,5	21,62	21,16	no	16
09.09.2004	4,0	27,09	16,37	no	17
10.09.2004	4,0	26,13	17,53	no	18
11.09.2004	3,5	21,70	19,89	no	19
12.09.2004	3,0	16,61	19,27	no	20
13.09.2004	2,5	20,75	22,19	no	21
14.09.2004	3,5	24,81	23,11	no	22
17.09.2004	4,0	26,47	17,31	no	23
18.09.2004	4,0	25,01	18,07	no	24
19.09.2004	0,5	15,96	18,11	no	25
20.09.2004	3,0	18,10	20,87	no	26
26.09.2004	3,0	17,31	12,87	no	27
01.10.2004	1,0	15,06	15,34	no	28
03.10.2004	1,0	19,44	18,34	no	29
04.10.2004	1,0	17,98	18,07	no	30

3.2.3 Result

No appreciable changes.

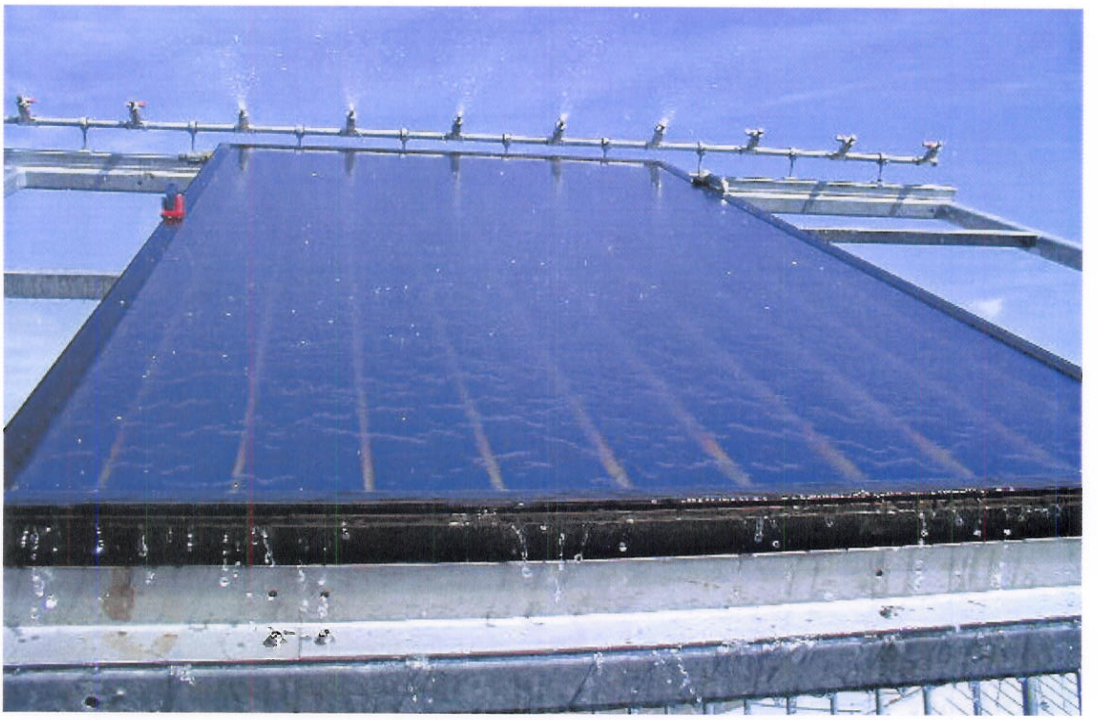
3.4 External thermal shock

3.4.1 Method

Outdoor test; flat plate collector; therefore additional specifications concerning tests of vacuum tube collectors are void.

3.4.2 Test conditions

Shock No.	1	2
Warm up phase		
Collector tilt angle	26°	26°
Average hemispherical solar irradiance	898 Wm^{-2}	780 Wm^{-2}
Minimum hemispherical solar irradiance	581 Wm^{-2}	660 Wm^{-2}
Average ambient air temperature	30,8 °C	25,2 °C
Time of steady state before test	> 60 min	> 60 min
Shock:		
Average hemispherical solar irradiance	850 Wm^{-2}	868 Wm^{-2}
Minimum hemispherical solar irradiance	828 Wm^{-2}	814 Wm^{-2}
Average ambient air temperature	31,6 °C	25,4 °C
Amount of spraying	>0,04 $kgs^{-1}m^{-2}$	>0,04 $kgs^{-1}m^{-2}$
Water temperature	19,2 °C	22,4 °C
Irrigation time	16 min	19 min
Test combined with long- term- test	yes	yes
Test combined with high temperature resistance	no	no



3.4.3 Result

No further visible changes.

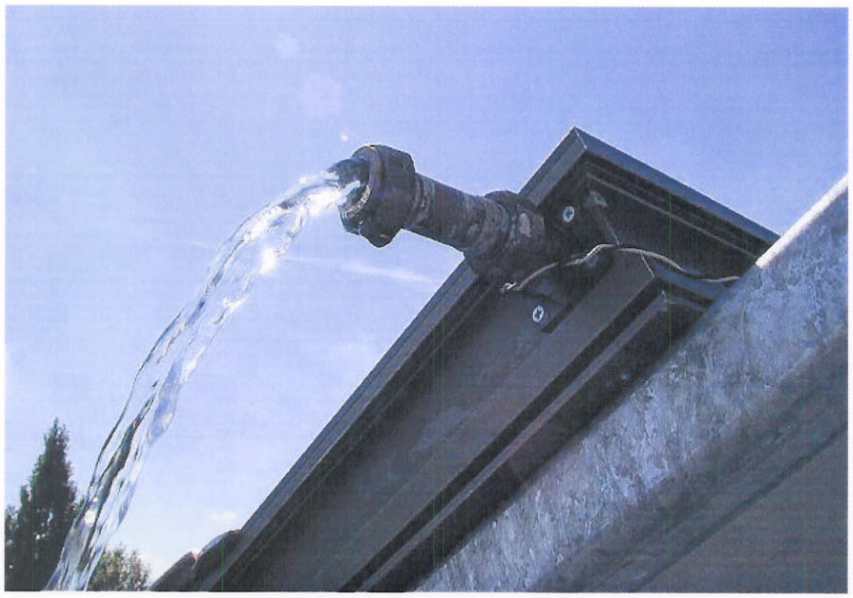
3.5 Internal thermal shock

3.5.1 Method

Outdoor test; flat plate collector; therefore additional specifications concerning tests of vacuum tube collectors are void.

3.5.2 Test conditions

Shock No.	1	2
Warm up phase		
Collector tilt angle	26°	26°
Average hemispherical solar irradiance	952 Wm^{-2}	881 Wm^{-2}
Minimum hemispherical solar irradiance	261 Wm^{-2}	199 Wm^{-2}
Average ambient air temperature	26,0 °C	27,8 °C
Time of steady state before test	> 60 min	> 60 min
Shock:		
Average hemispherical solar irradiance	810 Wm^{-2}	964 Wm^{-2}
Minimum hemispherical solar irradiance	272 Wm^{-2}	960 Wm^{-2}
Average ambient air temperature	26,4 °C	30,1 °C
Flow rate	>0,02 $kgs^{-1}m^{-2}$	>0,02 $kgs^{-1}m^{-2}$
Water temperature	19,2 °C	16,7 °C
Time of flow	7 min	6 min
Test combined with long- term- test	yes	yes
Test combined with high temperature resistance	no	no



3.5.3 Result

No appreciable changes.

3.6 Rain penetration test

3.6.1 Method

Outdoor-test; the collector is mounted on an open frame with a tilt angle of 20°. The absorber is pressurised with hot water (at least 50°C).Test under natural solar radiation. Rain is simulated with pivoted spray nozzles. Spraying all over the collector.

3.6.2 Identification of leakages

The identification of potential leakages:

a) Measurement of humidity inside the collector and
b) Inspection

3.6.3 Test conditions

Spraying during a periode of 4 hours with more than 0,05 $kgs^{-1}m^{-2}$ flow rate and a water temperature of 15,2°C.

3.6.4 Result

a) Measurement of humidity inside the collector:

absolute humidity x before spraying	13,5 gH_2O / kg air
absolute humidity x after spraying	13,1 gH_2O / kg air

b) Inspection:

No penetration of water visible.

3.6.5 Judgement

No penetration of water and no significant increase of absolute humidity.

3.7 Internal pressure test (2)

The tested product is a covered frame collector. The maximum operation pressure, according to the manufacturer, is 6 bar.

3.7.1 Method

Load test with a 1,5 times higher pressure than maximum operation pressure.

3.7.2 Test conditions

The collector is mounted horizontally.

Ambient air temperature:	18,1°C
Test pressure:	1000 k Pa
Test duration:	15 min
Heat transfer fluid:	water

3.8.1.1 Result

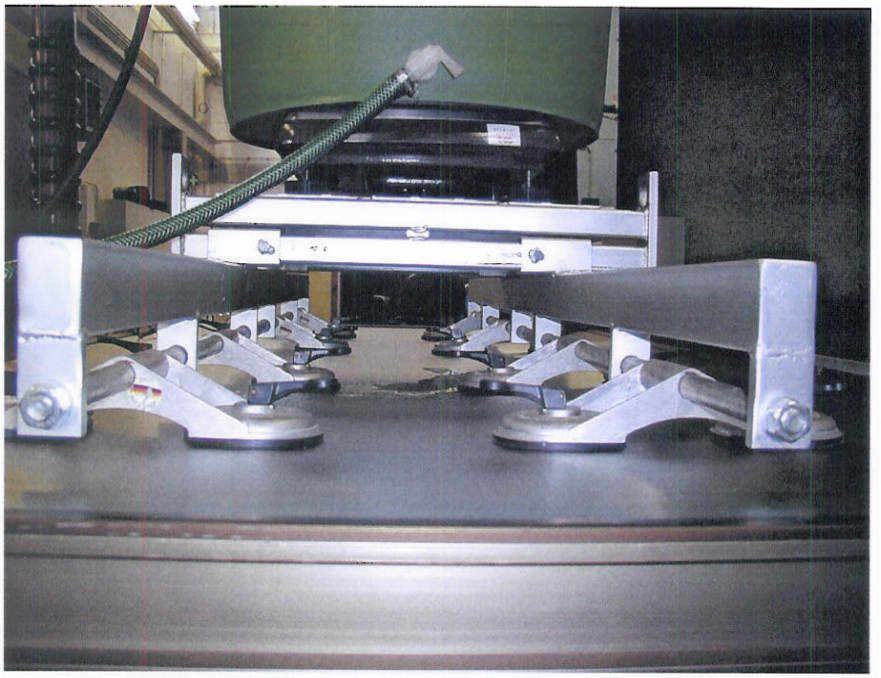
No visible changes.

3.9 Mechanical load tests

3.8.1 Positive pressure test of the collector cover

3.9.1.1 Method

The collector cover is loaded step by step up to an area load of 1000 Pa by means of a mechanical device.



3.8.1.2 Test conditions

Position of the collector: horizontal; the collector is mounted on a frame. The load increases in steps by 100 Pa up to a maximum of 1000 Pa (based on the aperture area).

3.8.1.3 Result

No visible damage has to be reported up to the maximum load.

3.8.2 Negative pressure test of the collector cover

3.8.2.1 Method

The collector is loaded up to a negative area load of 1000 Pa (based on the aperture area) with a tensile testing facility.

3.8.2.2 Test conditions

Position of the collector: horizontal; the collector is mounted on a frame. The load increases in steps by 100 Pa up to a maximum of 1000 Pa (based on the aperture area).

3.8.2.3 Result

The collector cover takes off slightly. Up to the maximum load the warp of the cover increased. However if the load decreases the collector cover is laying in the original position on the sealing. No visible damage up to the maximum load.

3.8.2.4 Remark

The test was accomplished additionally on a further collector fixation (spec. manufactured roof-fixations). The test is failed. According to manufacturer the fixation is not any more used!

3.8.3 NEGATIVE PRESSURE TEST OF COLLECTOR MOUNTINGS

3.8.3.1 Method

While the cover is loaded the same load is on the collector mounting.

3.8.3.2 Test conditions

See point 3.8.2.2

3.8.3.3 Result

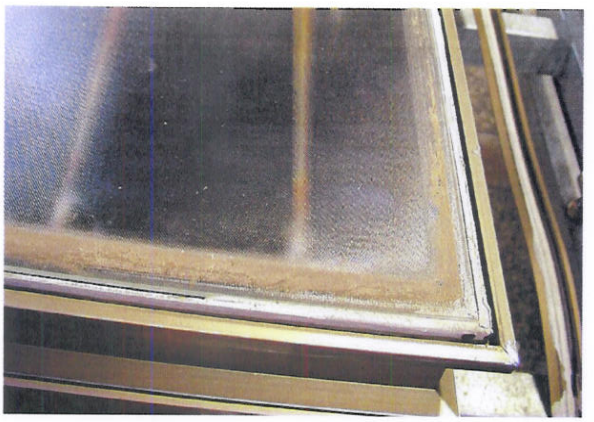
See point 3.8.2.3

3.9 Final inspection

3.9.1 Monitoring

Photo: opened collector

Connection frame/glass with silicone



Bonded 10 mm of side wall insulation

Back side and edges with silicone sealed

Photo with ventilation slot
(approx. 12 x 4 mm)
on the top right and left down

No considerable observations.

3.9.2 Appraisal of results

0→ no problem

1→ marginal problem

2→ serious problem

°→ Inspection was impossible

Component	Possible problem	Appraisal
1. collector box	breakage, corrosion, penetration of water, bendings	0
2. fixings/glass holder	fatigue of material/security	0
3. seals	breakage, adhesion, elasticity	0
4. covers/reflector	breakage, tearing, lumps, dissolution, creation of perspiration water	0
5. absorber coating	breakage, tearing, lumps	0
6. absorber tube, distributor tube and header	deformation, corrosion, leakage, solve the connection	0
7. absorber mounting	deformation, corrosion	0
8. thermal insulation	water absorption, fumigation, degradation	0

3.10 Summary

Client	RIPOSOL Handels GmbH
Address	Industriepark 12, A-9330 Althofen
Telephone and fax	Tel. +43/4262/37855 Fax: +43/4262/37855-13

Test report No. – date of issue	2.04.00241.1.0-Q of 22.11.2004
Year of production	2004
Collector type and name	Flat plate collector RP 200 VF Neu 2,75
Serial number	257

Type of test	Test start	End of test	passed
1. Internal pressure test (1)	06.07.2004	06.07.2004	yes
2. High temperature resistance	20.07.2004	20.07.2004	yes
3. Exposure test	21.07.2004	04.10.2004	yes
4. External thermal shock (2x)	22.07.04/30.07.04	22.07.04/30.07.04	yes
5. Internal thermal shock (2x)	23.07.04/30.07.04	23.07.04/30.07.04	yes
6. Rain penetration test	03.11.2004	03.11.2004	yes
7. Internal pressure test (2)	11.11.2004	11.11.2004	yes
8. Mechanical load test	11.11.2004	18.11.2004	yes
9. Final inspection	19.11.2004	19.11.2004	yes

The test results are only valid for the collector which was tested by arsenal research. The collector which is mentioned above has passed the durability and reliability test on EN 12975-1 and 2.

Test engineer

Thomas Huger

Approved signatory

i.V.

DI (FH) Christian Buchbauer

Head of business unit

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Dipl.-Ing. Hubert Fechner