TEST REPORT

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EVALUATION CENTER

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RENDERED TO
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Spiesheimerweg 22,55286 Woerrstadt
MANUFACTURER
Zhejiang Shentai Solar Energy Co.,Ltd
199 Lianhong road,Yuanhua industry Zone,Haining Zhejiang,China
PRODUCT EVALUATED: Model EUROTHERM SOLAR PRO CPC 8R and EUROTHERM SOLAR PRO CPC 24R
EVALUATION PROPERTY:
EN12975-1:2006 + A1:2010
Thermal solar systems and components – Solar collectors – Part 1:General Requirements
EN 12975-2:2006
Thermal solar systems and components – Solar collectors – Part 2: Test methods

Report of Testing Model EUROTHERM SOLAR PRO CPC 8R and EUROTHERM SOLAR PRO CPC 24R solar collector for compliance with the applicable requirements of the following criteria: EN 12975-1:2006+ A1:2010/ EN 12975-2: 2006. All samples are normal before test.

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1 Summary of test results

Qualification of a solar collector according to EN 12975 -1:2006+A1:2010/EN 12975-2:2006

Manufacture: Zhejiang Shentai Solar Energy Co.,Ltd

Brand name:

Serial No:

SHC8-0001; SHC24-0001/0002

Drawing document No.:

SHC8-58/1800-01; SHC8-58/1800-14; SHC8-58/1800-27; SHC8-58/1800-31

Collector reference No.: S131016040-001/002/003

Test		Date		**Summary of main test results**
		Start	End	
Internal pressure		2013.10.17	2013.10.17	Pass
High-temperature resistance		2013.12.2	2013.12.2	Pass
Exposure		2013.10.26	2013.12.9	Pass
External thermal shock	First	2013.10.27	2013.10.27	Pass
	Second	2013.12.5	2013.12.5	
Internal thermal shock	First	2013.10.31	2013.10.31	Pass
	Second	2013.12.9	2013.12.9	
Rain penetration		2013.11.23	2013.11.23	Pass
Freeze resistance		2013.12.15	2013.12.27	Pass
Mechanical load (positive pressure)		2013.12.28	2013.12.28	Pass
Thermal performance		2013.11.16	2013.11.27	Pass
Impact resistance		2013.12.28	2013.12.28	Pass
Final inspection		2013.12.28	2013.12.28	Pass

Submitted samples are tested in accordance with specified requirement, the test results are listed in the report.

INTERTEK TESTING SERVICES Shenzhen Ltd. Guangzhou Branch

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2 General Specification

2.1 Sample selection

Samples were selected based on the Solar Keymark rules by Intertek inspector and submitted to Intertek directly from the client. Samples were received at the Evaluation Center on 2013-10-15.

2.2 Sample and assembly description

According to the Solar Keymark Scheme rules, there is an agreement concerning collectors, which differ only in size, so called series or families. Only the biggest (EUROTHERM SOLAR PRO CPC 24R) and the smallest (EUROTHERM SOLAR PRO CPC 8R) collector have to be tested in this case. A complete collector test according to EN12975-1:2006+A1:2010/EN12975 -2:2006 has to be performed on the biggest collector (EUROTHERM SOLAR PRO CPC 24R). The thermal performance test is sufficient on the smallest collector (EUROTHERM SOLAR PRO CPC 8R). The Solar Keymark label based on this test is valid for the whole series.

(MS): means manufacture specification.

Model name	Test collector	Number of tubes	Length of tubes
EUROTHERM SOLAR PRO CPC 8R	Yes	8	1800
EUROTHERM SOLAR PRO CPC 12R	No	12	1800(MS)
EUROTHERM SOLAR PRO CPC 16R	No	16	1800(MS)
EUROTHERM SOLAR PRO CPC 20R	No	20	1800(MS)
EUROTHERM SOLAR PRO CPC 24R	Yes	24	1800

2.2.1 Specific data of the collector

(MS): means manufacture specification.

Brand name:	solardirekt24.de
Type:	EUROTHERM SOLAR PRO CPC 8R
Serial no.:	SHC8-0001
Year of production:	2013
Collector reference no.(Intertek):	S131016040 -003
Gross area:	1.744m^2
Aperture area:	1.406m^2
Absorber area:	2.009m^2
Height:	133mm
Weight empty:	27Kg(MS)
Volume of the fluid:	0.75L(MS)

Brand name:	
Type:	EUROTHERM SOLAR PRO CPC 24R
Serial no.:	SHC24-0001/0002
Year of production:	2013
Collector reference no.(Intertek):	S131016040-001/002
Gross area:	5.118m^2
Aperture area:	4.406m^2
Absorber area:	6.026m^2
Height:	133mm
Weight empty:	81.9 Kg
Volume of the fluid:	2.26L(MS)

2.2.2 Specification of the tubes

Type:	Vacuum tube
Material of the cover tube:	High borosilicate glass 3.3(MS)
Number of covers:	1
Transmission of the cover tube:	0.89(MS)
Outer diameter of the cover tube:	Φ58.20mm
Thickness of the cover tube:	1.78mm
Outer diameter of the inner tube:	Φ46.90mm
Thickness of the inner tube:	1.79mm
Distance between two tubes:	110mm

2.2.3 Absorber

Solar absorptance α :	≥93% (MS)
Hemispherical emittance ε :	≤5% (MS)
Surface treatment:	Selective absorption coating
Material of header pipe:	Copper
Outer diameter of the header pipe:	35.14mm
Construction of the absorber:	Evacuated tube and heating pipe connected by Aluminium fin
Material of the fin:	Aluminium
Thickness of the fin:	0.24mm
Conduction oil	HT350(MS)

2.2.4 Thermal insulation and casing

Insulation material:	glass fabric
Thickness of the thermal insulation:	30mm(MS)
Casing material:	Anodized aluminum alloy(MS)
Sealing material:	Silicon seal (MS)

2.2.4 Reflectors

Material	aluminum sheet(MS)
Reflectivity	90%(MS)
Surface treatment	polished(MS)

2.2.5 Limitations

Maximum operation temperature:	120℃(MS)
Maximum operation pressure:	1MPa (MS)
Heat transfer medium:	Water/ antifreeze
Flow rate range:	0.01Kg/(s*m^2)~0.034 Kg/(s*m^2) (MS)
Stagnation temperature:	275.6℃

3 Testing and Evaluation Methods

3.1 Condition

The specimens were held in standard laboratory conditions before testing for at least 24 hours at a temperature of 23 ± 2°C and a relative humidity of 50 ± 5%.

3.2 Specimen Preparation

3 test specimens which contain one pieces of EUROTHERM SOLAR PRO CPC 24R and 2 pieces of EUROTHERM SOLAR PRO CPC 8R were submitted and received in good condition.

3.3 Test Standard

EN12975-1:2006 + A1:2010 – Thermal solar systems and components – Solar collectors – Part 1: General requirements.
EN 12975-2: 2006 – Thermal solar systems and components – Solar collectors – Part 2: Test methods.

4 Execution and Evaluation

4.1 Internal pressure test

Collector reference No.: S131016040-001
Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.2

4.1.1 Collector type

Cover:	☑ Glazed	☐ Unglazed
Maximum collector operation pressure specified by manufacturer:	1000kPa	

4.1.2 Test conditions

Test temperature [°C]	Test pressure [kPa]	Test duration [min]
15.2	1500	15

4.1.3 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.2

4.2 High temperature resistance

Collector reference No.: S131016040-001

Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.3

4.2.1 Method used to heat collectors

☑ Outdoor test method	☐ In solar simulator

4.2.2 Test conditions

Collector tilt angle[degrees form horizontal [°]:	30
Average irradiance during test [W/ m^2]:	1037
Average surrounding air temperature [°C] :	19.21
Average surrounding air speed [m/s]:	0.4
Duration of test [h]:	1

4.2.3 Stagnation temperature

Mean irradiance [W/ m^2]:	1036
Mean absorber temperature [℃]:	273.6
Mean ambient temperature [℃]:	19.20

Note: The temperature sensor was placed at the centre of the header of the collector.

The stagnation temperature t_{stg} for required ambient conditions Gs=1000 W/ m^2 and t_{as} = 30 °C is calculated according

$$t_{stg} = t_{as} + \frac{G_S}{G_m}(t_{sm} - t_{am})$$

to t_{stg} = 275.6℃

4.2.4 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.3

4.3 Exposure test

Collector reference No.: S131016040-001

Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.4

Collector tilt angle (degree from horizontal): 30 degrees

4.3.1 Climatic conditions for all days during the test

Date	H (MJ/m^2)	t_a (^OC)	Rain (mm)	Date	H (MJ/m^2)	t_a (^OC)	Rain (mm)
2013.10.26	22.54	21.3	0	2013.11.8	9.37	24.9	0
2013.10.27	20.71	21.9	0	2013.11.9	10.51	26.3	0
2013.10.28	17.67	22.6	0	2013.11.10	16.35	25.6	14.7
2013.10.29	11.21	23.4	0	2013.11.11	5.40	25.4	5.3
2013.10.30	12.69	25.1	0	2013.11.12	7.75	21.2	13.7
2013.10.31	20.82	29.3	0	2013.11.13	1.81	16.7	17.4
2013.11.1	21.72	26.1	0	2013.11.14	5.26	17.1	3.5
2013.11.2	14.17	26.1	0	2013.11.15	22.37	19.8	0
2013.11.3	17.94	25.9	0	2013.11.16	21.40	19.6	0
2013.11.4	6.38	23.5	0	2013.11.17	11.95	20.1	0
2013.11.5	4.31	20.6	0	2013.11.18	23.36	20.3	0
2013.11.6	16.08	23.8	0	2013.11.19	5.35	18.7	0
2013.11.7	20.69	25	0	2013.11.20	10.28	19	0

2013.11.21	15.89	20.5	4.6	2013.12.6	19.02	18.4	0
2013.11.22	19.57	23	2.5	2013.12.7	18.99	18.9	0
2013.11.23	14.35	23.2	0	2013.12.8	16.08	20.3	0
2013.11.24	10.28	21.9	11	2013.12.9	19.08	22.4	0
2013.11.25	25.20	15.6	0				
2013.11.26	21.66	22	0				
2013.11.27	2.40	16.9	16.7				
2013.11.28	22.78	15.5	0				
2013.11.29	25.36	14.7	0				
2013.11.30	23.66	16.2	0				
2013.12.1	24.08	18.2	0				
2013.12.2	24.85	18.1	0				
2013.12.3	21.70	18.5	0				
2013.12.4	20.95	19.4	0				
2013.12.5	22.98	18.7	0				

Total: 30 days in which H > 14 MJ/m^2

Maximum daily rain fall: 17.4 mm

4.3.2 Time periods in which irradiance and surrounding air temperature have values greater than those specified in Table 4 which is in clause 5.4.3 of EN12975-1:2006

Date	G (W/m^2)	t_a (^oC)	Time periods (min)	Date	G (W/m^2)	t_a (^oC)	Time periods (min)
2013-10-26	931	21.3	181	2013-11-25	984	15.6	259
2013-10-27	916	21.9	122	2013-11-26	932	22	172
2013-10-28	900	22.6	87	2013-11-28	937	15.5	190
2013-10-31	884	29.3	92	2013-11-29	996	14.7	256
2013-11-1	894	26.1	79	2013-11-30	954	16.2	237
2013-11-3	914	25.9	43	2013-12-1	961	18.2	238
2013-11-6	948	23.8	83	2013-12-2	989	18.1	260
2013-11-7	895	25	128	2013-12-3	927	18.5	173
2013-11-15	924	19.8	184	2013-12-4	891	19.4	110
2013-11-16	939	19.6	199	2013-12-5	945	18.7	215
2013-11-18	955	20.3	240	2013-12-8	898	20.3	75
2013-11-21	995	20.5	115	2013-12-9	866	22.4	51
2013-11-22	935	23	171				
2013-11-23	975	23.2	30				
2013-11-24	892	21.9	39				

Total time: Suffered more than 67.1 hours in which G > 850 W/m^2 in the exposure period.

4.3.3 Test Results:

Evaluate each potential problem according to the following scale:

0 – No problem

1 – Minor problem

2 – Severe problem

* - Inspection to establish the condition was not possible

Collector component	Potential problem evaluation	Result
Collector box/fasteners	Cracking/warping/corrosion/ rain penetration	0
Mounting/structure	Strength/safety	0
Seals/gaskets	Cracking/adhesion/elasticity	0
Cover/reflector	Cracking/crazing/buckling/ delamination	0
Absorber coating	Cracking/crazing/blistering	0
Absorber tubes and headers	Deformation/corrosion/leakage/ loss of bonding	0
Absorber mountings	Deformation/corrosion	0
Insulation	Water retention/outgassing/ degradation	1

Note: 1-there are some changes in color of insulation.

And there are no major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.4.

4.4 External thermal shock test

Collector reference No.: S131016040-001

Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.5

4.4.1 Test conditions

☑ Test performed outdoors	☑ Combined with exposure test
☐ Test performed indoors in solar simulator	☐ Combined with high temperature resistance test

	First shock		Second shock	
Collector tilt angle[°]	30		30	
Min & mean irradiance [W/ m^2]	922	937	963	981
Min & mean surrounding air temperature[^oC]	30.2	30.7	25.9	26.1
Period during which the required operating conditions were maintained prior to shock [min]	60		60	
Flow rate of water spray [kg/s · m^2]	0.04		0.04	
Temperature of water spray [^oC]	21.4		18.1	
Duration of water spray [min]	15		15	
Absorber temperature immediately prior to water spray [^oC]	Not determined		Not determined	

4.4.2 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.5.

4.5 Internal thermal shock test

Collector reference No.: S131016040-001

Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.6

4.5.1 Test conditions

☑ Test performed outdoors	☑ Combined with exposure test
☐ Test performed indoors in solar simulator	☐ Combined with high temperature resistance test

	First shock		Second shock	
Collector tilt angle[°]	30		30	
Min & mean irradiance [W/ m^2]	880	893	867	883
Min & mean surrounding air temperature[^{o}C]	31.6	31.8	26.7	26.8
Period during which the required operating conditions were maintained prior to shock [min]	60		60	
Flow rate of heat transfer fluid [kg/s · m^2]	0.04		0.04	
Temperature of heat transfer fluid [^{o}C]	22.1		17.8	
Duration of heat transfer fluid flow [min]	5		5	
Absorber temperature immediately prior to heat transfer fluid flow [^{o}C]	Not determined		Not determined	

4.5.2 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.6.

4.6 Rain penetration

Collector reference No.: S131016040-001

Lead through and boundary conditions acc. To EN12975-2:2006-part 2, clause 5.7

4.6.1 Test conditions

Collector mounting:	☑ Open frame	☐ Simulated roof
Collector tilt angle[°]:	30	
Collector experienced effective exposure days:	15	
Method used to keep absorber warm:	☐ Hot water circulation	☑ Exposure of collector to solar radiation
Water spray flow rate[kg/(s · m2)]:	0.05	
Water spray temperature [°C]	20.6	
Duration of water spray [h]:	4	

4.6.2 Test results

Area with visible sign of water penetration [expressed as a percentage of aperture area]	No
Give details of water penetration, reporting the place where water penetrated	NA
The time the sign of rain penetration took to vanish	NA
Collector weight before test [g]:	81930
Collector weight after test [g]:	81940

And no major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.7

4.7 Freeze resistance test

The tested Vacuum tubes were from the collector, which reference No. is: S131016040-001

Lead through and boundary conditions acc. to SKN_N0106_AnnexF_R0.

4.7.1 Collector type and tilt angle

☐ Flat plate collector	☑ Vacuum tube collector
Tilt angle of collector during test [°]:	60

4.7.2 Test conditions

Heat-pipe fluid temperature in Freeze cycles			Heat-pipe fluid temperature in Thaw cycles		
Lowest temperature [°C]	Highest temperature [°C]	Duration [min]	Lowest temperature [°C]	Highest temperature [°C]	Duration [min]
-20.9	-20.1	40	10.2	12.4	40
Number of freeze-thaw cycles:			20		

4.7.3 Test results

No.	Average tube diameter (mm)	Initial average tube diameter(mm)	The biggest deformation rate
1	8.005	8.072	0.83%
2	8.013	8.012	-0.01%
3	8.029	8.009	-0.25%
4	8.014	8.005	-0.11%
5	8.017	8.017	0
6	8.020	8.004	-0.20%
7	8.012	8.002	-0.12%
8	8.031	8.031	0
9	8.006	8.006	0

Conclusion: no major failure appears after test acc. to SKN_N0106_AnnexF_R0

4.8 Mechanical load test

Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.9

4.8.1 Positive pressure test of the collector cover

Collector reference No.: S131016040-001

4.8.1.1 Method used to apply pressure

☐ Loading with gravel or similar material	☑ Loading with water
☐ Suction cups	☐ Pressurization of collector cover

4.8.1.2 Test condition

Maximum pressure load [Pa]:	2860

4.8.1.3 Test result

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.8.with 2860 Pa pressure load.

4.8.2 Negative pressure test of fixing between the cover and the collector box (NA)

It's not suitable to conduct negative pressure test on a vacuum tube collector.

4.8.2.1 Method used to apply pressure

☐ Suction cups	☐ Pressurization of collector box

4.8.2.2 Test condition

Maximum pressure load [Pa]:	---

4.8.2.3 Test result

Conclusion: ---

4.9 Impact resistance test using steel balls

Collector reference No.: S131016040-001

Lead through and boundary conditions acc. to EN12975-2:2006-part 2, clause 5.10

4.9.1 Test conditions

Diameter of ball [mm]:	33.4	
Mass of ball [g]:	150	
Test performed using:	☑ Vertical impact	☐ Horizontal impact

4.9.2 Test procedure

Drop height [m]	No. of drops
0.2	10
0.4	10
0.6	10
0.8	8

4.9.3 Test result

Conclusion: The collector cover was broken at the 0.8m drop with a 150g steel ball.

4.10 Final inspection results

Evaluate each potential problem according to the following scale:

0 – No problem

1 – Minor problem

2 – Severe problem

* - Inspection to establish the condition was not possible

Collector component	Potential problem evaluation	Result
Collector box/fasteners	Cracking/warping/corrosion/ rain penetration	0
Mounting/structure	Strength/safety	0
Seals/gaskets	Cracking/adhesion/elasticity	0
Cover/reflector	Cracking/crazing/buckling/ delamination	0
Absorber coating	Cracking/crazing/blistering	0
Absorber tubes and headers	Deformation/corrosion/leakage/ loss of bonding	0
Absorber mountings	Deformation/corrosion	0
Insulation	Water retention/outgassing/ degradation	1

Note: 1-there are some changes in color of insulation.

5 Test results of thermal performance

Collector reference No.: S131016040-002/003

Test method according to EN 12975-2:2006

☑ Outdoor-Steady State Method(6.1) ☐ Indoor-Steady State Method(6.2)

☐ Outdoor-Quasi-Dynamic Method(6.3)

5.1 Test conditions

Collector model:	EUROTHERM SOLAR PRO CPC 24R	EUROTHERM SOLAR PRO CPC 8R
Latitude [°]::	North 23.08	North 23.08
Longitude [°]::	East 113.15	East 113.15
Mass flow [kg/(s m^2)]:	0.02	0.02
Aperture area [m^2]:	4.406	1.406
Collector absorber area [m^2]:	6.026	2.009
The instantaneous efficiency is defined by:	$\eta_0 = Q / AG$	

5.2 Test results

Collector model:	EUROTHERM SOLAR PRO CPC 24R	EUROTHERM SOLAR PRO CPC 8R
Effective heat capacity in empty c [kJ/(m^2K)]:	3.17	
Incident angle modifier $K\theta$ (50):	0.92	0.95
Peak power [W_{peak}] per collector unit (G=1000 W/(m^2K), $t_m - t_a$=0):	3009	939

Determination of power per collector unit (second order fit to data):

$$\dot{Q} = A \cdot G\left(\eta_0 - a_1\left(\frac{t_m - t_a}{G}\right) - a_2 G\left(\frac{t_m - t_a}{G}\right)^2\right)$$

Coefficient based on aperture area

Collector model	EUROTHERM SOLAR PRO CPC 24R	EUROTHERM SOLAR PRO CPC 8R
η_{0a}	0.683	0.668
a_{1a}	1.223	1.496
a_{2a}	0.005	0.005

Power output per collector unit

EUROTHERM SOLAR PRO CPC 24R

$t_m - t_a$ [k]	Irradiance		
	400 W/m^2	700 W/m^2	1000 W/m^2
0	1203	2106	3009
10	1147	2050	2952
30	1021	1923	2826
50	875	1778	2681
70	711	1614	2517

EUROTHERM SOLAR PRO CPC 8R

$t_m - t_a$ [k]	Irradiance		
	400 W/m^2	700 W/m^2	1000 W/m^2
0	375	657	939
10	354	635	917
30	306	587	869
50	252	533	815
70	192	474	755

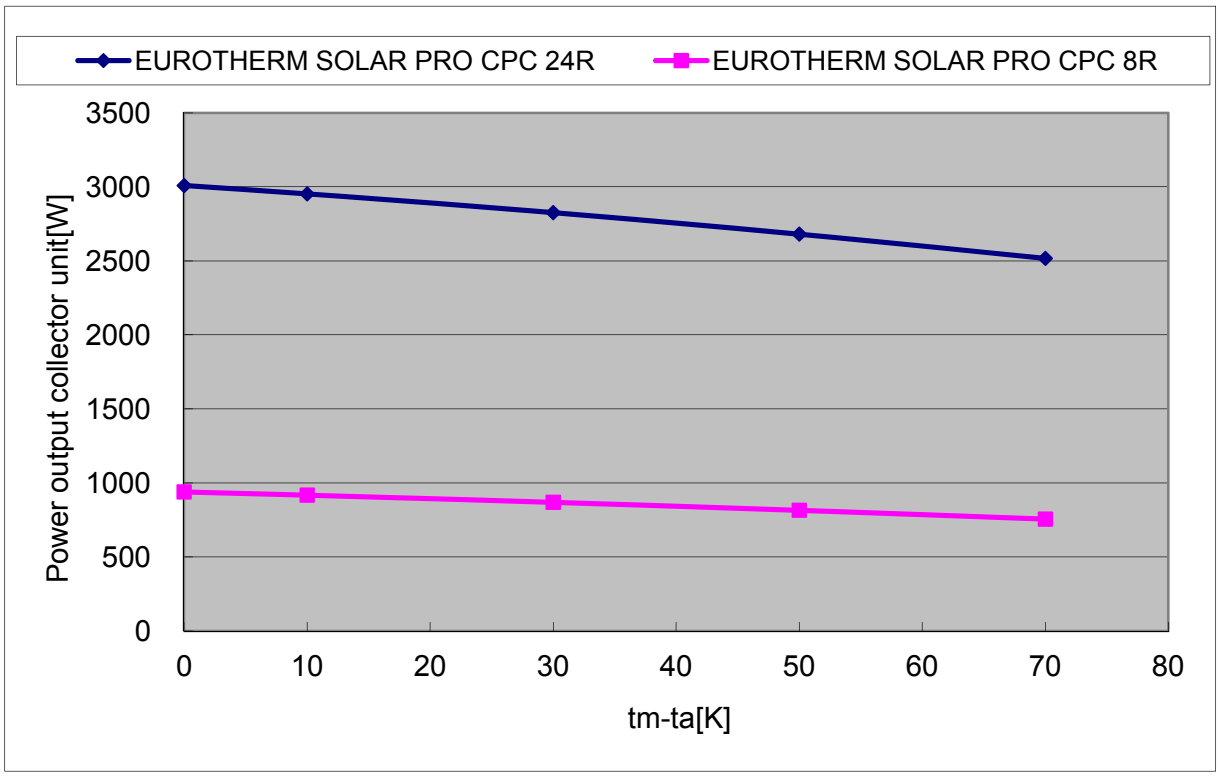

Figure 5.1 Power output per collector unit (For G=1000 W/m^2)

Incident angle modifier

EUROTHERM SOLAR PRO CPC 24R

IAM at ɵ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal:	1.0	——	1.02	——	1.04	——	1.14	——	——	——
Longitudinal:	1.0	——	——	——	——	0.92	——	——	——	——

EUROTHERM SOLAR PRO CPC 8R

IAM at ɵ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal:	1.0	——	1.03	——	1.05	——	1.18	——	——	——
Longitudinal:	1.0	——	——	——	——	0.95	——	——	——	——

Pressure drop

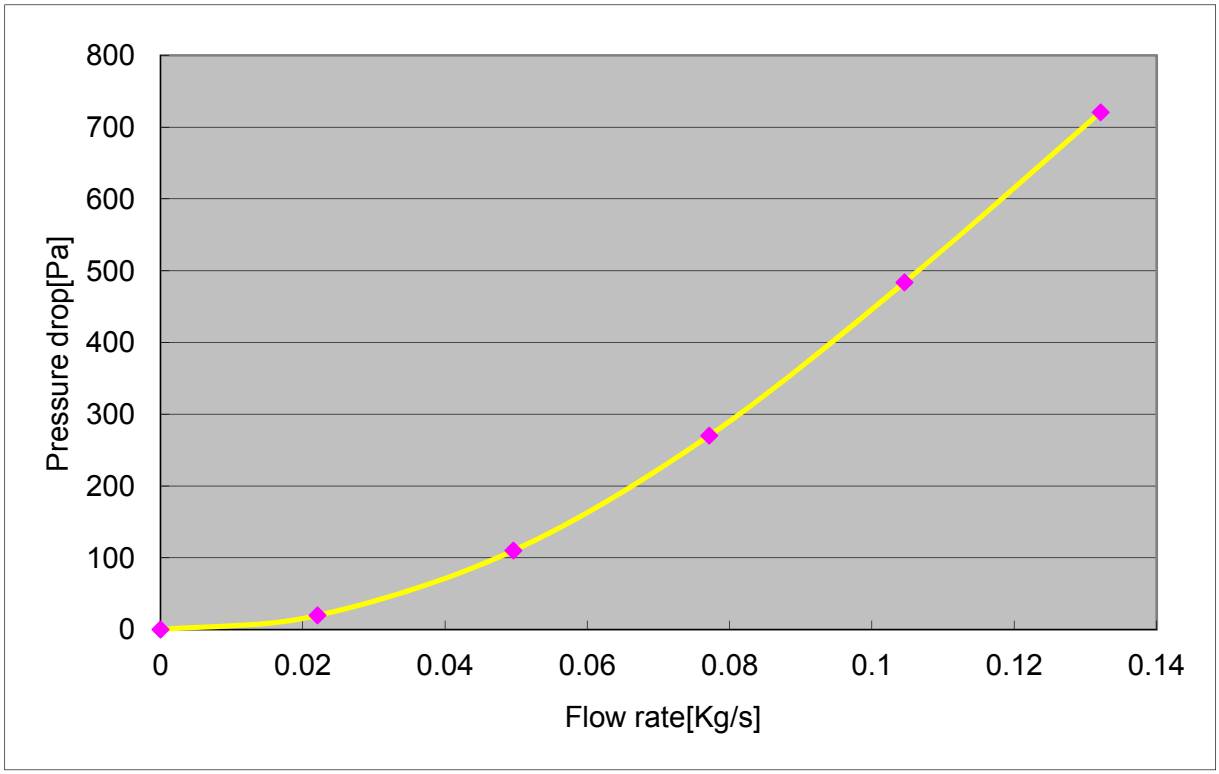

Figure 5.2 Pressure drop of the collector EUROTHERM SOLAR PRO CPC 24R (for 20°C water)

Annex A

Measured data

(Based on aperture area and mean fluid temperature)

Date	Time	G (W/m^2)	Gd' (W/m^2)	m (L/min)	t_{in} (^0C)	t_e (^0C)	t_m (^0C)	t_e-t_{in} (^0C)	t_a (^0C)	$(t_m-t_a)/G$ (K m^2/W)	η
EUROTHERM SOLAR PRO CPC 24R											
2013-11-25	12:47	1040	100	5.280	19.66	28.07	23.87	8.41	20.98	0.00278	0.6731
2013-11-25	12:57	1039	103	5.287	19.69	28.16	23.92	8.47	21.32	0.00250	0.6793
2013-11-25	13:07	1037	103	5.287	19.70	28.21	23.95	8.51	22.06	0.00182	0.6842
2013-11-25	13:17	1040	101	5.286	19.75	28.27	24.01	8.52	21.71	0.00221	0.6831
2013-11-25	14:11	1000	93	5.284	43.67	51.46	47.56	7.80	23.52	0.02404	0.6446
2013-11-25	14:21	998	94	5.287	43.70	51.53	47.62	7.83	23.99	0.02367	0.6492
2013-11-25	14:31	993	95	5.297	43.72	51.56	47.64	7.83	23.95	0.02385	0.6536
2013-11-25	14:41	990	94	5.290	43.66	51.50	47.58	7.85	23.32	0.02450	0.6558
2013-11-26	10:15	946	102	5.290	63.82	70.87	67.35	7.06	20.31	0.04975	0.6124
2013-11-26	10:25	956	101	5.289	63.87	70.93	67.40	7.06	20.16	0.04943	0.6062
2013-11-26	10:35	961	99	5.287	63.87	70.98	67.42	7.11	20.38	0.04896	0.6073
2013-11-26	10:45	952	102	5.289	63.87	70.97	67.42	7.10	20.44	0.04937	0.6122
2013-11-28	15:03	788	98	5.286	81.50	86.79	84.15	5.29	20.32	0.08099	0.5459
2013-11-28	15:13	775	97	5.285	81.52	86.81	84.16	5.29	20.56	0.08206	0.5557
2013-11-28	15:23	762	98	5.285	81.50	86.77	84.13	5.27	20.74	0.08315	0.5621
2013-11-28	15:33	762	99	5.283	81.49	86.68	84.08	5.18	20.13	0.08388	0.5527
EUROTHERM SOLAR PRO CPC 8R											
2013-11-18	9:48	993	99	1.691	16.15	24.00	20.08	7.85	19.35	0.00074	0.6616
2013-11-18	9:58	998	104	1.686	16.16	24.11	20.14	7.96	19.53	0.00061	0.6653
2013-11-18	10:08	1001	110	1.685	16.16	24.18	20.17	8.02	19.54	0.00064	0.6681
2013-11-18	10:18	1004	117	1.685	16.17	24.22	20.20	8.05	19.53	0.00066	0.6690
2013-11-18	11:37	1042	93	1.688	38.90	46.83	42.87	7.94	21.97	0.02006	0.6318
2013-11-18	11:47	1037	94	1.687	38.89	46.90	42.90	8.01	21.97	0.02017	0.6392
2013-11-18	11:57	1035	94	1.683	38.82	46.83	42.82	8.01	21.96	0.02016	0.6397
2013-11-18	12:07	1031	93	1.684	38.85	46.81	42.83	7.97	21.89	0.02032	0.6393
2013-11-18	13:01	1047	86	1.684	61.19	68.75	64.97	7.56	23.63	0.03949	0.5916
2013-11-18	13:11	1042	85	1.685	61.21	68.81	65.01	7.60	24.33	0.03904	0.5981
2013-11-18	13:21	1039	85	1.691	61.20	68.79	65.00	7.60	24.27	0.03919	0.6016
2013-11-18	13:31	1037	87	1.690	61.19	68.78	64.99	7.60	24.30	0.03923	0.6023
2013-11-22	12:59	1010	73	1.679	84.15	91.06	87.61	6.91	25.40	0.06162	0.5533
2013-11-22	13:09	1007	74	1.691	84.15	91.00	87.57	6.85	25.26	0.06189	0.5543
2013-11-22	13:19	1005	78	1.691	84.14	90.98	87.56	6.84	24.32	0.06295	0.5548
2013-11-22	13:29	999	82	1.690	84.17	90.99	87.58	6.82	24.85	0.06276	0.5559

Note: 1.The diffuse irradiance has been modified based on the diffuse irradiance pyranometer shade ring.

Annex B

Terms and definitions

Symbol	Term	Unit
A	Area(aperture, gross or absorber)	m^2
η_0	Zero-loss efficiency	-
η_{0a}	Zero-loss collector efficiency based on aperture area	-
Q	Useful power extracted from the collector	W
G	Solar irradiance	W/ m^2
t_m	Mean temperature of heat transfer fluid	^oC
t_a	Ambient air temperature	^oC
a_1	Heat transfer coefficient	W/ m^2/K
a_{1a}	Heat transfer coefficient based on aperture area	W/ m^2/K
a_2	Temperature depending heat transfer coefficient	W/ m^2/K^2
a_{2a}	Temperature depending heat transfer coefficient based on aperture area	W/ m^2/K^2
m	Mass flow	kg/s
t_{in}	Collector inlet temperature	^oC
t_e	Collector outlet temperature	^oC

Measuring uncertainties

Thermal performance:	±3.2%	K=2
Irradiance:	±2.9%	K=2
Temperature water:	±0.02K	K=2
Temperature air:	±0.03K	K=2
Water flow:	±0.18%	K=2
Air speed:	±0.1m/s	K=2
Aperture:	±0.95%	K=2
Mass:	±1.6g	K=2

Annex C

Photos of test collector

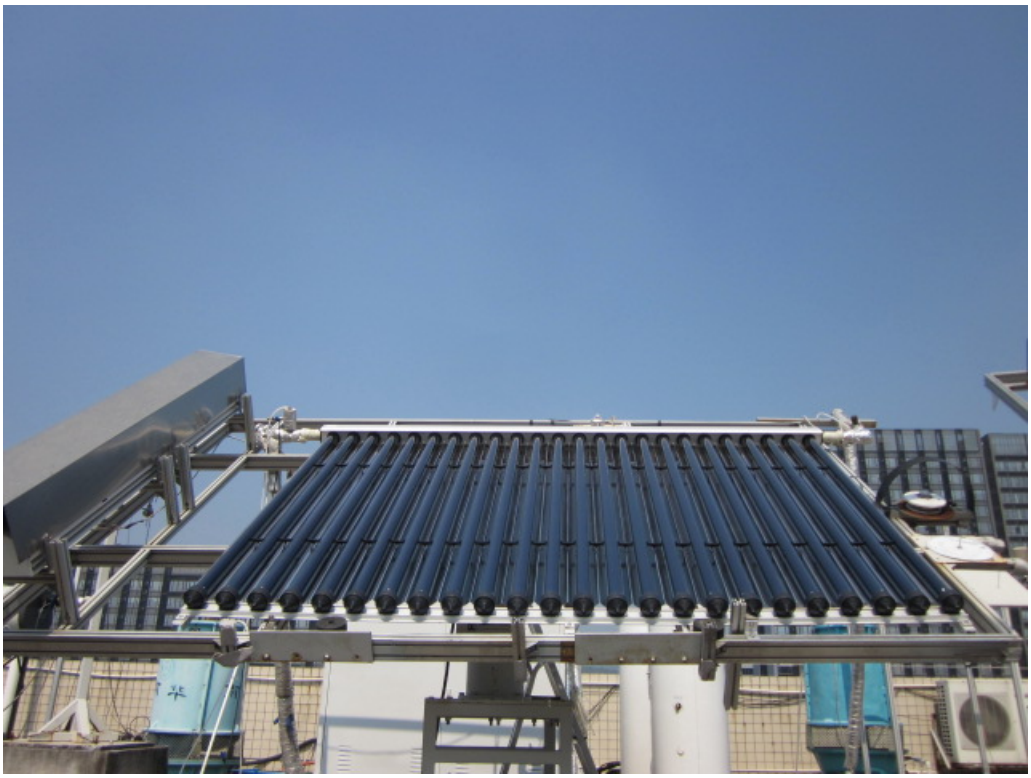

Figure C.1: Photo of the thermal performance test

Figure C.2: Photo of the positive pressure test

Figure C.3: Photo of collector without evacuated tube

Figure C.4: Photo of the insulation (after exposure test)

REVISION SUMMARY

DATE	SECTION	SUMMARY	INTERTEK INITIALS	
			TECHNICIAN	REVIEWER

End of the Document