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Zhejiang LINYAN

TEST Report

SCOPE OF WORKs
Solar Keymark – Solar collector – LY-HPC10 and LY-HPC30

REPORT NUMBER
171031198GZU-001

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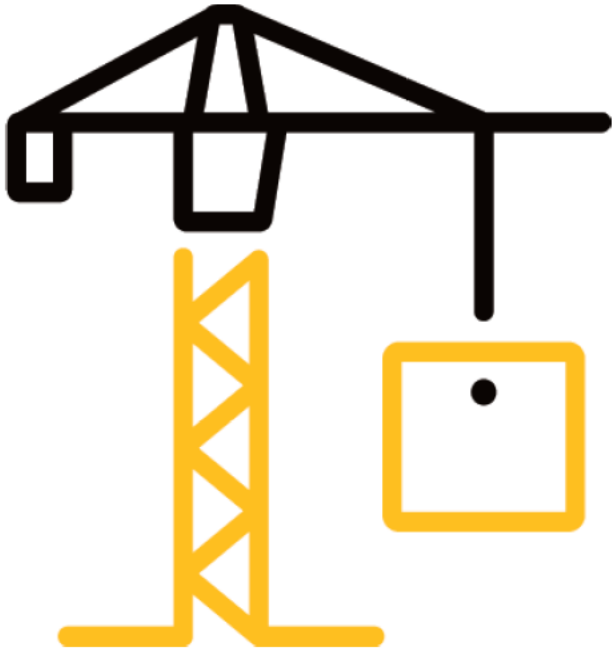

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Test Report

Report Number: 171031198GZU-001
Report Date: 2023/8/14

Applicant:	**Zhejiang LINYAN New Energy Co.,Ltd**
Applicant Address:	**Building 1, No.200, Xuqiao Rd, Liyuan Village,Yuanhua Town, Haining, 314400 ZHEJIANG, CHINA**

Sample information

Manufacturer:	Zhejiang LINYAN New Energy Co.,Ltd
Manufacturer Address:	Building 1, No.200, Xuqiao Rd, Liyuan Village,Yuanhua Town, Haining, 314400 ZHEJIANG, CHINA
Sample ID:	S171031198-001/002/003
Date of receipt of test item:	2017.10.31
Situation of receipt samples:	Received in good condition
Date (s) of performance of tests:	2017.10.31~2018.3.1

Testing information

Standard:	EN12975-1:2006+A1:2010, ISO9806:2013
Testing Laboratory name:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address:	Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD Guangzhou, China

Possible Test Case Verdits

Test Case does not apply to the Test object:	N/A
Test object does meet the requirement:	P (Pass)
Test object does not meet the requirement:	F (Fail)

Conclusion:
The submitted samples were tested and found to COMPLY WITH all applicable requirements of EN 12975-1:2006+A1:2010 and ISO 9806:2013.

* When determining the test result, measurement uncertainty has been considered.

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1 Solar collector description

The manufacturer produces family collector in different tubular number , there are model LY-HPC10,LY-HPC12, LY-HPC15, LY-HPC16, LY-HPC18,LY-HPC20, LY-HPC24, LY-HPC25, LY-HPC30. According to the Solar Keymark scheme rules, only one sample of the smallest and one sample of the largest module shall be taken and tested.The largest module shall be subject to all the tests required, and the smallest shall be subject to a thermal performance test.

Name of manufacturer:	Zhejiang LINYAN New Energy Co.,Ltd
Brand Name:	LINYAN
Collector Type:	Evacuated tube (Heat Pipe Type)
Serial No:	2017050305150
Collector no.(Intertek)	S171031198-001/002/003
Drawing document No:	LY 58/1800-75-NQ(G1);LY-SR01(A1)
	ϕ38/1-ϕ26/60-75-N-112.5(G1); HR8(24)x1800F.75.06
Year of Production:	2017
Test flow rate:	0.02 kg/(sm^2)
Standard stagnation temperature at 1000 W/m2 and 30℃ ambient temperature:	230 ℃
Collector mounting:	On roof installation

1.1 Collector:

Type name: Evacuated tube (heat pipe type)

1.2 Dimensions of collector unit:

	Model A	Model B
Model Name:	LY-HPC10	LY-HPC30
Length[mm]:	1962	1962
Width[mm]:	803	2303
Height[mm]:	160	160
Gross area[m^2]:	1.58	4.52
Aperture area[m2]:	0.94	2.83
Weight empty[kg]:	40.7(MS)	97.5(MS)
Fluid content[L]:	0.6(MS)	1.8(MS)
Enclosure side material:	aluminium alloy	aluminium alloy
Enclosure back material:	aluminium alloy	aluminium alloy
Frame fastening methods (pop rivets, screws ,etc.):	screws	screws

1.3 Absorber

Material:	Heat pipe and fin	
Fin Length:	1740	mm
Fin thickness:	0.25	mm
Solar absorptance α:	92%(MS)	
Hemispherical emittance ε:	7%(MS)	
Surface treatment:	SS-AlNx/Cu	
Bond between riser and fin/plate (e.g. mechanical, solder, weld-ultrasonic, laser):	mechanical	
Number of risers:	10;30	
Riser diameter or dimensions:	8	mm
Distance between risers:	75	mm
Dimensions (Length, Width):	1720mm*10*47mm; 1720mm*30*47mm	
Header diameter or dimensions:	38	mm
Header material:	Copper	
Flow pattern:	Parallel	

1.4 Glazing:

Material:	Glass	
Thickness:	1.6	mm
Solar Transmittance:	91	%
Glazing surface characteristics :	Not specified	

1.5 Heat pipe:

External diameter of pipe:	8	mm
External diameter of condenser:	24	mm

1.6 Reflector:

Type of reflector:	NA	
Dimensions:	NA	mm
Material:	NA	

1.7 Insulation and Enclosure

Insulation material and thickness (Back):	Glass wool 50	mm
Insulation material and thickness (Side):	Glass wool 60	mm
Collector Enclosure- Seal Compound	Silicon rubber	
Collector Enclosure- Predominant Hardware	Aluminum alloy	

1.8 Limitations:

Maximum operation temperature:	98(MS)	℃
Maximum operation pressure at 45 °C:	600(MS)	kPa
Maximum operating pressure at maximum temperature of operation:	600(MS)	kPa
Other limitations:	NO	
Photograph of the collector:	Refer to Annex 4	
Comments on collector design:	NO	
Schematic diagram of collector mounting	Refer to the manual	
Heat transfer medium:	water	
Specifications (additives etc.):	NA	
Alternative acceptable heat transfer fluids:	NA	
For solar collectors with integrated technical components (ventilator, PV-panel…) all components have to be listed with their technical data:	NA	

Note:
MS: means manufacture specification.
NA: means not applicable.

2 Record of test sequence and summary of main results

All significant damage to the collector, including rain penetration, should be summarized in Table 1. Full details should be given in the individual test result sheets.

Table 1 — Result summary table

Test		Date		Summary of main test results
		Start	End	
Internal pressure		2018.3.1	2018.3.1	PASS
High-temperature resistance		2017.12.22	2017.12.22	PASS
Exposure or pre-exposure		2017.11.1	2017.12.17	PASS
External thermal shock	First	2017.12.09	2017.12.09	PASS
	Second	2017.12.10	2017.12.10	PASS
Internal thermal shock	First	2017.11.1	2017.11.1	PASS
	Second	2017.11.2	2017.11.2	PASS
Rain penetration		2018.02.24	2018.02.24	PASS
Freeze resistance		2017.12.22	2018.01.05	PASS
Mechanical load		2018.1.25	2018.1.25	PASS
Impact resistance		2018.3.1	2018.3.1	PASS
Final inspection		2018.3.1	2018.3.1	PASS
Thermal performance		2017.12.19	2017.12.21	PASS
Pressure drop measurement		2017.12.20	2017.12.21	PASS

3 Internal pressure tests for fluid channels

3.1 General

The test method is Clause 6.1.

The maximum collector operating pressure specified by manufacturer: 600 kPa

3.2 Test conditions

Test fluid used Water

Test temperature 27.4 ℃

Test pressure: 900 kPa

Test duration: 15 min

3.3 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.2. and ISO 9806:2013 Clause 18.

4 High-temperature resistance test and determination of standard stagnation temperature

4.1 Method used to heat collectors

☑ Outdoor testing ☐ In solar simulator

4.2 Method used for determination of standard stagnation temperature

☑ Measurement and extrapolation (Clause 10.2)

☐ Calculation out of performance characteristics (Clause 10.3)

4.3 Test conditions

4.3.1 General

Collector tilt angle (degrees from horizontal): 45 °

Average irradiance during test: 982 W/m^2

Average surrounding air temperature: 20.3 °C

Average surrounding air speed: 0.7 m/s

Average absorber temperature: 215.7 °C

Duration of test: 90 min

If a fluid was circulated during the high temperature tests

☐ Yes ☑ No

If yes, please indicate the flow rate, fluid temperature, and duration of flow.

Flow rate -- m/s

Fluid temperature -- °C

Duration of flow -- h

NOTE If standard stagnation temperature was not determined together with the high temperature resistance test please give additional data on the test conditions valid for this determination within brackets.

4.4 Results from determination of standard stagnation temperature

Standard stagnation temperature at 1000 W/m2 and 30 °C ambient temperature

Given by the manufacturer: 230 ℃

Determined by the laboratory: 230 ℃

4.5 Results from high temperature resistance test

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.3. and ISO 9806:2013 Clause 18.

5 Exposure test

5.1 Test conditions

Collector tilt angle (degrees from horizontal): 45 °

If a fluid was circulated during the exposure test

☐ Yes ☑ No

If yes, please indicate the flow rate, fluid temperature, and duration of flow.

Flow rate -- m/s

Fluid temperature -- °C

Duration of flow -- h

5.2 Climatic conditions for all days during the test

Climate class : Class C Temperate

Table 3 — General exposure test data record

Date	H MJ/m2	ϑa °C	Date	H MJ/m2	ϑa °C
2017.11.1	20.799	22.34	2017.11.22	9.797	16.33
2017.11.2	20.926	24.06	2017.11.23	13.498	16.15
2017.11.3	20.818	25.44	2017.11.24	2.583	13.18
2017.11.4	14.903	24.41	2017.11.25	9.416	15.13
2017.11.5	17.832	22.95	2017.11.26	13.164	17.36
2017.11.6	8.401	20.5	2017.11.27	12.916	18.99
2017.11.7	3.812	20.45	2017.11.28	10.447	22.24
2017.11.8	7.004	21.59	2017.11.29	11.307	24.34
2017.11.9	8.123	24.41	2017.11.30	8.922	23.06
2017.11.10	8.565	25.98	2017.12.1	16.142	19.23
2017.11.11	10.123	28.18	2017.12.2	18.225	18.64
2017.11.12	8.921	25.31	2017.12.3	16.861	19.52
2017.11.13	2.522	17.35	2017.12.4	13.567	18.92
2017.11.14	4.015	23.06	2017.12.5	13.046	17.69
2017.11.15	1.572	21.23	2017.12.6	15.852	18.25
2017.11.16	4.627	23.24	2017.12.7	7.01	18.44
2017.11.17	6.627	24.75	2017.12.8	17.896	17.19
2017.11.18	3.897	22.44	2017.12.9	17.49	14.79
2017.11.19	3.265	16.58	2017.12.10	19.819	17.49
2017.11.20	3.005	15.17	2017.12.11	13.416	18.6
2017.11.21	8.86	15.38	2017.12.12	10.641	18.16

Date	H MJ/m2	ϑa °C	Date	H MJ/m2	ϑa °C
2017.12.13	4.76	18.86			
2017.12.14	5.12	17.18			
2017.12.15	6.295	16.53			
2017.12.16	9.73	12.63			
2017.12.17	3.998	10.53			
Total: The total H >490 MJ/m2.					

5.3 Time periods in which irradiance and surrounding air temperature have values greater than those specified in Table 4

Climate class : Class C Temperate

Table 4 — Data record of fulfilled exposure test requirements

Date	G W/m2	ϑa °C	Time periods min
2017/11/1	800	17.70	219
2017/11/2	800	18.40	226
2017/11/3	800	21.30	238
2017/11/4	800	21.60	46
2017/11/5	800	19.90	150
2017/11/9	800	21.10	91
2017/11/11	800	23.90	53
2017/11/23	800	14.40	61
2017/11/27	800	15.50	75
2017/11/29	800	20.30	32
2017/12/1	800	16.70	86
2017/12/2	800	15.20	233
2017/12/3	800	15.00	180
2017/12/4	800	16.80	71
2017/12/5	800	16.00	80
2017/12/6	800	14.50	150
2017/12/8	800	15.30	170
2017/12/9	800	11.40	163
2017/12/10	800	13.30	158
Total: Suffered more than 41 hours in which G> 800W/m2 and ϑa>10°C in the exposure period.			

5.4 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.4. and ISO 9806:2013 Clause 18.

6 External thermal shock test:

6.1 Test conditions

6.1.1 General

Test performed:

☑ Outdoors ☐ In solar irradiance simulator

Test combined with exposure test:

☑ Yes ☐ No

Test combined with high-temperature resistance test:

☐ Yes ☑ No

	First shock	Second shock	
Climate Class	Class B	Class B	
Collector tilt angle (degrees from horizontal):	45	45	°
Average irradiance during test:	955	960	W/m^2
Minimum irradiance during test:	944	950	W/m^2
Average surrounding air temperature:	20.1	21.4	°C
Minimum surrounding air temperature:	18.5	19.5	°C
Period during which the required operating conditions min were maintained prior to external thermal shock:	60	60	min
Flow rate of water spray:	0.04	0.04	$kg/(s \cdot m^2)$
Temperature of water spray:	17.4	18.3	°C
Duration of water spray:	15	15	min
Absorber temperature immediately prior to water spray:	--	--	°C

6.1.2 Additional information required if an evacuated tubular collector was tested

The temperature of the collector was not measured.

6.1.3 Additional information required if the absorber temperature was measured using a suitable fluid (as described in 12.2)

The absorber was partially filled with -- . And the average pressure was -- Pa, which corresponds to the absorber temperature given in A.8.1.1.

6.2 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.5. and ISO 9806:2013 Clause 18.

7 Internal thermal shock test:

7.1 Test conditions

7.1.1 General

Test performed:

☑ Outdoors ☐ In solar irradiance simulator

Test combined with exposure test:

☑ Yes ☐ No

Test combined with high-temperature resistance test:

☐ Yes ☑ No

	First shock	Second shock	
Climate Class	Class B	Class B	
Collector tilt angle (degrees from horizontal):	45	45	°
Average irradiance during test:	920	933	W/m^2
Minimum irradiance during test:	900	910	W/m^2
Average surrounding air temperature during test:	20.1	21.4	°C
Minimum surrounding air temperature:	18.5	19.5	°C
Period during which the required operating conditions were maintained prior to internal thermal shock:	60	60	min
Mass flow rate of heat transfer fluid:	0.04	0.04	$kg/(s \cdot m^2)$
Temperature of heat transfer fluid:	17.4	18.3	°C
Duration of heat transfer fluid flow:	15	15	min
Absorber temperature immediately prior to heat transfer fluid flow:	--	--	°C
	--	--	°C

7.1.2 Additional information required if an evacuated tubular collector was tested

7.1.3 Additional information required if the absorber temperature was measured using a suitable fluid (as described in 13.2, note 2)

The absorber was partially filled with -- and the average pressure was -- Pa, which corresponds to the absorber temperature given in A.9.1.

7.2 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.6. and ISO 9806:2013 Clause 18.

8 Rain penetration test

8.1 Test conditions

8.1.1 Collector mounting

Collector mounted on

☑ Open frame ☐ Simulated roof

Collector tilt angle (degrees from horizontal): 30 °

8.1.2 Water spray

Duration of water spray: 4 h

8.2 Test results

Conclusion: No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.7. and ISO 9806:2013 Clause 18.

9 Freeze resistance test

9.1 Collector type

☐ Freeze-resistant when filled with water ☐ Drain-down ☑ Heat pipe

9.1.1 Test conditions

9.1.2 Tilt angle of collector during test (degrees from horizontal):

Tilt angle of collector during test (degrees from horizontal): 60 °

9.1.3 Details of freeze–thaw cycles

Table 5 — Freeze test record

No. of freeze-thaw cycles	Freeze conditions		Thaw conditions	
	Test temperature °C	Duration min	Test temperaturea °C	Duration Min
1~2	-20±2	40	13±2	40
3~4	-20±2	40	13±2	40
5~6	-20±2	40	13±2	40
7~8	-20±2	40	13±2	40
9~10	-20±2	40	13±2	40
11~12	-20±2	40	13±2	40
13~14	-20±2	40	13±2	40
15~16	-20±2	40	13±2	40
17~18	-20±2	40	13±2	40
19~20	-20±2	40	13±2	40

[a] For freeze-resistant collectors, this is the temperature of the contents of the collector, e.g. water, ice.

For drain-down collectors, this is the temperature measured inside the absorber close to the inlet

9.1.4 Rate of chamber cooling: 35 K/h

9.1.5 Rate of chamber heating: 35 K/h

9.2 Test results

Conclusion: No major failure appears after test acc. to solar keymark scheme rules annex F. and ISO 9806:2013 Clause 18.

10 Mechanical load test

10.1 Positive pressure test of the collector and the fixings

10.1.1 Method used to apply pressure:

☐ Loading with gravel or similar material ☑ Loading with water

☐ Suction cups ☐ Other

10.1.2 Test conditions

Maximum positive pressure load applied in test: 2400Pa

10.1.3 Test results

Conclusion: No major failure appears when the positive pressure adding to 2400Pa.

acc. to EN12975-1:2006 + A1:2010, clause 5.3.8.

10.2 Negative pressure test of the collector and fixings

10.2.1 Method used to apply pressure:

☐ Suction cups ☐ Pressurization of collector box

☑ Other(an inflatable bag)

10.2.2 Test conditions

Maximum negative pressure load applied during test: 2400Pa

10.2.3 Test results

Conclusion: No major failure appears when the negative pressure adding to 2400Pa.

acc. to EN12975-1:2006 + A1:2010, clause 5.3.8.and ISO 9806:2013 Clause 18.

11 Impact resistance test using steel balls

11.1 Impact resistance test using steel balls

11.1.1 Test conditions

Diameter of ball: 33.4 mm

Mass of ball: 150 g

Maximum dropping height: 0.8 m

Test performed using:

☑ Vertical impact (dropping ball) ☐ Horizontal impact (pendulum)

Drop height [m]	No. of drops
0.4	4
0.6	4
0.8	2

11.1.2 Test results

Conclusion: the glass cover broken when the steel ball dropped at the height of 0.8m.

11.2 Impact resistance test using ice balls (NA)

11.2.1 Test conditions

Diameter of ball: -- mm

Mass of ball: -- g

Velocity of ball: -- m/s

Number of impacts: --

11.2.2 Test results

12 Final inspection results

12.1 Evaluate each potential problem according to the following scale:

0 - No problem

1 - Requirement apart from testing not fulfilled

2 - Requirements for testing not fulfilled

• - Inspection to establish the condition was not possible

	Collector component	Potential problem	Evaluation
a)	Collector box/fasteners	Cracking/warping/corrosion/rain	0
b)	Mountings/structure	Strength/safety	0
c)	Seals/gaskets	Cracking/adhesion/elasticity	0
d)	Cover/reflector	Cracking/crazing/buckling/ delamination/warping/outgassing	0
e)	Absorber coating	Cracking/crazing/blistering	0
	Absorber tubes and headers	Deformation/corrosion/leakage/loss of bonding	0
	Absorber mountings	Deformation/corrosion	0
f)	Insulation	Water retention/outgassing/degradation	1
g)	Any other abnormality resulting in a reduction of thermal performance or service life time		0

12.2 Test results

Conclusion: Except for the insulation has a little color changed, No major failure appears after test acc. to EN12975-1:2006 + A1:2010, clause 5.3.1.and ISO 9806:2013 Clause 18.

13 Performance test

13.1 Test method

☑ Outdoor ☐ Indoor

13.2 Location and orientation

Latitude:	North 23.08°	mean solar irradiance:	NA
Longitude:	East 113.15°	type of the lamps:	NA
Collector azimuth:	Normal to the irradiance	shading of long wave radiation:	Yes
Collector tilt:	Normal to the irradiance		

Orientation of absorber tubes during testing (horizontal or vertical): vertical

13.3 Test results for glazed liquid heating collectors under steady-state conditions

Power output

Table 6.1 — Collector power output record-Model LY-HPC10

Irradiance			
ϑm-ϑa in K	400 W/m2 (Gb = 200 W/m2, Gd = 200 W/m2)	700 W/m2 (Gb = 440 W/m2, Gd = 260 W/m2)	1000 W/m2 (Gb = 850 W/m2, Gd = 150 W/m2)
0	287	502	717
10	267	482	697
30	221	436	651
50	164	379	594
70	98	313	528

Table 6.2 — Collector power output record-Model LY-HPC30

Irradiance			
ϑm-ϑa in K	400 W/m2 (Gb = 200 W/m2, Gd = 200 W/m2)	700 W/m2 (Gb = 440 W/m2, Gd = 260 W/m2)	1000 W/m2 (Gb = 850 W/m2, Gd = 150 W/m2)
0	853	1493	2133
10	795	1435	2075
30	661	1301	1941
50	504	1144	1784
70	326	966	1606

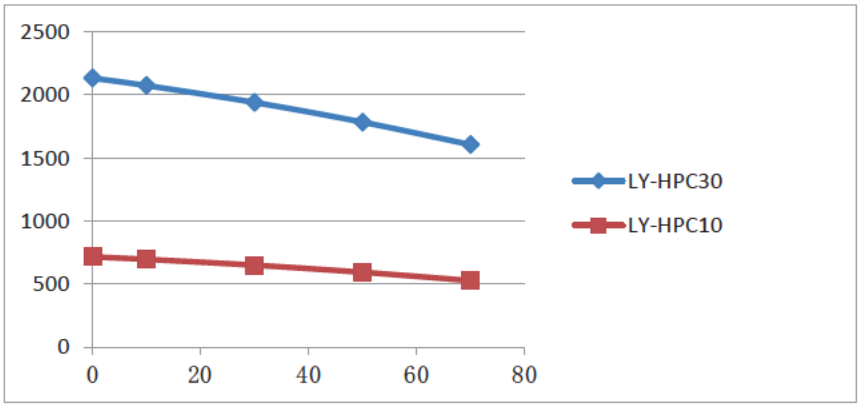


Figure 2 — Power output per collector unit (for G = 1000 W/m^2)

Instantaneous efficiency curve based on gross/aperture/absorber area and mean temperature of heat transfer fluid: Water

Area used for curve in m^2:

	LY-HPC10	LY-HPC30
Gross area (m^2)	1.58	4.52
Aperture area (m^2)	0.94	2.83
Absorber area (m^2)	0.81	2.43

The instantaneous efficiency is defined by:

$$\eta_{\text{hem}} = \frac{\dot{Q}}{A_G \cdot G}$$

Fluid flow rate used for the tests: kg/s

Second order fit to data:

$$\eta_{\text{hem}} = \eta_{0,\text{hem}} - a_1\left(\frac{\vartheta_m - \vartheta_a}{G}\right) - a_2 G\left(\frac{\vartheta_m - \vartheta_a}{G}\right)^2$$

Table 7 — Collector performance coefficients

Model LY-HPC10

	Based on Gross Area	Based on Aperture Area	Based on Absorber Area
$\eta_{o,hem}$	0.454	0.762	0.885
a_1	1.159	1.948	2.261
a_2	0.008	0.013	0.015

Model LY-HPC30

	Based on Gross Area	Based on Aperture Area	Based on Absorber Area
$\eta_{o,hem}$	0.472	0.754	0.878
a_1	1.236	1.975	2.300
a_2	0.006	0.010	0.011

Time constant (time constant is not test)

τc = --

Effective thermal capacity

C = J/K
Determination: --
Calculation: 5.45 kJ/(m^{2}K)
Indoors: --
Outdoors: --

Incident angle modifier (measured data in bold and derived in italic)

Model LY-HPC10

θ_L	*10°*	*20°*	*30°*	*40°*	*50°*	*60°*	*70°*	*80°*
$K_{\theta T}$	*1.04*	***1.07***	*1.19*	***1.30***	*1.37*	***1.43***	*0.95*	*0.48*
$K_{\theta L}$	*1.00*	*0.99*	*0.98*	*0.96*	***0.92***	*0.86*	*0.72*	*0.31*

Model LY-HPC30

θ_L	10°	20°	30°	40°	50°	60°	70°	80°
$K_{\theta T}$	*1.05*	***1.09***	*1.19*	*1.28*	***1.38***	***1.46***	*0.97*	*0.49*
$K_{\theta L}$	*1.00*	*0.99*	*0.99*	*0.97*	***0.95***	*0.91*	*0.83*	*0.57*

14.4 **Pressure drop measurements**

Pressure drop measured at five mass flow rates is reported according to Table 19.

Table 19 — Collector pressure drop record LY-HPC30)

Flow rate [L/s]	0.000	0.005	0.011	0.018	0.030	0.024
ΔP [Pa]	0	297	1329	3020	8220	5330

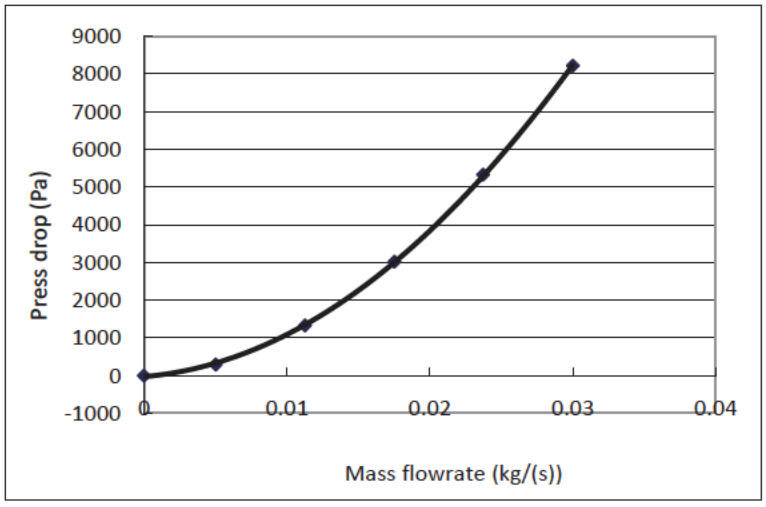


Fig.3 The press drop diagram of LY-HPC30

Annex 1

Terms and definitions

Symbol	Term	Unit
A_G	Gross area of collector	m^2
a_1	Heat loss coefficient at (ϑm - ϑa) = 0	$W/(m^2k)$
a_2	Temperature dependence of the heat loss coefficient	$W/(m^2 k^2)$
C	Effective thermal capacity of collector	J/K
G	Hemispherical solar irradiance	W/m^2
G_d	Diffuse solar irradiance	W/m^2
H	Hemispherical irradiation on the collector plane	MJ/m^2
$K_{\theta L}$	Incidence Angle Modifier along the coll. tubes or reflectors	--
$K_{\theta T}$	Incidence Angle Modifier perpendicular to collector tubes or reflectors	--
m	Thermally active mass of the collector	kg
Q	Useful power extracted from collector	W
T	Absolute temperature	k
T^*_m	Reduced temperature difference (= (ϑm – ϑa)/G)	m^2k/W
Δp	Pressure difference between fluidinlet and outlet	Pa
Δt	Time interval	s
ΔT	Fluid outlet and inlet (ϑe - ϑin)	K
η_{hem}	Collector efficiency, with reference to T*m, based on hemispherical irradiance G	-
$\eta_{0,hem}$	Peak collector efficiency, reference to T*m, based on hemispherical irradiance G	-
ϑ_a	Surrounding air temperature	oC
ϑ_m	Mean fluid temperature	oC
τ_c	Collector time constant	s

Annex 2

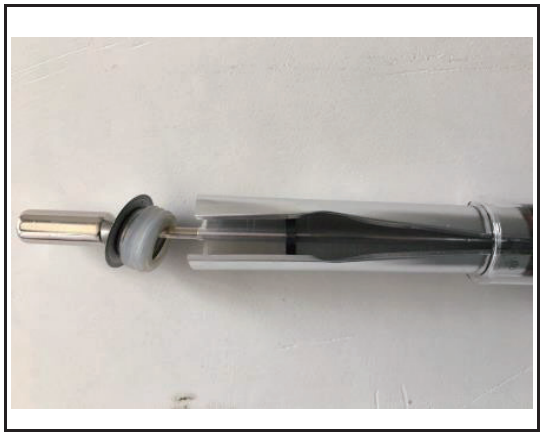
Measured data

Date	Time H:m	t_a (^{0}C)	t_{in} (^{0}C)	t_e (^{0}C)	m (L/min)	G (W/m^2)	G_d (W/m^2)	t_m (^{0}C)	Va m/s
LY-HPC10									
2017/12/20	12:58	18.23	14.71	20.63	1.852	1069	78	17.67	2.5
2017/12/20	13:08	18.18	14.71	20.68	1.839	1070	78	17.69	3.7
2017/12/20	13:18	18.39	14.71	20.61	1.867	1066	78	17.66	2.4
2017/12/20	13:28	18.45	14.70	20.59	1.871	1062	78	17.64	2.6
2017/12/21	10:25	14.95	39.85	44.81	1.886	1000	89	42.33	2.5
2017/12/21	10:35	15.31	39.95	45.05	1.884	995	90	42.50	3.7
2017/12/21	10:45	15.64	39.92	45.13	1.884	1030	92	42.53	3.4
2017/12/21	10:55	15.74	39.85	45.10	1.887	1031	89	42.47	2.4
2017/12/21	12:00	17.27	59.07	64.09	1.885	1056	73	61.58	2.6
2017/12/21	12:10	17.25	59.02	64.07	1.887	1056	72	61.54	3.7
2017/12/21	12:20	17.33	59.01	64.08	1.887	1057	73	61.55	3.0
2017/12/21	12:30	17.30	59.02	64.07	1.887	1055	72	61.55	3.0
2017/12/21	14:23	20.34	80.22	84.50	1.887	988	69	82.36	2.1
2017/12/21	14:33	20.43	80.23	84.50	1.892	983	67	82.36	3.4
2017/12/21	14:43	20.47	80.22	84.44	1.889	981	67	82.33	2.4
2017/12/21	14:53	20.65	80.24	84.44	1.892	982	68	82.34	3.4
LY-HPC30									
2017/12/21	11:42	17.40	14.13	20.12	5.438	1069	80	17.13	3.6
2017/12/21	11:52	17.15	14.17	20.18	5.445	1071	82	17.17	2.3
2017/12/21	12:02	17.35	14.23	20.23	5.449	1069	86	17.23	2.9
2017/12/21	12:12	17.25	14.22	20.24	5.440	1066	81	17.23	2.1
2017/12/20	13:47	18.44	38.59	44.21	5.442	1053	97	41.40	2.1
2017/12/20	13:57	18.91	38.58	44.20	5.443	1054	93	41.39	2.7
2017/12/20	14:07	18.65	38.54	44.17	5.441	1051	94	41.36	2.0
2017/12/20	14:17	18.97	38.58	44.19	5.439	1042	96	41.38	2.7
2017/12/20	11:40	17.28	60.58	65.74	5.438	1064	87	63.16	2.4
2017/12/20	11:50	17.39	60.63	65.87	5.443	1069	85	63.25	2.8
2017/12/20	12:00	17.10	60.66	65.94	5.439	1079	84	63.30	2.7
2017/12/20	12:10	17.86	60.66	66.01	5.435	1077	84	63.34	3.0
2017/12/20	10:00	16.13	82.77	87.41	5.437	1036	144	85.09	4.0
2017/12/20	10:10	15.88	82.75	87.37	5.439	1041	111	85.06	2.5
2017/12/20	10:20	15.86	82.78	87.42	5.435	1046	88	85.10	2.1
2017/12/20	10:30	15.68	82.79	87.45	5.437	1051	88	85.12	3.6

Annex 3

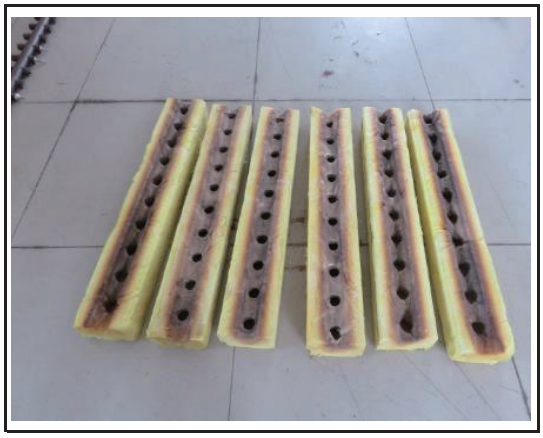
Photos

Performance Test



Heat Pipe

Hander



Insulation

Annex 4

Drawing

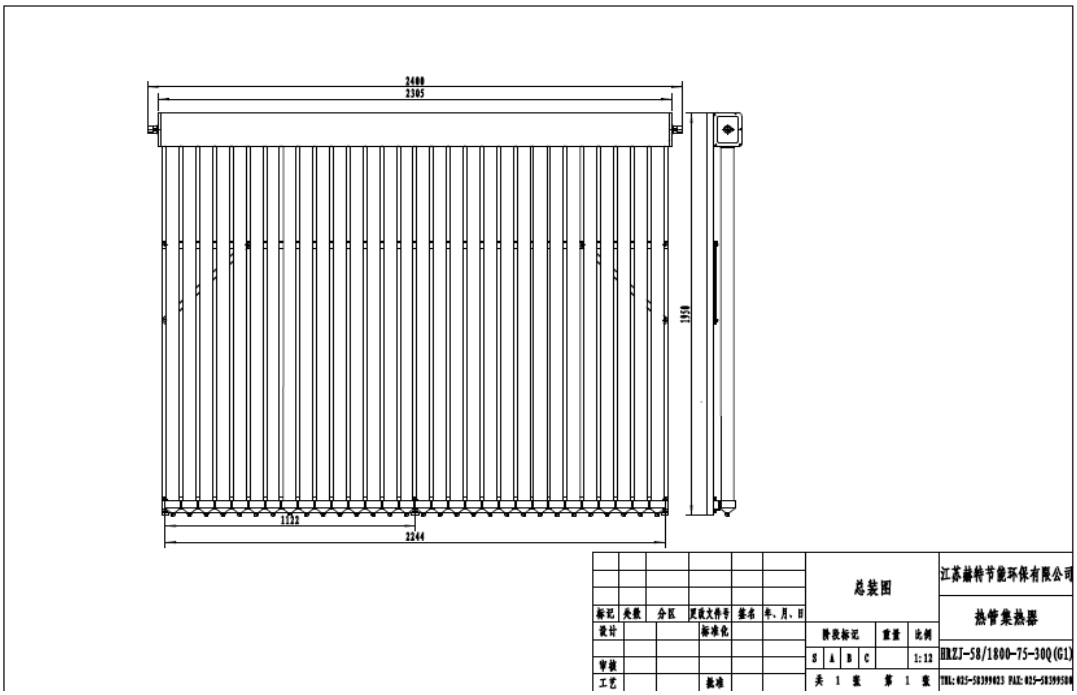


Fig. A4.1 General assembly drawing

Test Report

Report Number: 171031198GZU-001
Report Date: 2023/8/14

Approved by:

[redacted]

Name: Steve Zhu
Title: Reviewer

Prepared by:

[redacted]

Name: Jeskim Liu
Title: Project Engineer

Revision:

Revision No.	Date	Changes	Author	Reviewer
R1 (210621230GZU)	2021/7/9	Update the applicant address from "C14 No.9 Kechuang Raod, Liuhe District" to "C14 No. 9 Kechuang Road, Jiangbei New District."	Steve Zhu	Colin Xie
R2 (220507093GZU)	2022/5/25	Update the applicant address from "C14 No. 9 Kechuang Road, Jiangbei New District." to "No. 29 Ronghua Road, Chahe Town Laian county Chuzhou city ANHUI CHINA"	Jeskim Liu	Steve Zhu
R3 (230620092GZU)	2023/8/14	Add new models "LY-HPC15", "LY-HPC16", "LY-HPC25". Modified the pieture of Header in Annex 3.	Jeskim Liu	Steve Zhu

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The End of Report